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ABSTRACT BOOK

Energy, Resources, Environment and Sustainable Development in the Context of Carbon Peaking and Carbon Neutrality

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CONTENT

Keynote Speech

Assessment of the role of the state in the management of mineral resources

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Abstract: Mineral resources as natural capital can be transformed into human, social and physical capital that guarantees the sustainable development of a country exclusively through professional national management. Natural resources have historically played a significant role in the economic development of the most advanced countries. At the same time, most of underdeveloped countries have enormous mineral resources. Contracts of various forms between the state and the minerals developer, related to civil law acts, are faced with the problems of the sustainability of internal social relations. The governments of these countries are forced to tighten their influence over extractive companies by introducing social licences. The proposed model of public mineral policy as part of transnational management of mineral resources is based on a broad understanding of governance within the framework of the jurisdictional and sectoral capacity of the state. We have studied the effectiveness of country-specific government policies in regulating the mineral and mining market, as well as in managing the sustainable development of society, involving indigenous people in the mining process, and in assessing the ESG performance of specialised companies.

Green and low carbon building materials

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Abstract: Under the background of implementing the dual-carbon strategy, carbon emission in the construction field takes up significant portion of the total emission and is continuously rising year by year, which brings new challenges to the construction industry. In this presentation, the current situation and trend of carbon emission in global and Chinese construction industry, as well as energy consumption and carbon emission in the whole process of construction are firstly analyzed. Founded on such analysis, the leading technologies of carbon capture, utilization and storage are introduced, along with the latest key technologies relevant to green and low-carbon building materials recommended and introduced. These are provided to be candidate measures for coping with the challenges of carbon emission reduction and carbon neutralization in the construction industry.

Lunar mining ideas can transform earth mines

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Abstract: Mining on the Moon will provide oxygen, water, and building materials that enable the further exploration of space by humankind. The production of oxygen from lunar soil, called regolith, has received particular attention in recent years as it can be used both for life support and propellant for further missions. The overall flowsheet to produce oxygen from lunar regolith similar to that of metal production from a mined ore on Earth. The process flowsheets both include excavation and beneficiation of the regolith or ore to provide the feedstock for the chemical extraction of oxygen or metal.For example, hydrogen reduction of the lunar regolith produces oxygen by reduction of ilmenite. Lunar regolith contains less than a few percent ilmenite and must be upgraded first. Additionally, sizing to remove coarse and fine fractions is also required to control the feedstock into the reactor. Terrestrial mineral processing technologies will not work directly on the Moon, due to the low gravity, lack of atmosphere and, critically, the lack of water. Dry processing is the only viable route for regolith beneficiation. Electrostatic and magnetic beneficiation are of particular interest, as they does not require a process fluid and is enhanced by the absence of water. Furthermore, ilmenite is amenable to concentration using electrostatic methods, as is used for beach sands on Earth. In this presentation, we discuss the issues and potential for regolith beneficiation on the Moon. We look at the likely scale of lunar mining operations, and illustrate some of the sizing and beneficiation techniques required. In particular, we assess the potential for crossover of technologies and operational concepts into more sustainable terrestrial mining operations.

Driving the electric revolution-A pathway to net zero

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Abstract: To keep the global temperature rise below 1.5 degree, the CO2 emission must be strictly controlled as stated in the Paris agreement. Building a renewable energy dominant electric power system, the new electric revolution and significantly reducing the carbon emission in the electric power generation are all critical pathways to achieve carbon peak and carbon neutral (net zero carbon). In this talk, the pathways to achieve net zero will be reviewed, especially for enhancing the efficiency and reducing carbon emission in the full process of electric power generation, transmission, distribution and consumption. The opportunities and challenges related to the wider adoption of renewable energy will also be discussed. Furthermore, the power electronics based electric power system and its difference to conventional power systems will also be looked at, together with the adoption of energy storage and hydrogen systems.

Underground space use for sustainable urban development - The Singapore experience

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Abstract: The underground has been increasingly recognized as an important resource and part of the solutions to meet the needs for sustainable urban development. However, despite its promise and many benefits, the use of underground space has tended to be the last resort, due to high development cost and the complexities and challenges in its planning and development. Underground space development is complex because of the large size and budget of the development, the multi-disciplined nature of such projects, the long lead time in the planning and development, and the large number of and often diverse types of components or subsystems and stakeholders. The dynamic nature involving multiple time scales, which often outlive the technology cycle time, means that the requirements often change with geopolitical events and other economic and social development in society. Amidst such complexities, the task is often made even more difficult due to lack of long-term planning and coordination which results in high cost due to many constraints and construction in highly developed and congested urban settings. While the use of underground space in Singapore has been largely driven by resource constraints such as land space and water, there are many major benefits for sustainable urban development. In 2010, the Economic Strategies Committee of the Singapore government made developing underground space part of the government's long-term economic strategy with specific recommendations on master planning, geological investigations, investment in research and development, and addressing various legal and policy issues. With this, the use of underground space has been elevated to a strategic level and has become an economic imperative in resource-scarce Singapore. Based on the experience of Singapore, this presentation discusses the key sustainability issues and the important roles that underground space can play in responding to these issues. It gives an overview of underground space use, recent developments, and future perspectives in Singapore, discusses key challenges, and examines possible strategies and key lessons for optimum use of underground space as part of Singapore's sustainability efforts.
Keywords: Underground space; Sustainable development; Singapore

Topic 1: Resource Development and Utilization

The green mining technology integrating mining, separating, backfilling +X and its practices for deep coal resources

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Abstract: To meet the requirements for scientific exploitation and safe mining of deep coal resources, and ecological and environmental conservations of mining areas, an overall approach engaging an

integrated green mining technology covering mining, separating and backfilling etc. is proposed. The 'Mining, Separating, Backfilling + X' green mining technology, where 'X' stands for extensions and expansions of the former three elements, are developed to address the engineering challenges over safe and efficient coal mining, ground water conservation, and surface subsidence control etc. Key technical aspects of the technology are introduced, which include layouts of the system, ground control for workings with large sections, underground precise separating of unclassified run-of-mine coal, efficient and intelligent backfill mining, and quality monitoring over mining, separating, backfilling + X operations etc. Lastly, the performances of its field practices in Xin-Ju-Long and Ping-Ding-Shan No.12 coal mines are analyzed.

Study on ground subsidence rules in deep mining with giant-thick and weakly cemented overburden based on SBAS-InSAR

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Abstract: The surface subsidence induced by large-scale and high-intensity mining activities in western China poses a serious threat to the safety of various structures such as houses, roads, gas transmission lines, and the fragile ecological environment. In order to reveal the law of surface subsidence under deep mining with giant-thick and weakly cemented overburden in the west, this study takes Yingpanhao Coal Mine in Inner Mongolia as the test site, and uses SBAS-InSAR technology to obtain the time series of surface vertical displacement during the mining process of the 2401 working face. Based on the monitoring results, the spatial and temporal distribution characteristics of vertical displacements on the major cross-section along the advancing direction (MCAD) were analyzed with emphasis. It was found that under the non-sufficient mining condition, the surface settlement has the characteristics of small amount but extensive coverage. The subsidence curve on the MCAD is not symmetrical, but is divided into the west subsection, the east subsection and the east uplift section by the maximum subsidence point and the open cut eye. The settlement (W) of each point in the subsidence area linearly changes with the advancing length (L) of the working face, and has four types of change patterns. The functional expressions of each pattern and the empirical function of slope k are given. This study can provide reliable empirical information for further analysis of the elastic bearing capacity of giant-thick weakly cemented overburden, and useful references for accurate prediction of surface subsidence under deep mining in the western China.
Keywords: deep mining; weakly cemented overburden; mining subsidence; SBAS-InSAR

Influence of heterogeneous pore-fracture environment on the evolution of underground coal fire propagation based on multi-physical field coupling

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Abstract: The development of pores and fracture in coalfield fire area can promote the abnormal temperature, the greenhouse effect, and the release of toxic gases. It is of great significance to study the dynamic distribution characteristics of temperature field and concentration field of typical gas products in coalfield fire area under different pore-fracture environment for revealing the spreading law of underground coalfield fire. In this paper, the combined effect of coal combustion chemical reaction, heat energy transmission, flue gas seepage and pore-fracture development are considered. The evolution characteristics of the oxygen consumption, heat release rate and thermodynamic parameters of coal samples in coalfield fire area were obtained by thermogravimetric analysis. Taking Daquanhu coalfield fire area as an example, a three-dimensional unsteady model of coalfield fire area coupled with multiple physical fields was constructed based on the chemical reaction of coal combustion, convection heat transfer in fractures, heat transfer in porous media, gas seepage and improved partial differential equation of pore-fracture evolution. The evolution law of temperature field, CO_2, and CO concentration field in the coal field fire area under different air leakage and geological fracture conditions is analysed, and the influence mechanism of pore-fractures on coal fire spread and development is obtained.
Keywords: coalfield fire; pore-fracture environment; heat transfer; chemical reaction; multi-physical field coupling

Precursor prediction for early violent failure based on infrared radiation emissions for coal specimens under different loading rates

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Abstract: The early prediction of violent coal-bearing strata failure using effective monitoring is very crucial to avoid losses due to catastrophic failures and geological disasters to ensure safe and efficient underground deep coal mining. In this study, the early coal failure precursor was established by researching the application of Critical Slowing Down Theory (CSDT) using two Infrared Radiation (IR) indexes i.e., Variance IR Temperature (VIRT) and Variance of Differential Infrared Image Temperature (VDIIT) under different loading rates. The CSDT parameters: variance and autocorrelation, are evaluated using both indexes in different time window and lag step lengths. The test results revealed that the abrupt and significant fluctuations in variance and autocorrelation for both indexes occurred during rock deformation and before the violent damage. The autocorrelation comparatively shows an obvious reliable fluctuation due to stationarity (show no change in fluctuation before the inflection point), which can be used as a precursor for violent rock failure. It has been shown that the stress level of autocorrelation at the inflection point decreases inversely with the loading rate for both indexes. These stress levels for VIRT are 0.920, 0.890, 0.865, and 0.813 of the σ_{max} under the corresponding loading rates of 0.1, 0.4, 0.7, and 1 strain/s, respectively. For VDIIT, at loading rates of 0.1, 0.4, 0.7, and 1 strain/s the stress levels are 0.930, 0.892, 0.870, and 0.815 σ_{max}, respectively. Therefore, it has been recommended that the prediction performance of precursory characteristics of IR can be improved by applying the CSDT for an early prediction of rock failure.

Numerical investigation on stratum and surface deformation of underground phosphorite mining with different mining methods

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Abstract: With the ending of deep-concave open-pit phosphorite extractions and the gradual exhaustion of shallow mineral resources, phosphorite mines have entered or will enter into underground mining. Particularly for excavating slightly inclined thin and medium-thick phosphorite orebody, roof and surface deformation control under different mining methods is crucial for safe and effective exploitations. In this paper, taking the Kunyang Mine with slightly inclined thin and medium-thick phosphorite as the engineering background, based on the occurrence conditions, orebody thickness, dip angle, etc., the mining methods of underground phosphorite are selected, including the room and pillar method, the cement backfill method and the caving method. Numerical analysis on the roof deformation and surface subsidence under the three methods are conducted. The results show that the amount of roof and surface subsidence decreases successively by the caving method, the room and pillar method and the cement backfill method, and the maximum roof and surface subsidence by the caving method is 45.7 cm and 13.3 cm, respectively. Regarding shallow orebodies, the open-pit slope is obviously disturbed by the caving method and room and pillar method. Hence, slope displacement monitoring should be emphasized. Compared with the other two methods, the backfill mining method can use mineral waste as filling materials, but also it has less influence on roof and ground surface during excavations and is better at controlling the slope stability.
Keywords: phosphorite underground mining; roof deformation; surface subsidence; cement backfill mining; slope stability; different mining methods

Theoretical identification method of “vertical three zones” based on soft-hard overburden composite structure and its engineering application

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Abstract: Coal mining induces overburden damage which results in the formation of "three vertical zones" (i.e., the collapse zone, the fracture zone and the bending subsidence zone). The overburden generally migrates in the form of a rock group which comprises both lower hard rock that plays a bearing role and the upper soft rock. According to the key stratum theory and the fracture mechanics analysis, whether the broken rock strata can form a masonry beam structure and whether rock strata are broken are the key to distinguishing between the collapse zone and the fracture zone and between the fracture zone and the bending subsidence zone. In view of the above fact, in this study, the mechanical model under the critical condition of hard rock and soft rock breakage was established. Besides, the stability condition for the broken rock strata to form a masonry beam structure, as well as the bending deformation formula of soft rock and hard rock based on deflection, was deduced. Furthermore, a new theoretical identification method of "vertical three zones" based on soft-hard overburden composite structure was proposed. With reference to the specific mining geological conditions of the JX15101 longwall mining face, the results obtained by the proposed theoretical identification method, the numerical simulation results and the on-site measurement data were comparatively analyzed by means of borehole television observation, leaking liquid measurement and numerical simulation. Ultimately, the comparison successfully verified rationality and practicability of the proposed theoretical identification method.
Keywords: vertical three zones; soft-hard overburden composite structure; key stratum theory; theoretical identification method

A novel non-water fracturing method to enhance gas flow in coal

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Abstract: Coalbed methane is an important coal-associated resource, with abundant resource reserves and significant development and utilization value. Liquid nitrogen (LN_2) fracturing is an effective non-water technology for enhancing the gas flow in coal, which has a great prospect of application. Coal seam permeability is an important parameter for evaluating the recoverability of coal seams, while the permeability is mainly determined by the development of internal fractures. Considering the bituminous coal in the Xutuan Coal Mine of Anhui Province, China, the single and cyclic LN_2 fracturing experiments were carried out, and the evolution law of pore-fracture structure and permeability characteristics of coal samples were studied. Firstly, the mechanism of LN_2 fracturing was analyzed, and the feasibility and present situations of LN_2 fracturing technology were summarized. Secondly, the mineral composition of experimental coal samples was determined by X-ray diffraction and semi-quantitative analysis was performed. The mercury intrusion pore measurement and computerized tomography technology were used to quantitatively characterize the increasing changes of coal pores and fractures after LN_2 fracturing. The fractal geometry and pore network model were applied to analyze the fractal characteristics, distribution of spatiality and connectivity of micro-fractures. Finally, the seepage experiment was carried out by the Gas Flow and Displacement Testing Apparatus, which revealed the change law of coal permeability enhancement under single and cyclic LN_2 fracturing with different stress state.

Identification model of mine water bursting source based on multi-attribute data mining theory and its application

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Abstract: Due to coal resource starvation for Carboniferous-Permian Period in eastern-central China, the focus for coal mining has been gradually shifted to the Jurassic Coalfields in Ordos Basin, Midwest China. The roof of coal seam in Ordos Basin is weakly-cemented, in which the pores and fractures are widely developed, and with strong water abundance for aquifers in overlying strata, water inrush from roof often occurs. So how to accurately identify the water bursting source has always been an urgent problem in the field of preventing and controlling mine water disasters. Groundwater dynamic monitoring and hydrochemical characteristics suggest that when water inrush occurs, indicators such as water level, water inflow, water temperature and the ratios between characteristic elements usually show precursory abnormal changes. Taking the roof water inrush occurred in Guojiahe coal mine of Shanxi Province when the No. 3 coal seam (Jurassic Period) mining as the research background, water level, water inflow, water temperature, the ratios between characteristic macroelement, the ratios between characteristic trace elements and the ratios between characteristic stable isotopes are selected as identification indexes, datamining in the variation characteristics of precursory abnormal factors when water inrush occurs, and then the identification model based on rough set theory and unascertained measurement function, intelligent recognition model based on AWOA-ELM were constructed, besides, the contribution rates of each potential water source mixed in mine water bursting source were quantified, which provides a new

method for accurate identification of mine water bursting source.
Keywords: water bursting in mine; water source identification; unascertained measurement identification; intelligent recognition

Paradigm of ultra-deep injection and storage approach for reducing deep mine water surface drainage at coal mine areas

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Abstract: Mining activities inevitably produce enormous mine water drainage result in many problems in China's mine areas, such as poor water quality, high-cost water treatment, improper disposal approaches. This paper investigated the characteristics of mine water quality for seeking low-cost mine water treatment approaches and reducing deep mine water surface drainage (DMWSD). High concentration of conventional components is the main factor causing poor deep mine water quality, and the contents and proportions of toxic and harmful substances in mine water are lower than our imagination, more than 70% coal mines have better water quality than groundwater class III standard in China. We compared the differences between deep mine water quality and acid mine drainage (AMD) and pointed out the types of mine water that can be treated by ultra-deep injection and storage (UDIS), such as acidulous, alkalescent and high TDS types deep mine water. The technological framework of UDIS was established in this paper, and some technical and scientific questions of UDIS were proposed. Then the rationality, effectiveness and feasibility of UDIS technology were certified by a in situ UDIS project in Ordos Basin, China. Finally, we proposed some theory and technology bottlenecks of the UDIS approach. The UDIS technology will be of great significance to protecting water resources and sustainable environment of water dynamic, ecology and chemistry, and it provides a typical paradigm for reasonable DMWSD reduction at mine areas.
Keywords: deep mine water; water quality characteristics; ultra-deep injection and storage; surface drainage reduction

Mass transfer mechanisms for CO2 Storage and enhanced oil recovery in shale oil reservoirs

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Abstract: CO_2 injection in shale oil/gas reservoirs is a feasible method for CO_2 geological sequestration and enhanced oil recovery. However, the mass transfer mechanisms in inorganic pores and organic matter (kerogen) are still ambiguous. Thus, the mechanisms of diffusion and adsorption were experimentally and numerically investigated. A novel adsorption-diffusion model was proposed for mass transfer of CO_2 and oil in shale reservoirs. Mathematical models for hydrocarbon mass transfer in cylindrical shaped shale and limestone samples were derived. The predicted responses of the mathematical models closely matched the experimental data of CO_2 injection experiments performed on various shales and tight rocks under high pressure and high temperature conditions. Hydrocarbon recovery of shales shows a delayed effect compared to tight rocks due to the adsorption and diffusion in kerogen. Hydrocarbons were extracted out of the bulk kerogen and then diffused through the inorganic and organic pores. Hydrocarbon diffusion coefficients and mass transfer rate coefficients for shale samples were obtained by matching experiments and mathematical models. Hydrocarbon diffusion coefficients in limestone were obtained. Both diffusion coefficients and extraction rate coefficients decreased exponentially with carbon numbers. The extraction rate coefficients decreased exponentially because the diffusion coefficients of hydrocarbons in kerogen also decreased exponentially with carbon numbers. This research advances the mass transfer theories and promotes the CO_2 storage and enhanced oil recovery in shale formations.

Mechanism of water inrush in coal mines under stress-radial seepage coupling effect

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Abstract: Water inrush is a major threat for the coal mining safety in China. The study of mechanical and seepage characteristics of rock mass under stress-radial seepage coupling effect is an important

approach to exploring the formation of water-conducting pathway and the mechanism of water inrush disaster in coal mines. In this study, the radial seepage characteristics in the water inrush process were summarized first, and the radial erosion seepage tests of surrounding rock were carried out. Then, the radial water-rock-sand three-phase flow model was established to simulate the water-sediment inrush disasters in coal mines. After this, the creep-erosion coupling properties of weakly-cemented rock mass in coal mining was analyzed by the laboratory test. Finally, the radial seepage disaster mechanism of the surrounding rock was revealed. The main innovations and results are as follows: (1) The erosion seepage was divided into four stages: rapid growth, decelerated growth, slow growth and stable seepage, and the temporal-spatial evolution of the porosity of the surrounding rock was obtained. (2) By numerical simulation, the temporal-spatial evolution of the radial water-rock-sand three-phase flow characteristics (e.g., porosity, rock particle concentration, sand particle concentration, flow velocity, permeability and water pressure, etc.) was obtained. (3) By designing a novel creep-erosion coupling tests system, the synchronous loading of axial compression and radial erosion was realized. And the influence law of different factors on the water inrush characteristics was analyzed based on the creep-erosion coupling test results. (4) A permeability catastrophe characterization model of surrounding rock was established and verified, and the permeability rapid increase stage was regarded as the critical stage in water inrush disaster control.

A mine water hazard in China-Water inrush accompanied by strong mine pressure and sediment crushing

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Abstract: Mine water inrush accompanied by strong mine pressure and sediment crushing frequently occurs in northwest China. As the direct hydraulic resource and pathway of this water inrush, which are induced by mining activity, cannot be explored directly using borehole and geophysical prospecting prior to mining, it is extremely difficult to assess and predict the complex water hazard effectively. Recently, it has caused serious casualties and property damage. In this study, in-situ monitoring tests, simulations and theoretical analysis were performed to explore the evolution mechanism and prediction method of the destructive mine water hazard. First, water leakage, borehole video capture, water level of Cretaceous aquifer, mine pressure, micro-seismic monitoring were performed to study the strata structure evolution, fracture characteristics, and ground water seepage of overburden under longwall mining. Based on the overburden conditions, physical and numerical simulation are conducted to explore the evolution mechanism of water inrush accompanied by strong mine pressure and sediment crushing. Further, mechanical and statistical analysis was adopted for the effective prediction method and controlling technology. Results show that the direct water resource is from the mining-induced closed separation layers near confined aquifer. The evolution process of severe water inrush from separation layers involves the formation of closed separation layers, collection of water from confined aquifer, fracture of water-resisting layer. The buckling failure of high-level strata causes the strong mine pressure, and the weak cemented Jurassic strata leads to the sand crashing. On the basis of the formation conditions of water inrush accompanied by strong mine pressure and sediment crushing, some prevention methods, including risk zoning of mine areas, strata prediction indicators, indexes warning system, and drainage borehole from separation layers, are proposed to systematically predict and control the destructive mining-induced water hazard.
Keywords: mine water inrush; separation layers; overburden behavior; evolution mechanism; prevention methods

Strength and microstructural evolution of fly ash-based paste backfill activated by CO_2 and silicate additive

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Abstract: Backfill coal mining is a promising approach to mitigate the movement of the overburden. Industrial waste such as fly ash has been added to improve its economic viability, but the strength of the paste backfill diminishes. This study then aims at enhancing the strength of the backfill material using silicate additive and CO_2. The backfill material is formulated with 90% fly ash and 10% cement. The results show that the strength of the paste backfill is more pronounced by the co-activation of silicate additive and CO_2, where the strength is doubled after 28 days of curing. Furthermore, the setting time is also accelerated that shortens waiting sequence in backfill operation. Silicate additive and CO_2 reaction induce a denser paste backfill by higher C-S-A-H and silica gels and carbonate product. These findings could lower the material cost in backfill mining.

Keywords: cemented paste backfill; fly ash; silicate additive; CO_2; strength

Study on the pH of the brine based on prediction model in the process of mine water treatment project

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Abstract: Mine water reuse technology takes the coal mine drainage water as water source, then reuses treated waste water for the power plant water system via technical reform and innovation process. In this technique, the fresh water demand can be greatly reduced, thus it is considered as an important approach to solve the power plant water resources scarcity. The further water treatment is crucial to the coal mine water reuse project for power plants. Due to the high salinity of brine, the pipe scaling and corrosion problems accrue constantly at high operating temperatures. Therefore, the research on *p*H values of the high salinity brine water is essential for studding the acidification of pipe lines during the mine water reuse project. In this paper, the *p*H values at a temperature from 298 to 373 K for $MgCl_2$ and $CaCl_2$ solutions with molalitis ranging from 1 to 4 mol/kg were predicted via the geochemical simulator PHREEQC (version3.7.1) based on the Pitzer activity-coefficient model with parameters taken from the literature. This study observes the *p*H values of the brine change into an acidic condition when calibrated with HCl (0.01 mol/kg) and an alkaline condition when calibrated with CO_3^{2-} and HCO_3^- (0.0025 mol/kg). In the acidic condition, the pH of solution increases with increasing temperature and decreases with increasing concentration. In the alkaline condition, the *p*H of solution decreases with increasing temperature and decreases with increasing concentration.
Keywords: mine water reuse; Pitzer model; pH; magnesium chloride; calcium chloride

The evolution mechanism of sulfur atoms during the coalification process

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Abstract: The process of organic matter burial and coalification, which restrict the distribution of organic sulfur in macromolecular structure of coal, leads to different occurrence of organic sulfur. The genetic relationship between the compose of organic sulfur and coalification have been studied by using X-ray Photoelectron Spectroscopy (XPS) in Southern Guizhou coal of Permian Longtan Formation and the calculation method of bond dissociation enthalpies (BDE) of three type sulfur functional group. The result of BDE reflects that ph-S-ph (247.89 kJ/mol) < ph-SH (312.94 KJ/mol) < thiophene (332.93 KJ/mol). Therefore, the thermal stability of C-S bond in sulfur-containing functional groups is thioether < mercaptan < thiophene. The XPS spectrum of the coal samples in the middle and lower layers of Longtan Formation shows that the sulfur-containing organic functional groups are mainly mercaptan sulfur, differed from Marine coal HNP sample that is mainly in thiophene. With the increase of 0.3% Ro, mercaptan increased as well. Combined with the calculate of BDE, it is speculated that bridge bond (thioether) would crack into edge bond (mercaptan), but sulfur atoms of mercaptan could close to carbon and generate C-S Π bond (thiophene), or C-S bond dissociate, contributing to sulfur containing gas.
Keywords: organic sulphur; coalification; bond dissociation enthalpies; XPS

Research progress on hydrogen production mechanism of macromolecular pyrolysis of low rank coal

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Abstract: The research on the mechanism of macromolecular cracking of low rank coal to produce hydrogen is of great significance to improve energy efficiency and transform coal into clean energy. At home and abroad, the coal pyrolysis process, influencing factors, molecular dynamics mechanism and hydrogen generation mechanism have been studied to varying degrees. However, there are few systematic studies on low-rank coal pyrolysis for hydrogen production from the perspectives of macromolecular structure composition, micro-component diversification, geological genesis and geological resources of low-rank coal. By analyzing the relevant research progress at home and abroad, I believe that attention should be paid to the mechanism of low-rank coal pyrolysis macromolecular cracking to produce hydrogen. In particular, the evolution law and mechanism of macromolecular structure of low-rank coal under the

condition of hydrogen production. Clarify the macromolecular structure of coal, kinetics of hydrogen production, and hydrogen conversion pathways. This can provide key theoretical support for improving the efficiency and quality of hydrogen production.
Keywords: low rank coal; hydrogen production by pyrolysis; molecular structure evolution; molecular action; activation energy of reaction

Intelligent design of cemented paste backfill in mining engineering

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Abstract: Mining is one of the main solid waste generator sectors around the world. Due to increased environmental concerns and recently introduced United Nation Sustainable development goals (UNSDGs) mining industry has been looking for the solutions for tailing management. Therefore, the number of underground mines using cemented paste backfill (CPB) to store tailing in underground rather than surface tailing dams has been increasing. The main expectations from CPB are the strength that needs to be gained time determined by my planning engineers to provide safe working conditions and workability to be able to pipe the paste to any desired location in the mine. The main design parameters required for obtaining CPB with desired properties are cement to tailing ratio and solid content. Traditionally these are obtained by time and resource consuming trial-and-error process. Therefore, many of research articles published recently focusing on the model development for the prediction of strength and workability based on these key parameters to save time and resources. However, there are limited number of research, focusing on mathematical optimisation using constructed models. The purpose of this paper is to develop an algorithm giving the best possible design parameters to minimise the amount of cement while achieving multiple objectives such as strength in a desired time and workability considering different conditions such as physical properties of tailings.
Keywords: cemented paste backfill; machine learning; multiple objectives optimization

Frequency-dependent attenuation and dispersion caused by fractures at microscopic and mesoscopic scales: Three-dimensional numerical study

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Abstract: In the context of carbon peaking and carbon neutrality, coalbed methane (CBM), as clean energy, is of interest due to its huge reserves around the world. Fractures are both the reservoir and the transport channel of CBM. Therefore, seismic exploration of fractures is of great significance. In the case of coal seams fluid flow in mesoscale fractures is arguably the main cause of intrinsic seismic attenuation across the entire exploration seismic and acoustic frequency range. However, its quantitative analysis is complicated by the fact that the coal seam matrix is frequency dependent. The reason for this is the presence of microscopic heterogeneity, such as microcracks or broken particle contacts, resulting in the so-called modified dry frame stiffness being complex-valued and frequency-dependent, which in turn may affect the viscoelastic response to mesoscale fractures where fluid flow. In this work, we present a 3D numerical model consisting of fractures embedded in a solid matrix containing a series of microcracks. The frequency-dependent effective stiffness is obtained from the numerical modeling, and the dispersion and attenuation are derived therefrom. Furthermore, the numerical results are compared with the published analytical solutions related and analyse the impact of their assumptions. Two important areas for improvement in the analytical solution are finally obtained: the calculation of the frame stiffness modulus and the frequency dependence of mid-frequency attenuation and dispersion.
Keywords: coalbed methane; fractures; dual-scales; dispersion; attenuation; 3d numerical model

Nanostructure and oxidation activity of exhaust particulate matter from diesel engines using coal-based fuels

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Abstract: Both Fisher-Tropsch (F-T) diesel and methanol can be made from coal, which can be called coal-based fuels. The use of coal-based fuels can increase coal utilization and promote the diversified development of diesel fuel. The tests fuel used in the study was mixtures of F-T diesel and methanol in different proportions, where the volume fraction of methanol was 0%, 5%, 10%, and 15%, respectively. In order to study the nanostructure and oxidation reactivity of particulate matter in diesel engines using these four coal-based fuels, exhaust particles of diesel engines were collected under calibration conditions, and the particulate samples were analyzed by high-resolution transmission electron microscopy (HRTEM) and thermogravimetric analyzer (TGA). The results showed that exhaust particulate matter had a shorter fringe length (L_a), wider separation distance (d), and larger fringe tortuosity (T_f) with the increase of methanol volume ratio. It was also found out that the addition of methanol increased the amount of soluble organic matter on the surface of the particles and decreased the temperature of the particles burning at the maximum weight loss rate, the temperature at which the particles is completely oxidized, and the apparent reactive energy (E_a) of the particles. The blending of methanol reduced the graphitization degree, increased the disorder degree of the particulate matter, and contributed to the oxidation of particles. These results illustrated that the use of methanol has a great influence on the physical and chemical properties of the exhaust particulate matter, which will be significant for the improvement of diesel engine after-treatment technology.
Keywords: diesel engine; coal-based fuels; exhaust particulate matter; nanostructure; oxidative reactivity

The three-zones division and evolution mechanism of water quality in the mining area of Northwest China

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Abstract: Coal mining is bound to produce a large amount of mine water and may cause water environmental pollution problems. The formation and evolution mechanism of mine water quality is the theoretical basis for water pollution prevention and control in coal mining areas. Almost all the coal fields in northwest China are located in arid-semi-arid areas, with severe water shortage on the surface and fragile ecological environment, and their mine water is characterized by high TDS(Total dissolved solids), high suspension, rich in sulfate and sodium ions. In this study, we proposed the “three zones” model of mine water quality formation in mining area of northwest China according to the influence of coal mining activities, which are the initial zone, the mixed zone, and the water retention zone, and considered the third zone as the most critical area for mine water quality formation. And we selected a mine mining area in the Ordos coal-bearing basin in northwest China as the study area, and carried out indoor physical model simulation and sampling monitoring of the water retention zone. The research results shows that from the perspective of the whole life cycle of the mine, the evolution of water quality in the mine area is divided into three stages: initial-deterioration stage, balance stage and self-purification stage, and the water quality evolution mechanism is closely related to the provenance characteristics, anoxic or aerobic environment, microbial activities, etc. This study provides a new idea for mine water treatment technology with high salt and high salinity in the mining area of Northwest China and also provides theoretical support for safe and green coal mining and water ecological environmental protection in this region.
Keywords: mining area of Northwest China; mine water; three-zones of water quality; evolution mechanism of water quality; micro-organism

Effects of coalification on nano-micron scale pore development: From bituminous to semi-anthracite

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Abstract: Surface atom functionalization and the variation of aliphatic/aromatic structures within coal macromolecules are key factors to determine the pore structures within coalification. Here, the characteristics of nano-micron scale pore structures in coal were analyzed with the aid of coupled fluid intrusion and molecular probe technologies. Results indicate that the cleavage of long-chain aliphatic structures enhances the size of the pore throat and reduces the specific surface area (SSA) and pore volume (PV) of the mesopores (2-50 nm) when the third coalification jump occurs. Macropores (>50 nm) were slightly impacted by coalification and their development was primarily controlled by the diagenesis process, where macropores are gradually compacted and transformed into mesopores. Micropores (<2 nm) overall increase with the enhancement of aromatization and condensation polymerization, however, in the stage of low volatile bituminous, the blocking of minerals or low boiling hydrocarbon solids will temporarily reduce micropores. Meanwhile, similar surface structures and functional groups lead to similar characteristics of pore size distribution for mesopores and micropores. Furthermore, the peak

value of microporous PV migrates to the smaller pore size and pore of <0.4 nm in size generated from clearances among the aromatic layers gradually becomes dominant with the enhancement of condensation polymerization reaction. Results of fractal theories show that coalification has no effect on the fractal dimension (Df1) of macropores while a positive effect was discovered on Dv2 of mesopores and Dm of micropores. The heterogeneity and surface roughness of micropores and mesopores are controlled by coalification. Dv1 of mesopores is affected by diagenesis. Molecular probe analysis for atoms of pore walls suggests that the pore walls are contributed by aliphatic structures before the third coalification jump. Moreover, micropores among aliphatic structures developed relatively independently and small-scale pore networks frequently exist within them. With the enhancement of coalification accompanied by the cleavage of aliphatic structures, the aliphatic structures around the pore walls will be gradually replaced by the aromatic structure. Micropores of relative independence are decreased, and large-scale pore networks are gradually formed. Furthermore, the pore morphology developed more complex and strongly heterogeneous. High-density oxygen/nitrogen/sulfur functionalization will increase the micropores.
Keywords: fluid intrusion; molecular probe; coalification; chemical structure; pore structure; pore walls

Climate protection as a means to secure resources after the Russia-Ukraine War

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Abstract: Climate protection is also threatened by the Russia-Ukraine war, namely as a consequence of the resulting gaps in the supply of raw materials, which are needed for e.g. lithium-ion batteries. This war must therefore be a starting signal both for international access regulations for raw materials and for a global view of the security of supply with raw materials. In this respect, these are necessary elements of the climate protection requirement under Article 20a of the German Constitutional Law.
Keywords: raw materials; climate change; lithium; lithium batteries; e-mobility; international rules concerning raw materials; Russian-Ukrainian War

Adsorption behavior and mechanism of CO_2 in Longmaxi shale gas reservoir

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Abstract: Shale gas reservoir is a potential sequestration space of excess CO_2 in the atmosphere. This work clarified CO_2 adsorption behavior in Longmaxi shale, and Langmuir, BET (Brunauer-Emmett-Teller), DA (Dubinin-Astakhov), and DR (Dubinin-Radushkevitvh) models presented highly applicable on the fitting process of CO_2 adsorption experimental data. Micropore filling theory was the best model for CO_2 adsorption in the shale samples with the highest average R2 (goodness of fit) value, higher than that of monolayer adsorption and multi-layer adsorption theories, which was controlled by the widely developed micropores. Specifically, micropore filling adsorption mainly occurred in micropores, including the closed end of slit pores, capillary pores, and ink-shaped pores. Molecular layer adsorption mainly occurred in mesopores and macropores, including the open end of slit pores, plate pores, capillary pores, and ink-shaped pores. Slit pores are mostly intergranular pores, plate pores are mostly interlayer pores (intragranular pores) of clay minerals and microfractures, capillary pores are mostly intergranular pores, and ink-shaped pores are mostly organic matter pores. Besides, the prediction model of CO_2 storage quantity in deep shale gas reservoirs of China was established, calculated that 91.5 - 388.89 × 1012 m3 of CO_2 could be sealed in adsorbed state in theory, and CO_2 was mostly sealed by adsorbed state (higher than 95%) and free state with a good security and low leakage risk.
Keywords: CO_2 adsorption; Isothermal adsorption model; CO_2 sequestration; Longmaxi shale

Transformation of the geological environment during the opening of an array of rocks

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Abstract: The modern realities of mining in conditions of increasing scarcity of non-renewable resources have predetermined the need to develop deposits in difficult climatic, geological and structural conditions with a significant depth of mineral deposits. An urgent task in the design of quarries is to determine the optimal parameters of the slopes of the sides and ledges. The accuracy of calculations largely depends on the factors of engineering and geological conditions, underestimation of which will necessarily lead to the transformation of the geological environment, which will result in the manifestation of dangerous engineering and geological processes: landslides, rockfalls, landslides, subsidence, and filtration deformations. Today it is important to understand the dynamics of the transformation of the geological environment in the process of field development, even at the early stages of the study of mineral deposits, in order to develop measures to manage the stability of the structural elements of the quarry.
Keywords: engineering-geological conditions; mineral deposits; dynamics of engineering-geological processes

Engineering safety application of TEM in monitoring grout diffusion in the mined-out area of coal mine

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Abstract: At present, in the process of grouting mine-out area in coal mine, there exist some practical problems, such as leakage of slurry, which endangers engineering safety. Monitoring the diffusion range of grout is an important research direction in coal mining. TEM is a time-domain electrical exploration method, which has the characteristics of high electrical resolution, strong environmental adaptability, strong penetration of high resistance layer, small interference effect and high working efficiency. It has good exploration effect in mined-out area and karst. By TEM, the electrical property and scale of the underground geological body are determined according to the analysis of its attenuation characteristics. Therefore, the Caojiatan mine goaf project used TEM to analyze and compare the exploration results before and after grouting, conformed the downstream and upstream diffusion ranges of grout are 150 m and 100 m, respectively, and the height of grout accumulation is 1005 m. It provides a powerful guarantee for the safety production of coal mines.
Keywords: TEM; mine-out area; coal mine; monitoring grout diffusion; engineering safety

The potential of foamed backfilling in underground mines

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Abstract: Backfilling is the process whereby waste material (generally metallurgical tailings or prepared aggregate) is placed back underground into open mine workings (stopes). Backfill is typically used for the following applications: as a working platform, an artificial roof, a stope/void filler, an artificial sidewall, a pillar replacement and to limit surface subsidence and adverse damage to water. The most common methods are as a slurry or as a paste. Slurry filling has many transport advantages but has poor post filling performance. Paste filling has high transportation pressures so often needs pumps but has generally good performance once placed. Foamed backfills however have the potential to offer transport advantages and good post placement performance. The main advantage of using foam in backfill is to transport the backfill with low pressure losses then defoam the backfill so it is effectively placed with even less water than in a paste. If the placed backfill does not defoam under its own weight, then a defoaming agent (e.g. diesel) should be added otherwise the placed density is low and this adversely affects the backfill performance (especially if it is also cemented). This paper discusses the potential and gives some examples where foams have been used for underground filling applications.
Keywords: mine backfilling; foamed backfill; rheology; defoaming; case studies

Challenges and technological advances with deep block and panel caving mining operations

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Abstract: Climate emergency is forcing global ecoomies to switch to renewable energies, and electrification plays a critical role in accomplishing such a transition. Copper, which is the most important electric mineral, will be in high demands over the next decades. Underground caving mining operations have been contributing a large trunk of primary copper production. With depletion of shallower and richer resources, the block and panel caving operations are progressing to deeper and lower grade ores with massive caves and large footprints to maintain production levels. As getting deeper, the challenges, such as rock bursts, weak and fractured rock mass, fine fragmentation, high in-situ and induced stresses, air blasts, uncertainties over loss and dilution, and seismicity, which the mines had in the past, will only be incremented. This article examines the risks associated with the deepening super caves with specific field cases being reviewed; the existing measures to address the problems are also summarized through examining the best practices; last but not least, technological research endeavors needed to realize safe, efficient and economic deep block and panel caving operations are proposed.
Keywords: cave mines; block caving; panel caving; rock bursts; high stresses

Zoning evaluation of rockburst risk based on fuzzy analytic hierarchy process in Gaojiapu coal mine, China

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Abstract: The zoning evaluation of rockburst risk is an important basis for mine construction and pressure relief design. Taking Gaojiapu coal mine in Binchang mining area of Shaanxi Province, China as the study area, this paper quantified the complex geological structure based on the Fractal theory and established the zoning evaluation model of mining area rockburst risk index based on three conditions: the distribution characteristics of in-situ stress field, the distribution of geological structure and the sedimentary environment of coal seam overburden, combined with Fuzzy Analytic Hierarchy Process (FAHP). A new method for zoning evaluation of rockburst risk in coal mine was being proposed, and the rockburst risk in the study area was being evaluated. The first mining area of Gaojiapu coal mine was selected as the verification area of the evaluation method to verify the accuracy and rationality of the zoning evaluation results of the new method. In addition, according to the risk evaluation results of rockburst, the corresponding targeted measures were being put forward. This method can provide a basic basis and guidance for coal mine safety production and anti-scour and pressure relief design.
Keywords: rockburst; zoning evaluation; Gaojiapu coal mine; fuzzy analytic hierarchy process

Theoretical proposition and development strategy choice of China's coal mining in the new era

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Abstract: Traditional energy system now facing fundamental changes in the context of carbon neutrality, while China's energy demand still on the rise, how to determine a reasonable scale of coal mining and sustainable mining methods has become an urgent issue to be resolved. Taking the unbalanced situation in coal mining and utilization as the starting point, we put forward the theoretical proposition with China's characteristics in the new era, and give the strategic choice of the development of coal industry by comprehensively weighing the analysis and judgment of economics and sociology. The results show that: (1) Though the coal mining and utilization have made great contributions to the world economic growth, the tremendous price of resources and environment pollutions was paid. Entering the new era, China's coal mining shows the imbalance of resource production breaking through the "scientific boundary line", mining area environment approaching the "ecological bottom line" and coal mine accidents crossing the "main line of harmony". (2) According to the theoretical proposition analysis, the unbalance of coal mining in China is mainly caused by management failure and market failure. On the basis, three types of coal mining are distinguished, i.e., the optimal contributive mining in the process of economic growth, risky mining that caused by market failure, and disastrous mining caused by excessive government intervention and exclusion of market mechanism. (3) For the development strategy selection, we suggest that the primary mission is to eliminate catastrophic mining as soon as possible through the reform of property rights system and innovation of management system and mechanism. In addition, we also should focus on increasing the investment of science and technology in the coal industry to improve the safety of risky coal mining and provide safe and stable energy security for the economic development. The research results in this study will provide a newly theoretical basis and decision-making reference to innovate energy policies, achieve contributive mining and reduce coal mining imbalance in China's new era.

Keywords: economic transition; coal mining; theoretical proposition; strategic choice; China

Systematic ecological detriment and restoration methods of open-pit mining in the cold steppe area

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Abstract: The coordination of energy security and efficient development and ecological environment protection in large open-pit coal mine area is not only the basis of regional economic, environmental development and energy security, but also the key to the sustainable development of mining area. Aiming at the problems of energy development and environmental protection of large open-pit coal mines in the cold grassland area of eastern Inner Mongolia, the effects of open-pit coal mining on water, soil, vegetation, landscape and ecological stability were systematically studied; the concept of "source reduction and system restoration" is put forward. Taking systematic ecological reduction as the main line, technologies such as source reduction of mining technology, loss control during stratum reconstruction, quality and capacity improvement of topsoil, plant microbial drought resistance and growth promotion, landscape reconstruction imitating natural landform, water resource utilization guarantee of ecological restoration in mining area are developed, The ecosystem loss reduction and collaborative restoration technology system and application mode of large open-pit mining drainage recovery integration and multi factor coordination have been established, and good application demonstration has been carried out in Baorixile open-pit Coal Mine and Shengli energy open-pit Coal Mine in typical cold grassland mining areas, which provides a systematic solution to the ecological problems caused by open-pit mining in ecologically fragile areas in China.
Keywords: cold steppe area; systemic ecological impairment; source impairment of mining technology; process loss control; multi-element system restoration; integrated demonstration

Study on the acoustic characteristics of tectonically deformed coal in Huaibei Coalfield

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Abstract: Tectonically deformed coal (TDC) is closely related to gas outbursts. Since TDC exploration is an essential objective for coalfield exploration, it is of great significance to study the petrophysical properties of TDC. In this study, 17 samples of different types of TDC from the Huaibei coalfield were collected, and ultrasonic testing was used to measure their petrophysical parameters, including P- and S-wave velocities and their derived petrophysical parameters (VP/VS, P-wave impedance, and S-wave impedance). Undeformed coal and TDCs with different deformation types (Brittle, Shear, and Plastic deformations) show significant differences in their petrophysical parameters, and one can differentiate them with cross-plot analysis. Therefore, the changes in petrophysical parameters are good indicators to determine the type of coal deformation. However, the TDCs with the same deformation type have similar petrophysical parameters; it is not easy to distinguish them. Instead of direct classification, TDCs can be classified into at least five types with high accuracy using principal component analysis and cluster analysis. The research results can provide physical parameter guidance for the geophysical exploration of TDCs.
Keywords: tectonically deformed coal; ultrasonic testing; petrophysical parameters; clustering classification; principal component analysis.

Research on the initiation pressure criterion of directional hydraulic fracturing in coal mine

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Abstract: Directional hydraulic fracturing (DHF) is more and more widely used in coal mines in China

for hard roof and rock/coal burst control. The key to success of this technology is the initial pressure of the fracturing fluid that affected by the shape of the artificial notch and the stress state around the fracturing hole. Reasonable and simple formula for fracturing pressure calculation is essential since the fracturing bump used in coal mines is usually limited by the harsh conditions and hardly replaced once determined. Based on superposition principle in elasticity, the simplified 2D model of DHF was established as the elliptical hole with the internal water pressure in the in-site stress and solved by using the complex functions method. The analytical solution of tangential stress on the inner surface was obtained meanwhile the corresponding criterion of fracturing pressure can be set up. Considering the characteristics of DHF in coal mines, we further got a simplified formula that controlled by the ratio of major to minor axis of the ellipse-like notch, the ratio of the minimum to the maximum principal stress, as well as the tensile strength of the rock. The formula also gave a guide to the design of the notch that major diameter should be at least twice the minor diameter, and the optimal solution for the ratio is to 2～4 and recommended 4, which can resist the initiation pressure to a large extent affected by the in-situ stress. Once the pressure of the fracturing fluid is high enough to satisfy the equation in the paper a crack would arise at the tips of the notch along the major axis which belongs to mode Ⅰ crack and would grow unsteadily and rapidly. A PFC simulation model was used to verify the analysis, the results of which are very consistent with the theoretical solutions.

Keywords: directional hydraulic fracturing; rockburst; initiation pressure; notch

Predicting the floor failure depth based on a multiple regression model and Information entropy in the North China type coalfield

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Abstract: North China type coalfield mining area is threatened by water inrush from floor aquifer. Accurately predicting the depth of floor failure is the key to control the water damage in this type of coalfield. Field floor failure depth data were collected from 20 working faces of 10 mining areas in the North China type coalfield. A fitting formula was obtained by a multiple regression model and the weight of each factor was calculated by information entropy theory, allowing a prediction of the floor failure depth in the area. Compared with the prediction formula proposed by predecessors and the three empirical formulas recommended in the regulations, the predicted value obtained by this formula is closer to the measured value, and the average relative error is only 8.4%. Finally, the method is applied to 8 working faces of 4 coal mines in North China, and good application results are obtained, which verifies the universal applicability of the method in North China coal field. The local sensitivity analysis of each factor in the model is carried out. The sensitivity of each influencing factor is the inclined length of the working face, mining depth, mining thickness and coal seam inclination in turn. The results indicate that this method has high accuracy in predicting the floor failure depth of working face in North China Coalfield, and can provide a reference for the calculation of floor failure depth of working face in North China coalfield. In engineering practice, the damage depth of mining floor and the space-time state of the damage zone can be obtained through the microseismic monitoring method of underground wired and ground wireless clock synchronization, which provides strong technical support for the prevention and control of floor water inrush disaster.

Keywords: floor failure depth; nonlinear multiple regression; information entropy

Control of floor heave in soft rock roadway in the western mining area of China: A case study

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Abstract: The deformation of soft rock roadway caused by floor heave is a major challenge for coal mines in China western mining area. The modification of floor and effective support is a key point. To effectively control floor heave of soft rock roadway, this work considered the headgate at panel 11505 of the Yushujing Coal Mine as a case study. First, based on slip line field theory and limit equilibrium method, the model of floor heave in soft rock roadway was established, considering the deformation and stress characteristics of roadway, the mechanism of floor heave control was analyzed, and an optimized support method was proposed. Then, FLAC software was used to study the displacement, stress and failure zones of the surrounding rock with the original and optimized support. Finally, the feasibility of the support method was verified by field application. The results showed that floor heave is the main form of soft rock roadway

deformation, and 500 mm is the most reasonable among the tested thicknesses of the inverted arch. The numerical simulation was consistent with the theoretical calculation of the failure zone. The extrusion failure zone and shear failure zone were mainly affected by tensile and shear failure, respectively. The maximum convergences of the floor heave determined by numerical simulation and field measurement were 220 mm and 240 mm, respectively, which were reduced by 55% and 60% from those with the original support, and the convergence of both sidewalls decreased considerably. The optimized support method control the floor heave well. To provide reference for the control of floor heave of soft rock roadways in the Yushujing Coal Mine and the western mining area of China.
Keywords: soft rock; floor heave; mechanical model; control mechanism; optimized support

Application of long-distance power supply liquid in gangue filling working face

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Abstract: The waste filling working face can effectively solve the problem of Environmental Protection of waste rock produced in the production process of coal mine, the safety problem caused by frequent pulling and shifting equipment trains can be effectively solved by using the way of long-distance power supply and liquid distribution. Taking the successful application of long-distance power supply and liquid supply in CT201 gangue filling working face in Zhongtian Hechuang coal mine as an example, the total voltage drop at the start of the maximum power equipment in the working face is calculated, the actual starting pressure drop is used to verify the design, and the pump station and the long-distance liquid supply system are described, the feasibility of long-distance liquid supply is proved by calculating the flow demand of pump station and the total pressure drop of long-distance liquid supply and return pipeline, monorail crane and rubber hose between frames. The project summarized a set of relatively mature gangue filling working face's long-distance power supply liquid application experience.
Keywords: gangue backfilling face; remote power supply; long-distance feeding

Effect of water discharging on the mechanical properties of sandstone aquifer

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Abstract: Mining operations can affect the water resources in the aquifers or on the ground by causing the deformations and cracks of overlying water resisting strata, which will further cause groundwater exhaustion, surface water driving, and other environmental problems. It has been revealed by mining and geological researchers that aquifers above the coal seams is a common mining geological conditions in Shaanxi Province of China. Apart from the environmental issues related to mining under aquifer, water discharging will change the mechanical properties of aquifer, which will further affect the stress concentration, energy dissipation and micro seismicity distribution during mining process. The understanding of water discharging effect on the mechanical properties of aquifer will benefit the mitigation of environmental and safety issues associated with aquifer by providing fundamental water-rock interaction knowledge. This paper investigated the water absorption capacity and water distribution in the sandstone sample by water triaxial saturation tests and X-ray computed tomography observation. Then the uniaxial compression tests were conducted in the lab to understand the water discharging effect on the strength and failure of sandstone with the application of acoustic emission monitoring. It has been found that the water discharging will change the stress concentration and failure mode of sandstone.
Keywords: aquifer; rock mechanics; computed tomography; green mining

An integrated model to analyze economic development planning in energy rich regions in the US and China

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Abstract: Major economies are competing to dominate the emerging energy economy and governments, regardless of their position on the plan-market spectrum, play a critical and distinctive role in driving

technology development and adoption. The technology-energy-environment-economy (TEEE or TChain) interplay has profound implications for the world economy and presents very distinct analytical challenges both to social scientists and policy makers. We used input-output and computable general equilibrium models (CGEs) to develop an integrated modeling framework to analyze TChain elements and simulate development scenarios in the energy rich regions. This research funded by the U.S. National Science Foundation compared two Energy Rich Regions (ERRs) of West Virginia and Shanxi - within two distinct economic systems of the U.S. and China - as they develop and move toward adopting new energy technologies and respond to changing environmental realities and globalization processes. The prominent role of government of China in country's sustained economic growth in recent decades and the same time the dismal performance of Western style market economies has rekindled plan-market debate in economic development circles again. Many developing countries are closely watching and scrutinizing East (China) and West (US & Europe) prescribed development model, often with contentious debate among their scholars and activists each subscribing to one or the other model. This debate is particularly acute in energy rich economies, where the control of windfall revenues has often led to what Askari 2013 calls a form of collaborative colonialism. For example, oil rich economies of the Persian Gulf (particularly those with few non-oil resources, such as Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates) have looked to the West for development direction at the same time as clinging to an all dominant central government much like those in the East. The optimal mix of private and public sector in the economy and the appropriate role of government is an important question, particularly in economies that largely depend on exhaustible energy resources, and there is a large interest to incorporate these issues in economic development simulation models. With a focus on energy-economy interactions, this paper introduces energy rich regions (ERRs), describes TEEE chain as an integrated modeling framework for ERRs, and reports results from applying an optimal depletion CGE model to a typical ERR under two distinctive economic structures: planned and a market economy.
Keywords: economic development; integrated model; energy-economy

The capabilities of geoinformation monitoring system technology for ecological environmental monitoring

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Abstract: The technology of the Geoinformation Monitoring System (GIMS-technology) model combines the methodology and algorithms of mathematical modeling with ground-based and remote sensing observations of the environment. Links are developed between experiments, algorithms and models of environmental processes and subsystems for the implementation of effective operational control and diagnosis of the environment. GIMS functions include: -acquisition and accumulation of in-situ and remote sensing data and their analysis with the subsequent subject processing; -systematic monitoring and assessment of the environment; -evaluation and synthesis of knowledge about the atmosphere, soil-plant cover, and aquatic medium change; -predetermination of diagnostic forecasting of environmental change under anthropogenic forcing; -analysis of trends in environmental processes when anthropogenic scenarios are implemented; -identification of causes of ecological disturbances and warning of risks. The aim of this work is twofold: 1) To present a working methodology for the combined use of modeling technology and microwave remote sensing measurements in the assessment of environmental processes and the dynamics of biosphere subsystems. 2) To illustrate this methodology with computer calculations of the global change dynamics for the different scenarios.
Keywords: GIMS-technology; observations; environment; data processing; scenarios; anthropogenic forcing

Utilization of mine water resources in Eastern Australia - Managing water in open pit mines in a watershed context

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Abstract: Utilization of mine water resources and managing water in open pit mines is increasingly important in water-stressed areas. This paper aims to review information and present new data and

discussion on water that is utilized during mining of black coal and brown coal in Eastern Australia. Coal from underground and open pit mines is produced for export and generation of electricity in the Australian National Electricity Market (NEM). Utilization of mine water resources in this context refers to water that is extracted or seeps into a mine void, water that is used by mine operations, or water that is available from the mine to be utilized for other uses (e.g. for irrigation), either during mine operation or after closure during mine site rehabilitation. Trends of water utilization over recent years with primary energy generation will be presented, along with associated water utilization for coal at NEM scale, and for selected mine sites. Challenges for management of water resources in a catchment (watershed) context are considered, particularly open pit mines that are located on floodplains, with increased large rainfall events, and reduced water availability over the long-term due to climate change. Rehabilitation options for open pits after mine closure typically favor pit lakes for various beneficial uses, however, deficits of available water mean that it may take decades to hundreds of years for hydraulic equilibrium. Examples are presented of small to large pit scales (35-2000 hectare pit areas, with <20, 20-1000 and >1000 Gigalitre volumes). The goals of safe, stable and sustainable management of open pits requires reliable models of potential hazards of pit interactions with aquifers, wetlands and rivers.
Keywords: open pit mine; rehabilitation; water; watershed

Evolution law of crack space development of expansive soil with low permeability boundary under evaporation condition

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Abstract: The evolution law and the development mechanism are investigated in this paper, which expansive soil crack space under the low permeability boundary soil. With the large-size compacted expansive soil samples, the experimental test of crack development was carried out and the moisture content evolution in the evaporation process was monitored by sensors. The acoustic sounder was selected to measure the change of crack development depth and a self-compiled binary image procedure was applied to extract the unearthed crack area ratio. A crack space model was established based on the horizontal strain incremental constitutive theory. This study conclusively showed that, the moisture content in topsoil decreases faster than that in subsoil under the condition of low permeability boundary. A dynamic triangular balance among moisture content, crack rate, and crack depth has been detected in this study. The change of moisture content could be determined as a paramount factor of crack development. The calculated value of fissure space volume is basic anastomotic with the measured value of slope crack grouting model volume.
Keywords: crack propagation; moisture content; image processing; special soil; permeability

Experimental and numerical study of coal mechanical properties during coalification jump

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Abstract: The mechanical characteristics of coal reservoirs are important parameters in the hydraulic fracturing of coal. In this study, coal samples of different ranks were collected from twelve coal mines located in Xinjiang and Shanxi provinces, China. The coal ranks were identified with by the increased Maximum vitrine reflectance (Ro, max) value. The triaxial compression experiments were performed to determine the confining pressure effect on the mechanical properties of coal samples of different ranks. The numerical approaches, including the polynomial, arctangent, and exponential function models, were used to find the correlation between coal elastic modulus and the confining pressure. The compressive strength criteria measured the resistance to deformation of different coal ranks under increasing confining pressure. The results showed that the coal compressive strength of different ranks has a positive linear correlation with the confining pressure. The elastic modulus of different coal ranks and confining pressure show an exponential function. Poisson's ratio of coal and confining pressure show negative logarithmic function. The stress sensitivity of the coal elastic modulus decreases with the increase of confining pressure. The coalification jump identifies that the compressive strength, compressive strength coefficient, elastic modulus, and stress sensitivity coefficient of coal have a polynomial relationship with the increase of coal ranks. The inflection points in coalification at Ro,max = 0.70%, 1.30% and 2.40%, are the first, second, and third coalification jumps . These findings provide significant support to coal fracturing during

CBM production.
Keywords: compressive strength; elastic modulus; confining pressure; Poisson's ratio, coal ranks

High-precision reconstruction method of acoustic logging curve in the Jurassic strata

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Abstract: The Jurassic strata are weakly cemented strata which mean low strength and low density, so the density difference between the coal seam and the surrounding rock is smaller than that of the Permian and Triassic. The acoustic curve reconstruction method needs to be established because traditional reconstruction methods are not suitable for Jurassic formations. This research takes the logging curves of a mine in the Ordos area as the research object. Firstly, the multi-scale wavelet transformation and histogram adjustment were used to preprocess the logging curve, which reduced the noise and improved the consistency. Then, based on the preprocessed logging curve, the fitting relationship between density and acoustic wave in the Jurassic strata was established, and was applied to other wells in the study area. The correlation coefficient between the measured acoustic curve and the reconstructed acoustic curve of each well was high, indicating that the results were more reliable. Finally, the reconstruction results of logging curves obtained by this method were compared with the results of the traditional Gardner formula. The results showed that the correlation coefficient between the reconstructed curve and the measured results was higher and more reliable obtained by this method. This study provides a high- precision reconstruction method for acoustic logging curve in Jurassic strata. It's beneficial to improve the processing, interpretation and inversion accuracy of seismic data, and ensures the safe production of coal mines.
Keywords: acoustic logging; curve reconstruction; Jurassic strata

The establishment of the hydrate survey prediction model in the plateau permafrost area based on the logistic regression method

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Abstract: Since natural gas hydrate (NGH) was firstly drilled in 2008 in the Muli area of Qinghai, China, a large amount of geophysical and geochemical survey work has been carried out in this area. A large amount of geophysical and geochemical information has been obtained. However, the regularity of the NGH enrichment has always been unclear, it is difficult to locate the NGH reservoir based on this information. In our work, we summarized the geophysical, geochemical and geological data obtained in the area. The favorable identification characteristics of the NGH reservoirs have been analyzed. Moreover, the prediction variable conversion rules of these favorable information have been given. We made predictions based on the logistic regression method. The results show that the high favorable area we predicted and the drilling of the NGH in line matched very well. And the drilling of the non-drilling NGH is basically located in the low favorable area, so the algorithm is practical.
Keywords: natural gas hydrate; logistic regression method; the plateau permafrost area; Muli area

Characteristics of permeability evolution and pore structure of coal with high gas

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Abstract: To understand the influence of gas pressure on the evolution of coal permeability, the permeability experiments of coal samples collected from 9# coal seam (high gas coal seam) in Tangshan Coal Mine of Hebei Province, China were performed under different gas (helium and nitrogen) pressure; deformations induced by nitrogen adsorption were obtained simultaneously. Besides the pore structure characteristics of coal samples were acquired by the mercury injection porosimetry (MIP) experiment, and pore surface fractal dimensions were obtained. As the nitrogen pressure increases from 0.3 MPa to 3 MPa, adsorption strain increases from 0.168×10^{-3} to 1.076×10^{-3}, and the range of increase decreased

gradually, but the permeability of coal samples decreases from 16.05×10^{-18} m² to 4.91×10^{-18} m² and then rises to 5.69×10^{-18} m² are demonstrated. The trend of permeability for helium is consistent with that for nitrogen, and the average permeability for helium is 1.42~1.88 times as much as that for nitrogen under the same gas pressure. The gas pressure corresponds to the lowest value of permeability for helium and nitrogen are 1.5 MPa and 2.5 MPa, respectively. Consequently, the absorptivity of gas is crucial to the permeability evolution of coal samples. According to the mercury intrusion porosimetry data, coal matrix compressibility is 7.2×10^{-11} m²/N based on, and the corrected porosity of coal samples is 53.8% considering coal matrix compression. Additionally, the seepage pores with pore sizes larger than 100 nm are relatively developed, accounting for 80.4% of the total pore volume, which is conducive to gas seepage. The surface fractal dimension D_{s1} is larger than D_{s2} and D_{s3}, and D_{s1} is positively correlated with micropore volume content, while D_{s2} and D_{s3} are negatively correlated with pore volume content and gas permeability.
Keywords: coal permeability; gas pressure; adsorption strain; pore content; coal matrix compressibility

Mechanical behavior and permeability characteristics of deep coal reservoirs and their geological constraints

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Abstract: The mechanical behavior and permeability of deep coal reservoirs are important research directions in the development of deep coalbed methane. However, it is difficult to measure them in deep in-situ conditions and its geological constraints are unclear. In this study, the raw coal from Baode block was collected, and three-axis equipment was used to explore the change characteristics of coal mechanical behavior and permeability under different temperatures and pressures. The results show that the stress-strain curves of coal under the combined action of temperature and confining pressure are similar to the typical curve, but its stage is not obvious. In order to accurately identify the stages of coal mechanical behavior, the micro-slope method is proposed for stage division, and the whole process is divided into five stages. The permeability is closely related to the deformation stage and exhibits a U-shaped change with the increase of the axial strain, and its minimum value mostly occurs at the end of the elastic deformation. The increase of confining pressure strengthens the mechanical properties of coal, which leads to the increase of peak stress (σ_{max}) and the prolongation of peak strain (ε_{max}). While the temperature plays a role in weakening the coal body strength, the σ_{max} and the ε_{max} decrease as the temperature increases. For permeability, both confining pressure (10~30 MPa) and temperature (30~80℃) play a negative role. The initial (K_o) and post-destruction permeability (K_d) of coal samples are more sensitive to changes in temperature and confining pressure, and the minimum permeability (K_{min}) remained basically stable. Finally, the temperature-stress-strain-permeability model of deep coal reservoir is established. This study is expected to provide a reference for understanding the mechanical behavior of deep coal reservoirs.
Keywords: stress-strain; dynamic permeability; damage; permeability; deep

Mechanism of water conservation coal mining with CO_2 mineralized coal based solid waste filling

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Abstract: A large amount of CO_2, fly ash and goaf will be produced in the process of coal mining and utilization, which will induce a series of problems, such as environmental pollution, surface subsidence, groundwater loss and so on. If CO_2, fly ash and other coal-based solid wastes can be filled into the goaf, the waste will be turned into treasure. This paper attempts to use CO_2 and fly ash as the main raw materials to develop new CO_2 mineralized filling materials and mineralized grouting materials. On the basis of testing the mechanical properties of CO_2 mineralized materials, the rock movement and fracture development characteristics of mineralized materials during filling and mining are studied, and the performance of mineralized grouting materials to block mining fractures is discussed. Optimize and determine the key parameters such as reasonable mining height, mining width and filling proportion of CO_2 mineralized material filling, so as to realize the efficient disposal and utilization of CO_2 and fly ash. The research on the mechanism and mining method of CO_2 mineralized coal based solid waste filling and water conservation mining has important engineering and scientific significance for the of water conservation and the disposal and utilization of CO_2 and mine solid waste.
Keywords: disposal and utilization of CO_2; water conservation; coal based solid waste; CO_2 mineralized filling materials; mineralized grouting materials

Design and development of the gold recovery from e-waste: A feasibility study

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Abstract: Although hazardous cyanide- and nitric acid-based leachates are the most prevalent electrolytes for the gold recovery industry, an environmentally friendly process could open a new era for the worldwide feasibility of gold recovery from the e-wastes in their local area. Combining porous 3D-printed anode electrode in an alkaline 1.5 M NaOH media and graphite cathode electrode in acidic media within the thin-film compartments of an advanced flow reactor can create a high-efficiency electrochemical recovering process. The versatility and feasibility of additive manufacturing can create a high catalytic active Ti-6Al-4V metal mesh anode electrode with a large volumetric area and suitable gas release characteristics. Furthermore, a synthetic Cu-Au acetic acid-based solution plus 1.5 M HCl and 0.6 M H_2O_2 was used as the acidic electrolyte. This study evaluates the viability of gold recovery in an electrodialysis flow reactor by the cyclic voltammetry method. According to the results, the electrodeposition of gold applies to the graphite cathode. More importantly, there would not be any chlorine gas or other toxic gas generation on the anodic side. Thus, the larger current window of the advanced flow reactor and its green approach opens a new path for the electrochemical recovery technologies and applications for the e-waste.
Keywords: gold recovery; 3D-printed electrode; advanced flow reactor

Numerical simulation of CO_2 sequestration and enhanced coalbed methane production cased by a pilot CO_2-ECBM project in Qinshui basin, China

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Abstract: Injecting CO_2 into the methane-bearing coal seams can not only store CO_2 but improve coalbed methane recovery. In this paper a fully coupled adsorption-thermo-hydro-mechanical-chemical (AHTMC) model for CO_2 enhanced coalbed methane (CO_2-ECBM) is constructed, including the multiple fields with the coupling relationships of competitive adsorption of CO_2 and CH_4 in the coal matrix (A), gas-water two-phase flow in reservoir and gas diffusion in formation water(H), heat conduction/convection and energy changes caused by gas sorption, gas dissolution, geochemical reactions(T), coal deformation(M), geochemical reactions of various anions and cations and the mineral dissolution in formation water (C). The AHTMC model is verified by the cored coal sample experiments in the laboratory and applied to simulate a CO_2-ECBM pilot project in Qinshui basin with different CO_2 injection rates. Results show the CH_4 adsorption capacity in the coal matrix decreases affected by CO_2 competitive adsorption, and the hydrogen ion concentration in formation water increases after CO_2 injection into the coal seam. With the increase of CO_2 injection rate, the storage rate of CO_2 decreases, the recovery rate of CH_4 increases, and the pH value of produced water decreases significantly. The greater the distance between injection well and production well, the earlier CO_2 breakthrough, the more notable the CH_4 stimulation effect, and the earlier the pH value of produced water drops. The CO_2 injection rate of 25 t/d can be applicable to the field project of CO_2-ECBM because of the optimal CH_4 recovery and CO_2 sequestration, of which CH_4 recovery increased by 14.89% compared with the primary and CO_2 storage ratio is higher than 96% in a CO_2 injection duration of 8000d.
Keywords: adsorption-thermo-hydro-mechanical-chemical (AHTMC) coupling; CO_2 sequestration; coalbed methane; geochemical reaction; numerical simulation

Progressive damage mechanism for coal pillars under the coupling of stress-water immersion in underground reservoirs

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Abstract: Underground reservoir water storage technology has become one of the important approaches to achieve efficient coal mining and water resources protection in mining areas in Western China. As the coal pillars in the underground water reservoir is the main bearing structure of the coal mine, the stability of coal pillars in the underground water reservoir play a vital role in the stable operation of underground

water reservoir projects. Based on the characteristics of the coal pillar dam and residual coal pillars on the site of underground reservoir, this paper explores the stress distribution of coal samples under different cyclic loading and unloading conditions and the influence of different water immersion cycles on the strength of coal samples after cyclic loading and unloading through experiment; it analyzes the progressive damage characteristics of coal pillar dam and residual coal pillars during mining influence and water storage by using FLAC^{3D} numerical simulation. The results show that during the same water immersion cycle, the strength of coal samples showed a trend of sharp decrease followed by steady decrease with different cyclic loading and unloading times, and the strength of damaged coal samples under a single condition decreased. Given the same cyclic loading and unloading times, the strength of coal samples showed a trend of gradual decrease during different water immersion cycles. After multiple stress damages, with the extension of water immersion cycles, the coal samples showed load fluctuations in the pre-peak area and residual strain delay in the post-peak area. Compared with 3 cyclic loading and unloading times during 7 days and 14 days of water immersion, the load fluctuation and strain extension in the post-peak area reached the maximum after 3 cyclic loading and unloading times during 21 days of water immersion. The numerical simulation shows that the coal column suffered tensile damage on the top and shear damage in the middle and at the bottom near the goaf side during the mining period. After the coal pillars were weakened by water logging, with the increase of the weakening times of the coal pillar dam, the plastic zone of the coal pillars gradually extended to the inside of the coal pillars. The plastic zone of the coal pillar dam increased from 6m to 11m after mining, and the residual coal pillars were gradually destroyed, mainly presented as shear damage. The pore pressure inside the coal pillars of the underground water reservoir gradually transferred to the inside, until the coal pillar dam ultimately stabilized. The pore pressure inside the coal pillars gradually decreased from near the goaf side to the inside, and the diffusion is positively correlated with the damage degree of the coal pillars.
Keywords: underground reservoir; coal pillar dam; water immersion; progressive damage

Skewness subsidence dynamic prediction model based on the Box-Cox transform algorithm

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Abstract: In the process of coal mining, the support of goaf and coal pillar to overlying strata is different, which makes the static and dynamic subsidence of overburden and surface lose spatial symmetry. To solve the problem that the prediction error of traditional symmetrical subsidence function model is large, this paper takes the subsidence velocity as an example. Firstly, based on the viscoelastic theory, the subsidence functions of overlying strata on goaf side and coal pillar side are constructed, and the spatial distribution function of subsidence velocity of overburden rocks on both sides is deduced. Based on the spatial change rate of subsidence velocity functions, the right skew distribution law of dynamic subsidence of overburden rocks on both sides is revealed. Secondly, based on the idea of lossless propagation of harmonic wave and idealized the propagation environment, the spatial propagation relationship of surface subsidence velocity in time domain is established; Then, the Box-Cox transform function is introduced to improve the normal distribution probability density function, and a new dynamic subsidence prediction model based on the Box-Cox transformation is obtained, which is suitable for the full mining stage. Finally, the reliability of this model is verified by the measured data. The results show that the prediction results of the prediction model are consistent with the actual situation, and the relative error is less than 7%, which meets the requirements of engineering prediction accuracy.
Keywords: dynamic subsidence prediction; subsidence velocity; skewness; Box-Cox transform

Research on supporting technology of composite roof mining roadway in close distance coal seam

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Abstract: Close coal seam coal seam mining under the supporting problem is close distance coal seam group mining technology research, the selection of reasonable support parameters and the establishment of supporting system is the close distance coal seam under the control of surrounding rock of coal seam mining are the key, because of general layout of roadway in coal seam, can cause the decrease of strength of surrounding rock, roadway maintenance difficulties and other issues, At the same time, the roof of the lower coal seam has been damaged due to the influence of the mining of the upper coal seam in the near

distance, which increases the difficulty of surrounding rock control in the mining roadway of the lower coal seam. In this paper, Shanxi Jinhuilongtai Coal Industry Co., LTD. 10 under the coal seam mining roadway support problem is studied, through the analysis of goaf under the roadway surrounding rock failure characteristics, broken surrounding rock roadway support form, according to Shanxi Jinhuilongtai Coal Industry Co., LTD., the site production geological conditions select the appropriate roadway support mode, Then according to the calculation of roadway support parameters and then select reasonable 10 coal seam mining roadway support parameters, and finally realize the safe and efficient support system of mining roadway.

Keywords: close seam; the compound roof; mining roadway; technology research

Effects of rapid igneous intrusion heating on the geochemistry, petrography and microcrystalline structure of coals from Huainan, China

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Abstract: Igneous intrusion into coal-bearing strata may change the geochemical, petrographic and microcrystalline structural characteristics of coal, including maceral petrographic composition, geochemical parameters and microcrystalline structure size. Here, a series of coal samples affected by igneous intrusion were analyzed by petrography, geochemistry and X-ray diffraction, and compared with the trends observed in normal burial maturity altered coals, so as to evaluate whether the intruded coals adhere to another maturation pathway. This study reports the data of petrographic, geochemical, and microcrystalline structure of intruded coals. Petrographic analysis shows that R_o increases from 0.66~0.72% of background levels to 5.73%, and the ability to distinguish liptinite is lost. Pyrolytic carbon, isotropic and anisotropic coke with fine-grained circular mosaic structure is formed at the intrusion. Moreover, the degree of structural order of coal samples increases approaching to the intrusion. There are transition phases with different structural orders due to subjected to different degrees of metamorphism. The d_{002} is used to distinguish ordering of graphite coal samples formed under contact metamorphism. And the (002) reflection asymmetry index (AI) of XRD patterns correlate well with d_{002} of coal samples from semi-graphite to graphite zone. Petrographic and geochemical data indicate that the Zhuxianzhuang (No.8) coal in the intrusion may followed another maturation pathway from normal burial maturation, which may be related to the rapid geological thermal event related to the intrusion. Different igneous intrusive events have different maturation pathways, depending on the scale of intrusion, heating rate and continuous heating time. However, the results of XRD data suggest that the microcrystalline structure of igneous intrusion coals is consistent with growth the trend of normal burial. This study of geochemical petrography and microcrystalline structure of surrounding coal seams by rapid intrusive heating of igneous not only greatly improves the natural coke industrial utilization, but also provides an important theoretical basis for the generation and enrichment of coalbed methane in igneous thermal abnormal coal reservoirs.

Keywords: igneous intrusion; geochemical; microcrystalline structure

Application of remote power supply and liquid supply in gangue filling face

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Abstract: green mining is the mainstream of coal mining, and gangue is the main environmental protection problem perplexing most coal mines. Gangue filling working face can effectively solve the gangue generated in the process of coal mine production. The existing gangue filling working face mostly uses the layout of short-distance power supply and liquid supply by transfer trains, and the layout of long-distance power supply and liquid supply can effectively solve the safety problems caused by frequent pulling and moving equipment trains. Taking the successful application of long-distance power supply and liquid supply in ct201 gangue filling face of Zhongtian Hechuang Hulusu coal mine as an example, this paper briefly introduces the gangue filling face and its main equipment; This paper discusses the long-distance power supply design of the main power supply system of the mine and the working face, obtains the total voltage drop at the start of the maximum power equipment of the working face through the calculation of the voltage drop of the high and low voltage line and the shift transformer, demonstrates the feasibility of the long-distance power supply design, and verifies the feasibility of the long-distance power supply design with the actual start-up voltage drop value; This paper describes the liquid supply pump station and long-distance liquid supply system, demonstrates the flow of the pump station through the formula, calculates the total supply and return hydraulic pressure drop of the long-distance liquid supply and return pipeline, monorail crane and the liquid supply hose between racks to demonstrate the

feasibility of long-distance liquid supply, and verifies the rationality of the long-distance power supply and liquid supply design combined with the actual feedback data on site. This application summarizes a set of mature application experience of long-distance power supply and liquid supply in gangue filling face, which can be used for reference and application in the selection and matching of equipment in filling face with the same process.
Key words: gangue filling face; remote power supply; remote liquid supply

Topic 2: Environmental Science and Engineering

Monitoring the efficiency of reclamation of depleted coal deposits

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Abstract: With the development of the industrial revolution in the middle of the 19th century in Russia, as well as throughout the world, there is an intensification of the processes of coal mining of all grades, which continues to this day. Thus, in the Russian Federation in 2021, more than 430 million tons of coal were mined, with 325 million tons of open-cast mining. The activity of coal mines is accompanied by significant negative impacts on the natural environment: more than 10,000 hectares of land are disturbed annually, of which only 5% is recultivated, 21 billion tons of coal mining waste have been accumulated in dumps over the past 10 years. After the full development of coal reserves, the unprofitability of mining, the risk of destruction of the mine working or its flooding, the deposits are liquidated. One of the main problems in the liquidation of coal mines is the threat of endogenous fires due to the ability of the remaining coal seams to ignite when oxygen is available to them. Such a problem arose during the liquidation of the Korkinsky brown coal mine, in the impact zone of which an ecological disaster zone was formed. Features of the location of the Korkinsky coal mine characteristic of most brown coal deposits in Russia. The Korkinsky brown coal mine functioned as an enterprise for coal mining between 1932 and 2018. As of 2018 coal mine Korkinsky was the largest mining facility in Chelyabinsk region and one of the largest brown coal mines in the world. To the primary environmental problems - heritage mining enterprise, endogenous fires should be attributed to section, leading to air pollution in Korkino and adjacent settlements. To liquidate the Korkinsky coal mine, it was decided to fill the mining-out space with waste from the processing plant of the Tominsky GOK, located 14 km. The conducted analytical studies have shown that in order to obtain an objective picture of the distribution of pollutants in the atmospheric air in the territory exposed to endogenous combustion processes in the Korkinsky coal mine, the most rational is the use of drones according to the methodology developed by the authors. Monitoring the effectiveness of reclamation and comparison of different approaches to assessing the air quality of the study area will be shown in the report.
Keywords: coal mines; endogenous fires; reclamation; remote monitoring; drones

Spatial simulation and reorganisation mechanism in agricultural rural settlements based on CA-ABM

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Abstract: A Land-use change is an important representation of urban-rural system evolution. In rural areas, the modern agriculture industry promotes spatial pattern changes. This study introduces a multi-agent system into the spatial simulation and reorganisation of rural settlements. The cellular automata and agent-based model (CA-ABM), a type of simulation and prediction model, was constructed using the geographic information system platform and CA tool. Based on data from 2000 to 2020, the parameters of the model were revised, and the model was used for spatial prediction in 2030. Using six rural settlements from plain areas, hilly areas, and mountainous areas as examples-combined with field investigation, remote sensing images, official land use planning, and other data-this study analysed land-use evolution under the influence of farmers, developers, and government agents. From the perspective of the three kinds of agents' decision-making, land use prediction and optimization suggestions were

proposed. Compared with previous research, this study shows that the CA-ABM can reflect the dynamic behaviour of farmer agents, government agents, and developer agents in the simulation system. With the help of the CA tool, the model successfully fuses rural settlement attribute information and a spatially accurate simulation. This study can provide a scientific basis for the quantitative study of rural settlement land use prediction. Simultaneously, the proposed spatial optimisation mechanism provides a reference for the spatial reorganisation of agricultural rural settlements (ARS) worldwide.
Keywords: rural settlement; rural land use planning; spatial prediction; CA tool; multi-agent decision-making system

Advanced CFD and measurement technology for the study of multiphase flow in a media with complex structures

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Abstract: In this presentation, an overview of the development of the Computational Multiphase Fluid Dynamics (CMFD) and measurement technology for the multiphase fluid flow in a complex geometry will be presented. With the application of the Euerlian Eulerian method, population balance model, closure models for interfacial force, Algebraic interfacial area density model (AIAD), a Generalized Two-Phase flow concept (GENTOP) was developed which is able to simulate a multiscale multiphase flow which contains large free surface structure between liquid and vapor, small dispersed bubbles and droplets simultaneously. Simulation and modeling requires also verification and validation from experiment data. Here, an invasive measurement technology (Wire-Mesh Sensors) and two non-invasive technologies (Gamma ray CT, ultra-fast X-ray CT) which are able to capture cross-sectional phase distribution will be introduced. The developed numerical methods and experimental technologies have high potential to be applied in the research of the multiphase flow in the complex pollutants release and migration behaviors inside soil and strata mediums.
Keywords: multiphase phase flow; CFD; invasive/non-invasive measurement; computational tomography

Isotope effects as analytical probes to decipher dehalogenation mechanisms

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Abstract: An overview of how the knowledge coming from the use of modern computational techniques can be applied to the analysis of the behavior of various systems ranging from model chemical reaction to complex enzymatic processes will be presented. Application of theoretically predicted kinetic isotope effects to establish/confirm the molecular mechanism of selected chemical reactions (nucleophilic substitution, elimination) in the condensed phase as well as enzyme-catalyzed dehalogenations will be demonstrated. An interplay between theory and experiment, which usually allows valid mechanistic conclusions will be also discussed.
Keywords: kinetic isotope effects; dehalogenation; QM/MM; QM cluster; SN2; elimination

Synergies of mining and resource cooperation along the belt and road under the carbon neutrality landscape

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Abstract: The mining industry provides material and energy for mankind, and supports the prosperity and socio-economic development of the world. At present, the globalization of mineral resource development and its environmental problems are becoming increasingly prominent, and the international community has increasingly higher expectations and requirements for the development and utilization of sustainable mineral resources. In the context of the international consensus of accelerating the realization of global carbon neutrality, the socio-economic systemic changes required by the construction of ecological civilization and global energy transition will also put forward higher and greener requirements for the development and utilization of mineral resources. Guided by the systemic, holistic, and synergistic development concept in Xi Jinping's thought on ecological progress, promoting the "Belt and Road" green

mining and mineral resources cooperation could create complex synergies for China to build a “mineral resource power” and achieve the goal of carbon peak and carbon neutrality, to accelerate global carbon neutrality in order to achieve the 2°C target of the Paris Agreement, to promote economic and trade cooperation on the “Belt and Road”, as well as to create “a community of green energy with a shared future” and jointly implement the 2030 Sustainable Development Goals has compound synergy significance.
Keywords: ecological civilization; carbon neutrality; Belt and Road; mining and resources cooperation; resource-power country; complex synergies

Investigation on the bubbling behavior in the flat sheet membrane reactor (FSMBR) Part I: Experimental study

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Abstract: FSMBR is a promising wastewater treatment and reclamation technology that is gaining increasing attention in recent years. In its operation, air bubbles are injected to rise in the narrow gaps formed by the flat sheets, typically at a spacing between 3-12 mm. The bubble rising behaviour within the narrow gap, yet has not been fully understood, plays a vital role in FSMBR performance and durability by affecting the oxygen dissolution, enhancing mass transfer, suppressing the membrane fouling and contributing to the energy cost. In this work, we used the high-speed camera to systematically investigate the bubble rising feature in a narrow channel with the spacing of 5 mm and compared to that in unbounded conditions. By varying the bubble size from 0.2 mm to 20 mm, we were able to extract the bubble terminal velocity, bubble shape and rising trajectory from the recorded videos. As expected, the terminal velocity of bubbles larger than 1 mm is generally 10-20% lower in narrow channels than in the unbound liquid. Interestingly, the terminal velocity of bubbles around 4 mm is roughly equivalent to that in unbounded liquid, which can be attributed to the wall effect on the bubble wake structure and the bubble-wall collision effect on the zig-zag rising trajectory. By analysing the rich phenomena (e.g., bubble deformation, trajectory) observed for bubbles larger than the gap spacing, the shear stress of bubbles exerted on the wall is also discussed. The outcome obtained from this study is expected to provide good guidance for the optimization of bubbling technology in FSMBR design.
Keywords: flat-sheet membrane bioreactor; bubble dynamics; bubble terminal velocity; shear stress

Investigation on the bubbling behavior in the flat sheet membrane reactor (FSMBR) part II: Computational fluid dynamics simulation

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Abstract: Aeration, an effective approach to the alleviation of membrane fouling, has been broadly used in the wastewater treatment. Despite the wide application of aeration in the fouling control, the enhancement of surface shear by producing slug bubbling flow within the narrow gap has not been fully understood. In the present research, extensive numerical investigations were carried out to elucidate the dynamics of bubbly flow in the flat-sheet membrane bioreactor with the validation of our experimental results. Conforming to the experiments, the simulations indicated that there exists a transition in the terminal velocity of 1 –2 mm bubble where the transit of flow pattern was discovered. The transition of bubble shape and its trajectory alters the velocity distribution in the confined zone between the membranes, leading to the change of shear stress and mass transfer properties adjacent to the membranes. Theoretically, the mechanics of how the bubbles within the channel between flat-sheet membranes adjust the velocity gradient near the membrane surface were revealed. Moreover, with the increase of bubble diameter, it was found that the enhancement of shear stress becomes less significant at the cost of greater gas inflow. An optimal range of bubble diameter was proposed to retain a relatively high efficiency of wastewater treatment at the economically-friendly expense of aeration. The outcome obtained from this study provides good guidance for the optimization of bubbling technology and contributes to the development of wastewater treatment.
Keywords: flat-sheet membrane bioreactor; bubble dynamics; bubble terminal velocity; shear stress; computational fluid dynamics

Study on countermeasures of rural revitalization design empowerment from the perspective of design criticism

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Abstract: Design empowerment is an effective method for rural revitalization. The existing problems are subjective, experimental, homogenization, beautification project, urban imitation and so on, which damage the original ecology of the countryside. There are two reasons for these problems. On the one hand, blind pursuit of monetary gain. On the other hand, designers lack serious social responsibility. Therefore, the intervention of design criticism is particularly important. The empowerment of rural revitalization design involves three aspects: actors, users and society; It also contains three forms: economic form, environmental form and cultural form. The author puts forward the critical view of "temperature" evaluation on how to coordinate design for energy efficiency. This "temperature" means that designers can get close to rural needs, collect rural "temperature" and build rural feelings. Let the user feel the new atmosphere, new life, kind, natural; Let the social side feel the economic and social benefits brought by the design. This is how rural revitalization should be designed.
Keywords: design criticism; rural revitalization; design empowerment; temperature; strategy

Temporal cumulative impacts of long-term mining disturbance and progressive rehabilitation on regional ecosystems

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Abstract: Surface mining can seriously disturb and reshape natural landscapes which results in a range of impacts on local ecosystems. To address the influences of disturbance, progressive rehabilitation is commonly advocated. However, there is little research focusing on how these impacts affect ecosystem services within mine sites and changes over time. The aim of this study was to assess the cumulative impacts of mining disturbance and rehabilitation on ecosystem services through mapping and quantifying changes at multiple spatial and temporal scales. Four ecosystem services including carbon sequestration, air quality regulation, soil conservation and water yield were assessed in 1989, 1997, 2005 and 2013. Disturbance and rehabilitation was mapped using LandTrendr algorithm with Landsat. We mapped spatial patterns and pixel values for each ecosystem service with corresponding model. In addition, we assessed synergies and trade-offs using Spearman's correlation coefficient for different landscape classes and scales. The results showed that carbon sequestration, air quality regulation and water yield services were both positively and negatively affected by vegetation cover changes due to mined land disturbance and rehabilitation, while soil conservation service were mainly influenced by topographic changes. There were strong interactions between carbon sequestration, air quality regulation and water yield, which were steady among different spatial scales and landscape types. Soil conservation correlations were weak and changed substantially due to differences of spatial scales and landscape types. Although there are limitations associated with data accessibility, this study provides a new research method for mapping impacts of mining on ecosystem services, which offer spatially explicit information for decision-makers and environmental regulators to carry out feasible policies, balancing mining development with ecosystem services provision.
Keywords: ecosystem services; coal mining; progressive rehabilitation; land use; synergy and trade-off

Research on "Living Inheriting" of traditional craft intangible cultural heritage in the context of rural culture revitalization

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Abstract: The intangible cultural heritage of traditional crafts are facing the bottleneck of the inheritance and utilization of cultural resources, under the background of the rural revitalization strategy. "Living Inheriting" is a momentous concept during the protection and practice of the intangible cultural heritage. In the context of rural cultural revitalization, this paper discussed the current situation and mode of the structuring the active space in the intangible cultural heritage, through the four dimensions: Industry, Tourism, Science and Technology, Education. The paper proposed three "Living Inheriting" principles: "Interpretability of rural culture", "Sustainability of rural culture", and "Identity of rural culture". Guided by the problems existing in the practice of rural revitalization assisted by traditional craft of the intangible cultural heritage, and aiming at structuring the path of "Living Inheriting" in the traditional craft of the intangible cultural heritage. The paper tries to provide scientific and theoretical support for the sustainable development of rural revitalization, meanwhile it also contributes to the intangible cultural heritage.
Keywords: rural cultural revitalization; intangible cultural heritage; living inheriting

Remediation of petroleum contaminated soil and carbon neutralization

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Abstract: Petroleum is the blood vessel of the national economy in a modern country. However, it has brought environmental pollution and greenhouse gas emissions due to the exploitation and application of petroleum. In this report, general trends and harm of petroleum pollution from oilfields will be analysed, including soil, the soil-water interface, and the soil-gas interface, in particular, ecological deterioration directly and indirectly caused by oil field exploitation and refining. Then, some progresses in remediation and treatment of petroleum contaminated soil and its surrounding environment will be summarized, including advanced technology and green materials, and new ecological remediation technology of petroleum contaminated soil based on bioelectrochemical systems will also discussed. At the last, future development and application directions of remediation technology for petroleum contaminated sites based on carbon neutralization will be prospected.
Keywords: contaminated soil; petroleum exploitation; ecological remediation; carbon neutralization; ecosystem health

Research on agricultural cultural and creative design under the background of rural revitalization

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Abstract: Agricultural cultural innovation is an important way to realize rural revitalization. Agricultural cultural innovation is an organic combination of agriculture and cultural innovation to empower agricultural products, make agricultural products unique, become cultural, connotation, improve the added value of agricultural products, build agricultural cultural innovation brand, promote the sustainable development of rural economy, and better promote the development of rural revitalization. Based on wen gen products, cultural and economic basis of related theory research, many outstanding case, through the analysis of agricultural integration analysis, create value and constituent elements of the building agricultural culture and the design of the path, and summarizes the experience, to provide the reference direction for the practice of design, and for the development of agricultural wen gen and the development of the rural revitalization model for reference.
Keywords: rural revitalization; agricultural cultural innovation; cultural creativity; design empowerment;

Environmental risk and prevention and control of Non-ferrous metal tailings pond

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Abstract: Introduces the tailings library environment risk and safety requirements of environmental protection, including environmental management, pollution control measures and environmental risk emergency response. In view of the pollution status and environmental risk of XX cyanide residue reservoir, the risk prevention and control and ecological restoration scheme was designed and implemented. Through retaining dam and rainwater diversion project of flood interception ditch, rainwater flowing into tailings pond is reduced. Multilayer barrier and seepage prevention method was adopted to slow down the influence of tailings leaching environment in the reservoir. Under the dam, the process of “seepage wall + curtain grouting” and supporting extraction facilities are adopted to block the diffusion path of tailings pond leachate. The overall process combination has achieved remarkable effect on the environmental risk prevention and control of cyanide residue reservoir.
Keywords: tailings; environmental management; environment risk; pollution control

Analysis of disaster prevention strategy of soil resources in pit courtyard village based on ecological wisdom perspective-Taking Baishe village as an example

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Abstract: Different from the low sustainability of modern disaster prevention strategies based on engineering facilities, the soil resource disaster prevention strategies of pit courtyard villages have a history of thousands of years of application and are a manifestation of truly high sustainability. As the most accessible and inexhaustible building material, soil resources are widely used in the disaster prevention construction of pit courtyard villages maintained and supported by loess. As a fresh carrier of soil resources disaster prevention wisdom, the characteristics of low technology, low cost, low maintenance and high sustainability of the soil resources disaster prevention strategy in the pit courtyard village are the important reasons why it is still in effective operation after thousands of years. Based on the conclusion that flood and drought are the main disasters in pit courtyard villages, this paper takes Baishe village as an example to conduct qualitative and quantitative research from three aspects of village layout pattern, village underlying surface composition, disaster prevention system and facilities, and calculate the data of off-season and local use of rainwater. The results show that under the influence of land resources disaster prevention strategies such as the layout of villages based on terrain, the layout of disaster prevention facilities that conform to the height difference, and the application of disaster prevention materials based on the characteristics of soil resources, the proportion of rainwater in Baishe Village is 65 %, which is similar to the requirements for sponge city construction (70%), and is an effective strategy to deal with droughts and floods. Finally, through the summary and condensing of its land resources disaster prevention strategies, it is expected to provide inspiration and reference for modern rural planning and layout, disaster prevention facilities construction, and disaster prevention construction materials application.
Keywords: ecological wisdom; soil resources; disaster prevention strategy; pit courtyard; Baishe village

How to improve the continuity and sustainable utilization of farmland in China- A perspective from sustainability, efficiency, and trade-offs

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Abstract: The co-success of Sustainable Development Goals highlights more attention on farmland within PAs, which is a typical manifestation of the conflicts between biodiversity conservation and food security. Here we developed a trade-off framework concerning farmland sustainability and efficiency, and conducted farmland decisions under different scenarios. We estimated 1.26Mha farmland for de-farming and 0.55Mha for reservation under the strictest habitat protection scenario; 0.81 Mha farmland for de-farming and 0.80Mha for reservation under the laxest habitat protection scenario. Such trade-off decisions were anticipated to cost 0.92~2.32 million tons of crop production while increasing 19.22~24.38 billion CNY of ecological benefits for habitats. We also found more than a tenth of farmland units (0.33Mha) within PAs in terrible agricultural conditions and argued them firstly de-farming regardless of benefits. This framework integrating crop production and habitat protection could provide a propagable approach for farmland trade-offs in global PAs and valuable decision support for the win-win of different SDGs.
Keywords: farmland protection; sustainable utilization; SDGs; China

Coordinated control of $PM_{2.5}$ and O_3 based on the improvement of public health

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Abstract: Based on the urgent requirements of the 'Healthy China 2030' strategy for the improvement of the urban atmospheric environment, the coordinated control may become a new breakthrough in governance. From the perspective of public health improvement, this research hopes to explore how to maximize the health benefits brought by the coordinated control of $PM_{2.5}$ and O_3. First of all, emission control and health benefits will be connected through the logical line of emissions-pollutant concentration-public health risks. Furthermore, the CMAQ model was used to simulate the changes in the concentration of pollutants caused by pollution emissions. While, the exposure response function was used to account for the health risks brought by the changes in concentration. Finally, the optimal solution for coordinated control of $PM_{2.5}$ and O_3 is determined by comparing the health risks under different emission reduction scenarios. The research results show that: 1) although the reduction of $PM_{2.5}$ emission

has been effective, the continuous increase in O_3 emissions has also led to health risks that are difficult to mitigate; 2) the same pollutant emission control produces the most health benefits under the collaborative emission reduction scenario, which are 1.7 times and 1.3 times that of the reference scenario and the single emission reduction scenario, respectively; 3) when the ratio of $PM_{2.5}$ and O_3 emission control is 2.21, the public health benefit can be maximized while the total emission reduction is fixed. In addition, the research results can use to formulate the next step of air pollution prevention and control policies in China, which can achieve the goal of continuously improving the quality of the air environment and building a healthy human settlement environment.

Keywords: pollution emission; coordinated control; health benefit; air pollution control

The study of the coexistence between ecological quality and restorative quality of riverine landscape

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Abstract: The abandon Yellow River in Xuzhou City starts from Dingjia gate to Lizhuang gate, with a total length of 16.4 km. It is a natural river channel running through the main urban area of Xuzhou. Riverine landscape is an essential part of urban landscape, the overall quality of riverine landscape involved ecological quality and restorative quality, therefore, how to improve the coexistence between ecological quality and restorative quality of riverine landscape become an urgent problem to be solved. This research selected 10 sample sites, and quantify the ecological quality and restorative quality of each one, every site assessment include 5 trained reviewers, the standard of ecological quality reference to QBR index created by Munné, and restorative quality reference to the Self Rating Restoration Scale created by Han. Then calculate the coexistence of them by a formula created based on statistical principle. By date analysis and theory study, find the landscape elements of the riverine landscape and ecological quality and restorative quality of the contact mechanism. Established a strategy concentrated on improving the coexistence between ecological quality and restorative quality of riverine landscape by the perspective of design. And provides theoretical basis and practical reference for future riparian landscape design practice.

Keywords: ecological green equivalent; land use structure; landscape; scenic area; China landscape ecology

Identification of key elements and evaluation studies of social-ecological system in ancient villages based on nested archetype analysis - Take the ancient village clusters in the Jinjiang Valley as an example

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Abstract: At present, the methods of spatial distribution and evolution of ancient villages based on the application of GIS tools and perceptual knowledge are difficult to explain the complex social ecological system (SES) of ancient villages, it is mainly due to the lack of identification of the key elements and quantitative evaluation of the complex ancient village SES. The ancient villages in the Jinjiang Valley are typical ancient village clusters derived from the prosperous trading system in ancient times. The highly integrated village formation starts from the important supporting background of the regional spatial-economic-social system. In this paper, the prototype analysis method is used to construct a comprehensive data set for the evaluation of the social ecological system (SES) of ancient villages, and combines 22 representative heritage sites, quantitatively identify the prototype of SES prototypes of multiple ancient villages. Analyse key elements such as cultural background, political events, economics and trade, and nested combination with SES prototype (for example, the prosperity and sudden change of SES in Political Event-type ancient village, the stability of SES in Natural flow-type ancient village, etc.). Analyse the interaction between the prototype elements, quantify the function, economic, social, and cultural connection modes of the ancient village ecosystem. This article provides a path method with strong explanatory power for the SES study of ancient villages, and it provides a basis for the protection and development of regional ancient villages.

Keywords: nested archetype analysis; social ecosystem; ancient village preservation; Jinjiang Valley

Estimation of $PM_{2.5}$ and PM_{10} mass concentrations in mining city cluster from Gaofen-1 aerosol optical depth data and the WRF-chem model

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Abstract: Mining cities are an important part of China's urban agglomerations, and as mining cities continue to develop, ecological and environmental pollution has become a primary problem. The level of pollutant emissions of mining cities is much higher than that of non-mining cities, and the ability to repair the environment is lower than that of non-mining cities. City structure and air pollution are correlated, and studies of city cluster are different from previous air pollution analyses that have been conducted on regional basis. Particulate matter estimation for city clusters requires high spatial and temporal resolution observations to further understand the mechanisms of model, validate modelling results, and improve the modelling capabilities. In this study, the aerosol optical depth (AOD) retrieval of major mining city clusters in China from 2013 to 2020 was carried out by using the Gaofen-1 satellite data, and a new hybrid model based on WRF-CHEM and GTWR was proposed for $PM_{2.5}$ and PM_{10} mass concentration estimation. The temporal and spatial analysis of particulate matter characteristics according to the different transformation stages and urban structure of mining cities was carried out in mining city clusters in China in the past two decades. The estimated results for $PM_{2.5}$ and PM_{10} were verified at ground stations with R^2 of 0.81 and 0.78, and RMSE of 9.52 μg/m^3 and 18.09 μg/m^3, respectively. The results indicate that $PM_{2.5}$ and PM_{10} have distinct spatial and temporal distribution patterns as mining cities in China are undergoing different types of transformation processes.
Keywords: mining city cluster; remote sensing; Gaofen-1; $PM_{2.5}$; PM_{10}; AOD

Case study: Sustainable rammed earth model house

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Abstract: This paper describes a case study using energy efficient, environmentally beneficial construction technologies based on the sustainable use of land resources. Rammed earth is a sustainable construction material providing many benefits for the environment including natural materials, universal availability, durability, recyclability, low embodied energy, low CO2 emissions, high thermal mass, traditional construction methods, and low cost for materials, construction, and transportation. Sponsored by the United States Department of Housing and Urban Development (HUD) and the Aleutian Housing Authority (AHA), West Virginia University (WVU) researchers worked in collaboration with the North American Rammed Earth Builders Association to construct a single-family rammed earth residence in Alaska based on what they learned from Hakka rammed earth buildings, as known as Tulous. Those buildings reflect the emergence of innovation, evolution and advancement in the engineering of rammed earth construction in China from the 8th to 20th centuries. Researchers performed material characterization of rammed earth beams at WVU before implementation in the field. The objectives were to adapt rammed earth construction for Alaska and use local materials, local skills (labor), and minimal energy to build a prototype single-family affordable housing unit that can be economically reproduced in the Aleutians and elsewhere. Since the completion of construction in 2018, researchers have been monitoring the thermal comfort and energy usage of the building through sensors. The research findings reveal that this model house demonstrates a high level of living comfort and energy efficiency under extremely cold climate conditions and offers very high resistance to earthquakes. The building survived a local Richter scale 7.1 earthquake on November 30, 2018 without a single crack.
Keywords: rammed earth; sustainable construction; energy efficiency

Evaluation of intensive utilization of land use in rural settlements from the perspective of double carbon: A case study of Yishui County, Shandong Province

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Abstract: With the continuous rise of rural urbanization in China, although urbanization has improved the living standards of rural residents to a certain extent, it has also increased the burden of rural land and increased carbon emissions. In this paper, through a large number of visits and surveys in the rural areas of Yishui County, we excavated the problems of intensive utilization of residential land in Yishui County, construct a double-carbon intensive utilization index system for residential land from five aspects, such as low carbon level and land sustainability. Based on the analysis of the degree and obstacle of the intensive use of rural residential land in Yishui County, the paper studies the level and obstacle factors of the intensive use of rural residential land in Yishui County. The study found that among the 18 towns in

Yishui County, Cuijiayu Town, Yuandongtou Town and other towns were at a moderate utilization level, such as Xujiahu Town and Shagou Town, were at a low utilization level; Yicheng Street and Zhuge Town were at an extensive utilization level. The obstacle factors affecting the intensive use of land in rural settlements in Yishui County are the arable land per capita, the average carbon emissions, the proportion of forest and grass area, the building density, the fertilizers use per unit of arable land, and the land construction investment. According to the research results, this paper puts forward the planning suggestions for rural settlements in Yishui County under the background of double carbon, and provides reference for other towns.
Keywords: double carbon; rural settlements; land evaluation

Gold recovery from E-waste with Fe-electrocoagulation: Performance, mechanism, and pilot study

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Abstract: The importance of gold recycling from e-waste (electronic waste) is continuously increasing due to raising gold demand and the need for new recycling methods for this complex waste. The low content of gold in e-waste such as WMPPCB (waste mobile phone printed circuit boards) makes the traditional recovery methods (cementation, ion exchange, carbon adsorption, solvent extraction and electrowinning) for the extraction step inefficient and costly. Herein, in this study, for the first time, we report an efficiently and economically strategy for the recovery of low contents of gold from e-waste using Fe-electrocoagulation. WMPPCB aqua regia leachate containing low concentrations (5.15 g/L) of gold was treated by electrocoagulation at pH=6 and a tank voltage of 0.5 V. The results showed that the gold interception rate reached 99.93% and the gold content in the dried electrocoagulation sludge reached 5.9%. The other platinum group metals simulations were also treated by electrocoagulation under the same conditions and their dried sludge contents reached: Pd 13.69%, Rh 7.01%, Ag 4.9% and Pt 2.54% respectively. By XPS and TEM-mapping analysis, Au (III) and other platinum group metal ions in solution were first adsorbed by the iron (oxy) hydroxides generated by electrocoagulation and then reduced to nano-gold. In terms of energy consumption, its economic feasibility has been evaluated. In overview, this work provides a sustainable route for the recovery of gold from e-waste containing low contents of gold.
Keywords: E-waste; gold recovery; electrocoagulation; nano-gold

Study on the contribution of ecological resources to ecotourism economy and sustainable development

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Abstract: In order to explore the sustainable development model of ecological resources in ecotourism economy, taking Taihu Lake ecotourism economic belt as the research subject, adding water quality regulation factors on the basis of traditional ecological value accounting, and combined with Cobb Douglas (C-D) production function, the contribution and contribution rate of ecological resources in the process of ecotourism economic development are calculated. The results show that: (1) In the process of eco-tourism economic development, ecological resources have a great output effect on the economy at the initial stage of eco-tourism construction; (2) The economic loss caused by the reduction of ecological resources is greater than the benefit brought by the restoration of ecological environment; (3) The relative value of ecological resources with positive value should be considered when developing ecotourism economy; (4) The superior ecological resources required by the economic development of ecotourism need the support of supporting capital investment and labor investment. The contribution rate of capital investment and ecological resources investment is maintained at about 50%, which can maximize the use of resources.
Keywords: ecological resources; tourism economy; production function; factor contribution rate; sustainable development

Technique of concurrent mining and reclamation in multiple-seams repeated mining with high underground water table

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Abstract: In China's coal-cropland overlapping area, the reduction of arable land caused by coal mining collapse is a direct threat to national food security. To maximize the protection of arable land resources, the whole mining life cycle of Concurrent Mining and Reclamation system based on pre-mining analysis-mining dynamic damage prediction- reclamation simulation has been formed basically, which gradually becomes an inevitable trend to realize the sustainable utilization and development of land resources. However, with the exploitation of deep coal resources, a more complex mining environment and drastic mining disturbance lead to more significant uncertainty of surface subsidence, and the repetitive mining-side rehabilitation of deep coal seam clusters urgently needs theoretical enhancement and technical perfection. This paper summarizes the development history of land reclamation methods in mining subsidence areas and introduces the concept, design, and principles of Concurrent Mining and Reclamation. Taking the repeated mining of 11-2 coal seam and 13-1 coal seam of Guqiao coal mine in Huainan mining area as the engineering background, the improved normalized difference water index (mNDWI) and maximum inter-class variance (OTSU) image segmentation algorithm were adopted to analyze the spatial distribution and expansion of mining subsidence wetlands from 2008 to 2020 based on Landsat remote sensing images. Combined with the mining plan, the Probability Integral Method was applied to invert the repeated mining surface movement to reveal the time-series influence of mining subsidence on surface water accumulation. Then, by using the numerical simulation software of FLAC(3D) the surface deformation law caused by different mining plans of multiple coal seams, aiming to effectively control the overlying strata movement and surface subsidence through rationalizing the preferred mining solution, and actively selecting the land use mode and treatment scheme according to the local conditions. Meanwhile, the feedback of land use planning was used to guide the design of the mining scheme, to realize the harmony and unity of coal mining and land use during the whole mining life cycle.
Keywords: mining subsidence; multiple coal seams; repeated mining; land reclamation; concurrent mining and reclamation

Study on health risk assessment and remediation technology of a chromium contaminated site

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Abstract: Chromium slags were left over from history in a chromium chemical enterprize. In order to remediate the chromium contaminated soils, the health risk assessment and indoor experiment were done. Through drilling and sampling, the chromium pollution status and spatial distribution characteristics were obtained. The maximum total chromium concentration is 5781 mg / kg, which seriously exceed the national standard. According to the technical guidelines for soil pollution risk assessment of construction land (HJ25.3-2019), the health risk was calculated. The results showed that the carcinogenic risk of Cr^{6+} reached the order of 10^{-4}, the non carcinogenic hazard quotient of Cr^{6+} was 3.72, and the non carcinogenic hazard quotient of Cr^{3+} was 1.58.The chemical reduction stabilization technology was employed for remediation. Ferrous sulfate heptahydrate and calcium hydroxide were selected to carry out laboratory experiment. The experimental results showed that ferrous sulfate heptahydrate optimal dosage was 8% of soil mass ratio, and calcium hydroxide dosage was 1.5% of soil mass ratio.
Keywords: chromium slag; health risk assessment; chemical reduction stabilization; ferrous sulfate; calcium hydroxide

Application of high density organic material in soils provides a potential measure for organic byproducts recycling and soil fertility elevating

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Abstract: Most of the arid and semi-arid areas in China is characterized in low temperature and insufficient soil moisture, resulting in a low decomposition rate of crop straw. Consequently, crop straw is not returned to the field after harvest, because the crop residue in topsoil blocks the tilling and sowing machine, and sometimes prevents the seeds from germination. Thus, an innovative method of returning straws in the soil is needed to solve the above problems. In this study, high density organic matter (HDOM) was made of wheat straw (HDOM-W) by granulator, with addition of 10% biochar (HDOM-WB) and 10% elemental sulfur (HDOM-WS) in weight, respectively. The relationship between hardness of HDOM and soil moisture, the effect of HDOM on wheat germination rate, the decomposition characteristics and the effect of HDOM on wheat growth were systematically assessed. The results showed that the hardness of HDOM-W decreased sharply when the soil moisture content increased to 3%. Compared to chopped wheat straw (CWS) treatment, wheat germination rate was not significantly reduced by HDOM-W. Lower decomposition rates were found in HDOM-W, but the trends were similar. The biomass, total N and P concentration of wheat in HDOM-WS increased by 137.9%, 137.1%, and 141.8%, respectively ($P< 0.05$) compared to CWS. Wheat K concentration in HDOM-WB increased by 39.7% ($P< 0.05$). Therefore, application of HDOM in soils can improve seed bed, promote crop growth and increase nutrients, which finally elevating soil fertility. Organic byproducts like crop straws, fruit tree branches, grasses, abandoned wood furniture, etc. can be potentially recycled as HDOM and returned to the field to tackle the problem of organic waste disposal and sustainably maintain soil quality.
Keywords: high density organic matter; granular wheat straw; hardness; germination rate; decomposition

Exploration of coal slurry sedimentation characteristics from the perspective of clay behavior

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Abstract: The tailings discharged from coal preparation processes are used to be pumped and stocked in tailings ponds for clarification. However in China, there are few tailings ponds for coal slurry. Most tailings are generally clarified in concentrators which volumes are far smaller than tailings ponds. The supernant is directly recycled to processing units and underflow is pumped to dewatering. Due to the limited settling space and periods, the clarification is very easy to interfered resulting in supernant with relative high concentration and underflow with low concentration. Because the supernant is the main resource of production water, under this case, separation units have to be ceased until the recycled supernant concentration lower than the standard. Therefore, clarification is crucial for the whole coal separation processes. In this paper, two representative clay minerals in coal slurry water, kaolinite and montmorillonite were taken as research objects. The dynamic process of surface hydration, interlayer expansion and particle dispersion of clay minerals in coal slurry water have been revealed step by step. Meanwhile, with the help of the development of computational chemistry, the matching characteristics of inorganic and organic hydrophobic regulatory agents were clarified from the molecular level. Finally, following an overview of the previous study progress so far made both within and abroad on sedimentation characteristics based on clay behaviors, the development trend of coal slurry water treatment technology is also prospected.
Keywords: settlement of coal slurry water; clay mineral; sedimentation characteristics; swelling inhibition; molecular dynamics

Characteristics of antibiotic resistance gene contamination in fishery reclamation subsidence areas

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Abstract: The groundwater buried in the mining area of eastern China is shallow, and the reclamation of coal mining subsidence is mostly by agricultural and fishing reclamation. However, the widespread use of antibiotics in the aquaculture industry has caused contamination of antibiotic resistance genes (antibiotic resistance genes (ARGs)).To explore the pollution characteristics of ARGs in agricultural and fishery reclamation subsidence areas, the abundance and composition of ARGs were analyzed using metagenomics technology. There were 957 ARGs in the reclaimed agricultural soil samples, with the most widespread distribution of MacB and tetA (58). It found that the composition and relative abundance of ARGs in reclaimed agricultural soils were higher than in ordinary agricultural soils, and increased with

soil depth. Reclamation agricultural soils show greater ARGs capacity and ARGs are able to migrate to deeper soil and accumulate. 21 subtypes of ARGs were found, with the highest content of multidrug ARGs, MLS ARGs and tetracycline ARGs. There were 29 ARGs in the fish pond sediments, with widespread distribution of MacB. The species and relative abundance of ARGs in the sediments were much lower than in the soil. In addition, the relative abundance of sulfamamine ARGs and tetracycline ARGs was high and multidrug ARGs were abundant in well water samples. In total, 20 subtypes of ARGs were found, of which the relative abundance of multidrug ARGs was the highest, at approximately 31.1%.There were 15 classes of ARGs subtypes in soil and sediment, with a similar composition. The relative abundance of most ARGs isoforms in the soil samples was significantly higher than the fish pond sediment samples, such as the glycopeptide ARGs and the tetracycline ARGs.
Keywords: antibiotic resistance genes; metagenomics; agricultural and fishing reclamation; sediment; soil

Toxicity contribution study of tire wear particles and leaching solution to Daphnia magna

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Abstract: Tire Wear particles (TWP) generated by the abrasion of tire tread against road surfaces, have been shown to represent the majority of anthropogenic particles released into the environment and are considered as an important category of microplastics (MPs). TWP entering the aquatic environment can be ingested by aquatic organisms and produce toxic effects. However, it is not clear whether the particles chemical composition (including polymers and additives) or particles themselves are driving factor for TWP toxicity. To explore this question, we choose Daphnia magna as a test organism and studied the acute toxicity of original TWP particles, leaching TWP particles and leaching solution under different exposure concentrations. The results showed that original and leached TWP particles with an average size of 40um were ingested by Daphnia magna and accumulated in the intestine, which resulted in the inhibition of the activity. Both particles themselves and particles chemical composition produced a negative impact on Daphnia magna physiological activity, such as reduced swimming vigor, inhibited feeding behavior, increased heart rate, decreased thoracic branch activity rate and oxidative stress. However, this toxic effect mainly depended on particle concentration and leaching time. Generally, higher particle concentration and longer leaching time contribute to higher pollutant concentration in the leaching solution, and the more likely it is to cause toxic effects on Daphnia magna. Interestingly, no significant dose dependence was observed in our study. Similarly, Toxic effects of raw TWP particles and extracted TWP particles on Daphnia magna appeared more random. Surprisingly, from the activity of acetylcholinesterase (AChE), they did not induce neurotoxicity in Daphnia magna. However, the induction of AChE activity altered diverse behavioral endpoints, which may affect adaptation and survival of the exposed organisms.
Keywords: TWP; extracted TWP; extracted solution; toxicity; water flea

Foliar uptake and transport of airborne trace metals bounded on fly ash in wheat seedling (LX-99)

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Abstract: Deposition of fly ash (FA) emitted from coal-fired electricity has been recognized as an important trace metal (Cu, Cr, Pb and Zn) source for crops growing in overlapped areas of farmland and coal resources. Adverse effects of high concentrated FA trace metals on crop growth have been observed, while limited research has been focused on trace metals uptake by plant leaves from FA. Trace metals stress on wheat seedlings (LX-99) with and without FA exposure were studied and results show that trace metals deposition with FA decreases seedling size and mass significantly. Chlorophyll a, b and total chlorophyll contents in seedlings with highest FA stressed decreased 17.3, 18.8 and 17.4% compared to blank and the Rubisco and GAPHD activity decreased 37.1 and 6.6% respectively. Pb content in leaves and roots, Cu and Zn in leaves and Cr in roots increased with FA deposition while no significant difference appeared in Cu and Zn in root and Cr in leaves. C Cr, Cu, Zn and Pb in FA are mainly existed in hydrochloric acid extraction with few water-soluble forms and liposoluble form. More than 60% of Cr, Zn and Pb in underground part and aboveground part were hydrochloric acid extract and debris states, Cu in

seedling of wheat was extracted by ethanol and deionized water form. The evaluation results of trace metal activity showed that Cr, Zn and Pb have low activity in wheat seedling, while Cu has high activity according to the results of trace metals fractions in plant.
Keywords: wheat seedlings; foliar uptake; transportation; trace metal fractions

Effect of non-ammonium leaching agent of ion-adsorption rare earth ore on soil properties

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Abstract: Non-ammonium leaching is an important way for the green development of ion-adsorption rare earth ores. However, the effects of different non-ammonium leaching agents on soil ecological environment remains unclear. Taking the raw ore as the blank control, we investigated the differences of the effects of three non-ammonium leaching agents (Magnesium sulfate, calcium chloride and calcium chloride-aluminum sulfate) and ammonium sulfate on soil physicochemical properties, microbial quantity and enzyme activity through indoor column leaching, and discussed the main limiting factors of tailings soil vegetation restoration under different leaching agents. Results showed that the soil properties of tailings leached by non-ammonium agents are significantly different from those of ammonium sulfate. Compared with ammonium sulfate leaching agent, non-ammonium leaching reduces the loss of potassium, brings rich calcium or magnesium elements, and improves the activity of acid phosphatase in tailings soil. However, the number of culturable bacteria and soil basic respiration after non-ammonium leaching are lower than those of ammonium sulfate. After leaching by calcium chloride and calcium chloride-aluminum sulfate, the microbial biomass carbon of tailings was significantly lower than that of ammonium sulfate. The raw ore soil is poor in nutrients and lacks nutrients such as organic matter, nitrogen, available phosphorus and available potassium. Non-ammonium leaching leads to the imbalance of the calcium-magnesium ratio in tailings soil, which is also one of the limiting factors of vegetation restoration. In addition, the residue of aluminum after calcium chloride-aluminum sulfate leaching is a potential limiting factor for tailings vegetation restoration.
Keywords: ion-adsorption rare earth ore; non-ammonia leaching; microorganisms; limiting factors of vegetation restoration

Biomass carbon accumulation in the regeneration process of dominant tree species in damaged subtropical ecosystems

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Abstract: Less study has investigated how the generation and carbon accumulation dynamics of sprouts on trees damaged by disturbances are related to the damage types. This study was performed by taking advantage of the “natural laboratory” in subtropical secondary forest formed after the disturbance like this heavy ice storm fall in southern China in 2008. Data were collected for eleven consecutive years and the sprouts generation of three major damage types were studied to track the sprouts biomass restoring process and the carbon accumulation dynamics of *Schima superba*. The results showed that the mean sprout total biomass per tree and the mean sprout total biomass carbon per tree for uprooted trees all exhibited a bimodal curve, rising over time to a maximum in year 4 and in year 9 after the storm, respectively, and then declining. They all increased rapidly after 6th year, and gradually stabilized in the 9th year after recovery for decapitated trees. After 11 years of restoration, the sprout biomass carbon per tree for decapitated trees was about 4.5 kg. While 3 years after the disaster, this value for uprooted trees maintained a stable level within the recovery process, and about quarter of decapitated trees. The sprout biomass carbon storage per unit area of decapitated trees increased gradually, and was about 6 tons per hectare after 11 years. While that of uprooted and leaning trees aintained a lower consistent level. In 2018, the total sprouts biomass of the decapitation trees only recovered to the state of the undamaged ones in 2009 after the disturbance. The results can provide a scientific basis for the natural restoration of the damaged ecosystem vegetation in the mining area.
Keywords: disturbance; *Schima superba*; sprout biomass; sprout biomass carbon accumulation; damage type

Analysis of hydrochemical evolution in strong alkali coal mine water and water source identification: A case study

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Abstract: As one of the important means to distinguish the type of water quality, the chemical characteristics of groundwater are of great significance for determining the source of water inrush in mines.According to the difference in water chemistry characteristics of different aquifers, the water-rock interaction analysis of strong alkaline mine water is carried out, and a mixed water identification model based on SFLA-BP neural network algorithm (Shuffled Frog Leading Algorithm-Back Propagation neural network) for mine water source is proposed. Taking the Muduchaideng Coal Mine as an example, the water quality of four aquifer systems (loose layer-LA, coal bearing sandstone-CA, and the underlying sandstone-TA) are analyzed. Groundwater samples are further classified by cluster analysis and factor analysis. Parameter optimization of BP neural network model using SFLA. Using 70% of the 67 sets of sample data as training samples and 30% as prediction samples, the simulation experiment was carried out to establish the SFLA-BP neural network model, which was compared with the BP neural network algorithm. The results suggest that major ion concentrations of the aquifer systems were different from each other, and factor analysis indicates that their chemical compositions are mainly originated from two kinds of contributions: dissolution of soluble minerals and weathering of silicate minerals. And the main water source of the mine is TA. Research believes that the water source identification model based on the SFLA-BP neural network algorithm can more effectively eliminate the influence of interference factors and accurately identify the type of mine water inrush.
Keywords: water source identification; SFLA-BP neural network; water chemistry characteristics; mine water hazard

A review on: Land reclamation and ecological reconstruction in Pingshuo opencast Mine from 1986 to 2021

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Abstract: Land reclamation was earlier carried out in Pingshuo opencast mine 35 years ago in China, and is having been implemented consistently covering period from 1986 till now. The practice case of integration of mining and land reclamation in the Pingshuo mining area was awarded the “Typical Case of Brand Building of National Central Enterprises in 2019” and the results of ecological construction have been listed by the State-owned Assets Supervision and Administration Commission of the State Council as the highlight of the central enterprises practice of the “Two Mountains Theory” in 2020. Aiming to provide applicable experience for researchers, managers from across the Loess Plateau, and to expect to play a demonstrative and reference role for the ecological construction and ecological industry from across the “Black Triangle” region of Shanxi Province, Shaanxi Province, and Inner Mongolia, this review described the development process of land reclamation and ecological reconstruction in Pingshuo mining area from the planting of grass, shrubs and trees to the restoration of cultivated land, summarized the experience and results of land reclamation and ecological reconstruction, and preliminarily planned the development direction of the future ecological industry. So far, the land reclamation area has reached about 4000 hectares in the dump area, the vegetation coverage rate reached more than 95%, which is much higher than that of the original, and the number of plant species in the mining area was over 213, wild animals 30, insects more than 600, respectively, turning dumps in the mining area that used to be without grass into a tree-lined and vigorous green ecological park. In conclusion, with land reclamation and ecological initiatives undertaken, the effect of ecological reconstruction in dumps is obviously better than that of the original ecology before mining.
Keywords: land reclamation; ecological reconstruction; applicable experience

Enhanced biodegradation of anthracene by multi-substrate progressive domestication of a mixed microbial consortium with *Pseudomonas aeruginosa*

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Abstract: The bioremediation of polycyclic aromatic hydrocarbons has attracted more and more attention due to its ecotoxicity. In this study, based on toluene-catechol-anthracene multi-substrate

progressive domestication, a mixed microbial consortium with synergistic metabolic activity was screened from the activated sludge of coking wastewater. High-throughput sequencing showed that the consortium was dominated by Flavobacteriia at the class level, with the proportion increasing from 8.88% to 56.41% after domestication, and that *Myroides* and *Brevundimonas* dominated at the genus level, increasing from less than 1% to 55.53% and 12.28%, respectively. Under temperature conditions of 30 °C, a pH of 7, and an initial anthracene content of 40 mg L^{-1}, the degradation ratio reached 85.7% just 16 days after inoculation. Degradation ratio of anthracene (40 mg L^{-1}) via the consortium plus an indigenous biosurfactant-producing strain *Pseudomonas aeruginosa* DM3 on the sixth day (83%) equated to that in the control group without DM3 on the 12th day. The first-order rate constant (k=0.240 and 0.159 d^{-1}) was calculated for the anthracene degradation within 10 days, with a corresponding half-life by the consortium of 2.9 days with DM3 and 4.4 days without DM3. Moreover, the intermediary metabolites 1-naphthol, dibutyl phthalate, and 1,2-benzene dicarboxylic acid, mono (2-ethylhexyl) ester were presented in the reaction, inferring the metabolic pathway of phthalic acid.

Keywords: multi-substrate domestication; mixed microbial consortium; *Pseudomonas aeruginosa* DM3; biodegradation; anthracene

A new approach to increase land reclamation rate in coal mining subsidence area: A case study of Guqiao coal mine, China

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Abstract: Underground coal mining inevitably causes land ponding in the region with high groundwater tables, which will affect sustainable land development. However, the traditional reclamation (TR) method has a low land reclamation rate. Thus, finding a suitable reclamation approach is crucial to alleviate the conflicts between coal exploitation and land protection. In this paper, the Guqiao Coal Mine of China, used as a typical case study, was seriously affected by mining-induced ponding. First, the dynamic distributions of surface subsidence and land damage from 2007 to 2017 were revealed based on concurrent mining and reclamation (CMR). Second, the land-water layout of five reclamation schemes (e.g., no reclamation, TR, CMR I, CMR II, and CMR III) were simulated. Then, a dynamic filling elevation model and filling thickness model were constructed. Finally, the earthwork allocation sequence was optimized. Results revealed that: (1) reclaimed land area: CMR III > CMR II > CMR I > TR > no reclamation. (2) Digging depths are directly proportional to the earthwork volumes and land area and are inversely proportional to the water areas, but with an increase in digging depths, the reclaimed land area is relatively lower. (3) CMR schemes had reclaimed 426.31~637.82 ha and 259.62~471.13 ha more land than no reclamation and TR scheme, respectively. Compared with no reclamation and TR scheme, CMR schemes can increase the proportion of reclaimed land by 33.77~50.52% and 20.57~37.32%, respectively. Research results provide a reference for increasing the mine reclamation rates in areas with high phreatic tables.

Keywords: coal mining; mining subsidence; high groundwater table; mine reclamation; sustainable land use

Coupling PLUS model and InVEST to assess the impact of coal mining and reclamation on carbon storage in high groundwater level mining areas

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Abstract: Carbon sequestration in terrestrial ecosystems plays an essential role in coping with global climate change and achieving regional carbon neutrality. In the mining area with high groundwater levels in eastern China, underground coal mining has severe damage to surface ecology. It is of practical significance to evaluate and predict the positive and negative effects of coal mining and land reclamation on carbon pools. This study set up three scenarios for the development of Yanzhou coalfield (YZC) in 2030, including (1) No mining activities (NMA). (2) No reclamation after mining (NRM). (3) Mining and reclamation (MR). The probability integral model is used to predict the subsidence caused by mining in

YZC in 2030, and the land use and land cover (LULC) of 2010 and 2020 are interpreted by remote sensing images. Based on the classification of land damage, the LULC of different scenarios in the future is simulated by integrating various social and natural factors. Under different scenarios, the InVEST model evaluated carbon storage and its temporal and spatial distribution characteristics. The results indicated that: (1) By 2030, YZC will have 4341.13 ha land disturbed by coal mining activities; (2) NRM's total carbon storage is 36796.04 Mg C less than NMA and 17315.54 Mg C More than NRM; Especially in Nantun mine, 71.74% loss is reduced due to reclamation measures. (3) Carbon storage has a significant positive spatial correlation, and coal mining will lead to the fragmentation of carbon sink. The method of carbon storage accounting and prediction proposed in this study can provide data support for mining and reclamation planning of coal mine enterprises and carbon-neutral planning of government departments.
Keywords: carbon storage; high groundwater level mining area; land reclamation; mining subsidence prediction; land use simulation

Biodegradation characterization and genomic function analysis of bis (2-ethylhexyl) phthalate esters-degrading bacteria Methylobacterium sp. F05R

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Abstract: A Gram-negative aerobic strain Methylobacterium sp. F05R isolated from the topsoil of a landfill can utilize a variety of phthalates and efficiently degrade bis (2-ethylhexyl) phthalate esters (DEHP). Under optimal conditions, 200 mg/L DEHP could be degraded by 92.2% in 7 days. Based on Gas Chromatography-Mass Spectrometry (GC-MS) analysis, monoethylhexyl phthalate (MEHP) and phthalic acid (PA) were considered to be the major metabolites. Combined with the genomic annotation of strain F05R, it is speculated that DEHP will generate 3-acetyl-CoA through degreasing, dehydrogenation, oxidation and other pathways, and then enter the TCA cycle to complete degradation. The substrate broad spectrum test proved that strain F05R was able to grow with 200 mg/L of DBP, BBP, and DnOP as the sole carbon source, and the degradation effect of these three PAEs were 85%, 84%, and 74% in 6 days, respectively. And the degradation ability of DBP with short branch chain is stronger than DnOP with long branch chain. In addition, strain F05R could effectively remove DEHP in contaminated soil. When the water-soil ratio is 2: 1 and the culture speed is 180 r/min, DEHP (50 mg/kg soil) in the contaminated soil can be degraded by 76.7% within 7 days. These results indicate that F05R strain has great potential for bioremediation of PAEs contamination.
Keywords: contaminated site; land reclamation; microbial degradation; DEHP

Evaluation of soil quality and maize growth in different profiles of coal gangue filling reclaimed land

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Abstract: Utilizing coal gangue (CG) as a filling matrix to construct different sections of coal mining subsidence and filling reclaimed land has problems of lack of water and fertilizer and low crop yield. 7 different profiles of reclaimed land were constructed in the field with maize planting experiments to systematically assess soil quality of reclaimed land, select soil profile, and verify factors affecting crop agronomic characteristics. Soil quality was evaluated by the minimum data set (MDS) of soil quality index (SQI) obtained by principal component analysis (PCA), the correlation between corn agronomic characteristics and soil physical and chemical properties was computed. The result shows that soil organic matter (SOM) and soil moisture (SM), pH value, and electrical conductivity (EC) were the critical indicators to evaluate soil quality of reclaimed farmland, pH contributed the highest value in the surface SQI. The surface SQI value increased with increase of the thickness of surface overburden, and decreased with the increase of the interlayer depth in reclaimed profiles filling with CG. R^2 between the SQI based on MDS and annual crop yield can reach 0.438. Agronomic traits of maize, except stem diameter, are positively correlated with the nutrient index and SM of the surface soil, and negatively correlated with pH, EC and total salt content (TS). This study indicates that it is necessary to take effective measures to reduce and control pH value of CG used as a substrate for filling and reclamation. Choosing a thicker surface overburden can effectively increase soil quality and crop yield. Meanwhile, the inherent characteristics of the surface and interlayer soil are supposed to be considered in the design of the reclaimed profile type.
Keywords: land reclamation; soil properties; soil quality index; maize growth

The effectiveness of typha angustifolia as phytoremediation agent for heavy metals (Fe, Mn) reduction in the coal mining operation

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Abstract: Mine water management is a systematic methodology to manage water as a direct or indirect generated from mining activities within the operation area. The water management methods are divided into two major categories; active and passive treatment. This field study aims to investigate the effectiveness of passive treatment in settling ponds with wetland systems implemented using Typha angustifolia as a phytoremediation agent in a coal mining operation. This study overlooked the heavy metals component, such as Iron (Fe) and Manganese (Mn) as a product of mine drainage and Typha angustifolia as a heavy metal accumulator. The locations for sampling water, such as disposal material, wetland area, and river. From the laboratory testing with the Atomic Absorption Spectrophotometer (AAS) testing. The concentration of Fe and Mn in the inlet of the wetland are 0.341 and 0.019 mg/L respectively. Water is directed into the wetland through open channels, processed for 30 days, and Fe and Mn accumulation in plants are 137.86 and 87.15 mg/Kg. The passive treatment results in the concentration of heavy metals Fe and Mn in the outlet are 0.086 and 0.011 mg/L respectively. This study showed that Typha angustifolia could reduce Fe and Mn concentrations by 74.79% and 40.23% on average.
Keywords: water management; phytoremediation; heavy metals; wetland system

Laboratory simulation in developing the swampy forest system for passive treatment of acid mine drainage

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Abstract: Coal mining that applies open pit method has potential to generate acid mine drainage. Acid Mine Drainage (AMD) treatment has been processed to mitigate by enormous challenges including active treatment of high costs with process uncertainty and passive treatment with its limitation. The new concept of Swampy Forest system is the development of passive treatment for AMD by lower costs, higher capacity, and a natural process to mitigate the AMD that has been generated. The laboratory simulation experiment has been carried out to obtain the basic data of the swampy forest system treatment. The basic references data those will be determined on this study including the total volume of water, the water debt flows into the swampy forest scale laboratory system and the retention time are obtained to change the parameter values that do not meet the quality standards to meet the quality standards according to the applicable regulation. The AMD swampy forest treatment design in pilot project at field of treatment apply the scale up of the basic data of simulation laboratory experiment result.
Keywords: acid mine drainage; threshold value; swampy forest system

Assessment and spatial-temporal analysis of ecosystem multifunction in the consolidated area along ancient yellow river

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Abstract: It is very important to reveal the evolution characteristics of ecosystem multi-function in the ancient Yellow River basin under the influence of comprehensive land consolidation to improve the sustainable ecosystem function and the optimal management of territorial space. To this end, this study selects the Suining section of the ancient Yellow River as the research area, and uses the InVEST model to comprehensively evaluate 8 ecosystem functions including primary production, human settlement carrying, recreational services, carbon sequestration, water production, water purification, soil conservation, and habitat maintenance. And reveal the change and trade-off-synergy relationship of ecosystem multifunctionality in the study area from 1990 to 2020. The research shows that: ①In the past 30 years, the land use in the study area has changed from agricultural production to a mode of use that

takes into account production, living and ecology; ②In each ecosystem function, production and living functions such as primary production, human settlements, and recreational services are all common. While the functions of carbon sequestration, water production, water purification, soil conservation, and habitat maintenance have fluctuated and increased; ③The multi-functionality of ecosystem in the region increased by 21.07% in the past 30 years.④ From a spatial point of view, there are significant synergistic relationships among the functions of habitat carrying-water production, habitat carrying-soil maintenance, carbon sequestration-habitat maintenance, while habitat carrying-carbon sequestration, habitat carrying-habitat maintenance, carbon sequestration. There are significant trade-offs among functions such as sequestration-water production, water production-habitat maintenance, and water purification-soil maintenance. Primary production-recreational services, primary production-water production, and primary production-habitat maintenance gradually evolved into a synergistic relationship. This study shows that the comprehensive improvement of the ancient Yellow River has a significant positive effect on the multi-functionality of the ecosystem, and synergistically improves the production-life-ecological functions (intensification of agricultural production, intensification of residents' carrying capacity, ecologicalization of the watershed, intensification of production, concentration of life, and ecological restoration).is an effective way for the sustainable development of the ancient Yellow River ecosystem. In the future, regional ecosystem adaptive management should be strengthened to improve ecosystem sustainability.

Keywords: comprehensive land improvement; InVEST model; ancient Yellow River; ecosystem multifunctionality

Effect of contact angle hysteresis on measurement methods of unsaturated soil matrix suction

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Abstract: The contact Angle plays an important role in matrix suction of unsaturated soils, but few studies consider the effect of contact Angle hysteresis on matrix suction. In this paper, taking sandy soil as an example, the influence of contact angle hysteresis on the suction of unsaturated soil matrix is studied by soil particle model calculation and experimental method. When the contact angle is less than 90°, the unsaturated soil will also produce water repellency, which is different from the capillary law that the contact angle is less than 90°, which has hydrophilic properties. When the water content is the same, the suction of the matrix decreases continuously with the increase of the contact angle; this model can lay a foundation for the study of water repellency of unsaturated soil. With the increase of water content, the matrix suction is not affected by the soil contact angle; it is proved that the contact angle in unsaturated soil is not a constant, but varies with the change of external environment. In the process of dehumidification, the apparent contact angle of sand at the same moisture content < receding contact angle; there is a difference in the matrix suction between the continuous measurement method and the intermittent measurement method, and the matrix suction of the continuous measurement method > the matrix suction of the intermittent measurement method. This study provides a theoretical basis for the study of unsaturated soil matrix suction.

Keywords: unsaturated soil; matrix suction; soil-water characteristic curve (SWCC);·contact angle hysteresis; sand soil

Extraction of ecological restoration zones in the Yellow River Basin and its impact on the temporal and spatial dynamics of ecosystems

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Abstract: The Yellow River Basin (YRB), as an important ecological barrier in China, has sustained extensive and profound ecological restoration efforts in the past decades. However, the spatial extent, spatio-temporal dynamic patterns, and dynamic impacts on the ecosystem of its ecological restoration zones (ERZs) are still limitedly explored. In this study, we used remote sensing technology, LUCC products, and trajectory-based change monitoring methods to quantitatively extract and characterize the spatial pattern of ERZs in YRB from 1985 to 2019. Three ecosystem services (ESs), including carbon storage (CS), habitat quality (HQ), and soil conservation (SC), were selected to quantitatively assess the

ecosystem quality of YRB in combination with the physiographic profile of YRB. The ecological restoration index (ERI) was constructed to establish the dynamic linkage between ERZs and ecosystems, and to explore the characteristics of the relationship between the spatial and temporal dynamics of ERZs on ecosystems. The results showed that from 1990 to 2015, the area of the ERZs in YRB was 184197.05 km². The changes in the geographic centers of the three subcategories of ERZs, forest restoration zones (FRZs), grassland restoration zones (GRZs), and shrub restoration zones (SRZs), show an obvious pattern of geographic migration. The total basin-wide carbon storage fluctuates up and then decreases sharply, reaching 170.33×10^8 Mg in 2019. The average habitat quality dynamics increases significantly, from 0.407 to 0.411. This study is expected to help clarify the characteristics and quantitative structure of the spatial dynamic change pattern of ERZs in YRB, quantitatively portray the synergistic/coupled effects of ERZs and ecosystem quality, and ultimately lead to the systematic and orderly deepening of ecological restoration in the YRB ecosystem.
Keywords: ecological restoration; ecological restoration zones; Yellow River Basin; ecosystem services; spatial dynamic

Topic 3: Energy and Sustainable Green Development

Mitigation and adaptation approach in neighbourhoods scale to cope with health risks under extreme heat stress: Experience and implications of 'cool neighbourhoods NYC'

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Abstract: This paper mainly discusses the relationship among space. The impact of urban heat wave on health is manifested in direct and indirect health risks, as well as the equity of risks. At the same time, these impacts overlap and condense a lot at the time and space levels, resulting in the prominent risk of heat health stress especially at the community level. Firstly, this article sorts out the general plan, sector plan and action plan of New York City's adaptation planning to address climate change. Secondly, the article focuses on the analysis of the 'Cool Neighbourhoods NYC' base on neighbourhood scale mitigation and adaptation approaches, including neighbourhood heat vulnerability assessment, neighbourhood heat mitigation strategies, neighbourhood heat adaptation strategies, and heat monitoring feedback systems. Finally, combined with current territorial planning and community governance in China, the article puts forward the implications and reference of dynamic health assessment, integrating health goals, improving service network and real-time monitoring feedback.
Keywords: health risks under extreme heat stress; mitigation and adaptation; neighbourhoods scale; cool neighbourhoods NYC; sustainable design

Towards low-carbon cities experiences from Germany

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Abstract: Low-carbon cities are in the center of the discussion about sustainable urbanization worldwide. However, the transition towards smart eco-cities is not at all easy, and it cannot simply be achieved by constructing new urban neighborhoods according to modern design standards. In fact, the transition towards more sustainable low-carbon cities can only be successful if we find ways to combine environmentally friendly and economically viable technological solutions with innovative appropriate urban design concepts. Such concepts have to respect the human scale, encourage the emergence of socially integrated neighborhoods, and provide options for a better quality of life in urban areas. Germany is among the countries, which have started early to gather experience with the change of energy systems and the transition towards low-carbon cities. We will share and discuss some experiences in this presentation. The presentation will cover the following issues: First, an overview of the ongoing international and national discussion about low-carbon cities is given. The major fields of action as well as challenges to manage the respective transition processes are discussed. Second, challenges and opportunities of the transition towards low-carbon cities are dealt with. Good practice examples from

Germany with a focus on technical solutions and procedural arrangements are presented. Third, perspectives regarding the transition towards low-carbon cities are discussed. They include recommendations concerning necessary future actions concerning practice and research.
Keywords: low-carbon cities; sustainable development; German practice

Energy transition, carbon peaking and carbon neutrality

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Abstract: To achieve the goal of carbon neutral carbon peak, we need to vigorously promote energy transformation and develop non-fossil energy sources such as wind power photoelectricity to replace fossil energy sources such as coal. As the cost of wind power photoelectricity and other non-fossil energy is higher than that of coal, the energy replacement process will drive up the cost of the energy system, which will bring new challenges to the security of China's industrial chain. The international competitiveness of Made in China depends to a considerable extent on the integrity of the industrial chain, and the security risk of the industrial chain brought by the rising energy cost may affect the international competitiveness of Made in China. Therefore, Carbon Neutral needs to balance the security of the industrial chain and the international competitiveness of Chinese manufacturing, and strive to resolve the pressure of rising energy costs in the process of energy transition.
Keywords: carbon peaking and carbon neutrality; energy transformation; energy costs; industrial chain security

Policy evolution and transformation effect analysis of sustainable development of resource-based cities in China

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Abstract: This paper summarizes the policy evolution of sustainable development of resource-based cities (RBCs) in China over the past 20 years and analyzes the results of promoting sustainable development of RBCs. The main points of this paper are as follows: 1) The evolution path of sustainable development policy of RBCs in China in the past 20 years basically follows the development logic of combining problem orientation and goal orientation, experienced from “administrative intervention”, “administrative guidance” to “comprehensive governance” changes. Generally speaking, the policy evolution can be roughly divided into three stages, namely, the stage of resolving difficulties, the stage of comprehensive promotion and the stage of high-quality development. 2) At present, China has formed a “four-in-one” policy framework for sustainable development of RBCs, which includes the transformation of resource-exhausted cities, innovative development of resource-rich cities, transformation and upgrading of independent industrial and mining areas, and comprehensive treatment of coal mining subsidence areas. 3) RBCs make full use of local advantages, and initially form some characteristic transformation development models. 4) In the new era, RBCs are faced with severe challenges such as large carbon emission reduction tasks, weak economic growth, and difficult development in special areas. It is urgent to make all-out efforts to solve key problems and promote sustainable development.
Keywords: resource-based city; sustainable development; policy evolution; transformation effect

Sociometabolic analytics for circular economy and carbon neutrality

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Abstract: Human civilization relies on the use of resources to fuel the multitude of socioeconomic activities satisfying human needs and well-being such as food, shelter, transportation, and communication. Industrialization and urbanization in the past centuries have been transforming vast amounts of raw materials from the biosphere and lithosphere to the anthroposphere in the form of buildings, infrastructure, and consumer goods. Such a continuing use of raw materials has raised concerns on both growing resource scarcity and supply constraint and increasing environmental challenges (e.g., waste boom and climate change) associated with materials production and consumption. Addressing these issues would therefore require a system understanding of the patterns, drivers, and implications of materials extraction, use, accumulation, and end-of-life management throughout our socioeconomic systems; and we call these systems approaches for complex problems “sociometabolic analytics”. The past

two decades have witnessed an increasing amount of effort with such a sociometabolic perspective for mapping and informing societal circular, low carbon, and just transition in the emerging field of industrial ecology. In this talk, I will briefly introduce the use of sociometabolic analytics for understanding the nexus between material, energy, and emission systems and thus informing circular economy and carbon neutrality policy, with empirical cases on agrifood systems, metal cycles, and construction materials use at various geographical scales.
Keywords: industrial ecology; circular economy; climate change mitigation; material flow analysis

Sustainable rural design

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Abstract: Rural area is a complete and organic system. The whole system is driven by different external and internal forces, so as to continuously develop and evolve. When planners and architects work in rural field, they should deeply understand this system, uphold the concept of sustainable development and operate carefully. Taking Shouchangsi village in Fuping County and Maopu village in Xinxian County as cases, this paper discusses sustainable rural design from three levels. First of all, at the level of planning and layout, the article puts forward the planning thought of “Extract the principle” and “Follow the context”. Before planning and design, through a large number of on-site investigations, excavate the original village planning concept and layout idea; In the process of planning and design, conform to the construction logic and spatial context of the village and let it grow organically under the constraints of natural and social conditions. Secondly, at the level of architectural design, pay attention to the transformation and reuse of existing abandoned buildings in the village, and encourage the preservation of space characteristics and traditional style and the inheritance of local construction skills; Third, at the level of landscape design, pay attention to the extraction and reproduction of “rurality”, so as to better retain the regional and cultural characteristics of the village.
Keywords: rural design; sustainability; regional characteristics

Has the stress on China’s carbon market been released? A consideration of national and pilot carbon market stress index construction

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Abstract: With the establishment of the carbon market of China, it is important to comprehensively measure the market stress. This paper constructs a new stress measurement system of carbon market from the perspective of trading, emissions reduction and external shocks, and then simulates the stress indices of national and pilot carbon markets through functional data analysis and CRITIC dynamic weighting. We find that first, the overall stress of the carbon market is in the shape of “W”, with frequent fluctuations and an upward trend, and the peak and valley values gradually increasing over time, with a range of [0.3-0.5]. At present, the stress is still at a high level, and there is no downward trend. The stress of Hubei, Beijing and Shanghai carbon market fluctuates and rises while the stress in Guangdong carbon market decreases. In addition, stress in Hubei and Guangdong carbon market is relatively small, indicating that a larger trading size can significantly release the market stress. Moreover, carbon market stress mainly comes from trading stress, followed by emissions reduction stress. The stress from external shocks is relatively small. Furthermore, from the characteristics of stress fluctuation, Guangdong and Beijing carbon market are more prone to “big waves” and are more sensitive to big events, while Hubei and Shanghai carbon market are relatively insensitive. Finally, the pilot markets are divided into stress-driven and stress-release market by stage, and the type of which keeps change in different period. Based on the findings, it believes that energizing trading and improving emissions reduction efficiency is an effective way to release stress.
Keywords: carbon market; stress index; FDA -CRITIC empowerment; emissions reduction stress

Identification of spatial conservation and restoration priorities for ecological networks planning in a highly urbanized region: A case study in Beijing-Tianjin-Hebei, China

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Abstract: Building ecological networks is not only critical for biodiversity conservation, but also for sustainable urban development. It is of great significance to integrate a connected network of protected areas into spatial planning as human-dominated land use changes are the most irreversible process.

Taking the Beijing-Tianjin-Hebei (BTH) region as an example, the Least Cost Path (LCP) model is adopted for ecological networks simulation at regional scale based on a resistance map composed by different factors (i.e., naturalness of land covers, the riparian corridor, and disturbance of roads) derived from very high resolution spatial data. Then, all least cost paths are classified as green or blue paths, and evaluated according to their contribution to the whole network connectivity. Two types of prioritized locations are identified for restoration and conservation: breaking points and stepping stones. The results show that there are a total of 246 potential ecological corridors between the protected areas, and 6 breaking points that need to be restored and 12 intersection points of LCPs (particularly with the blue paths) that are considered as stepping stones enhancing networks connectivity. Further spatial overlay of the ecological networks and Major Function Oriented Zone (MFOZ) plan shows that the current regional development strategy needs to be adapted to protect the integrity of the ecological networks from possible disturbance of human activities. On-site verification has proved that our results can provide reliable instructions for spatial conservation and restoration of ecological networks and contribute to the optimization of spatial planning in practice.
Keywords: ecological networks; breaking points; stepping stones; restoration priority; MFOZ plan; BTH region

Review of research on recreational utilization of abandoned mining areas and construction of research framework system

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Abstract: Strengthening the research on recreational utilization of abandoned mining areas is of great significance for promoting regional sustainable development and realizing high-quality tourism development. In order to realize the standardization and systematization of the research on the recreational utilization of abandoned mining areas, the research contents, research methods and other related achievements of recreational utilization of abandoned mining areas at home and abroad are systematically combed by literature review and inductive analysis. At present, the researches lack the perspective of “man-land relationship” and ignore the dynamics of recreational utilization. So, the connotation of “man-land relationship” of recreational utilization in abandoned mining areas is discussed, and at the same time the dynamic evolution law of recreational utilization is revealed in abandoned mining areas, and the research framework and method system are built under the theory of man-land relationship. According to the research, the essence of recreational utilization of abandoned mining areas is to coordinate the relationship between “people” and “land” in the natural environment through the rebuilding recreational function, so as to optimize the relationship between people and land. Recreational utilization of abandoned mining areas is a dynamic evolution process, which can be divided into three development stages: contradiction stage, reconciliation stage and coordination stage. Driven by the demand of “people”, abandoned mining areas have gradually evolved into a new leisure space with harmonious relationship between people and land through resource utilization, capitalization, industrialization and regionalization. The future research on the recreational utilization of abandoned mining areas should follow the research framework of “man”-“land”-“man-land relationship”, including studying the motive goal, value orientation and interest demands of “man"; analyzing the composition of leisure and recreation resources of “land” and the conditions for transforming abandoned mining areas into leisure and recreation spaces; discussing the mode, mechanism, effect of recreational utilization and the policy guarantee system in abandoned mining areas under the harmonious relationship between man and land.
Keywords: abandoned mining areas; recreational utilization; research framework; man-land; relationship theory

The spatial patterns and formation factors of brownfields in China: A meta-analysis

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Abstract: The spatial distribution pattern of brownfields can help governments at all levels, and investors have more detailed information on land resources, prioritize brownfield redevelopment, and guide urban spatial and strategic planning. These are an increasing global concern, yet knowledge of brownfield distribution patterns of macro scales remains limited, especially in China. In this paper, we present the first comprehensive dataset of known brownfield sites and their distributions in China, derived from

China National Knowledge Infrastructure (CNKI), Web of Science (WOS), and Chinese Industrial Heritage List published between 2001 and 2019. The results showed that the dataset contained 816 Geo-referenced brownfield records in 255 cities. Brownfields were mainly distributed southeast of the "Heihe-Tengchong Line", with an overall spatial distribution pattern of "East-dense-West-sparse". In terms of brownfields types, industrial brownfields were the most numerous, followed by mining brownfields. By applying the nearest neighbour indicator analysis, it was concluded that brownfields in China present significant spatial agglomeration characteristics, and that the six types of brownfields manifest different scales of spatial agglomeration. The hot spots were mainly concentrated in the Yangtze River Delta, Beijing-Tianjin-Hebei, and Pearl River Delta urban agglomerations. Factors influencing brownfield formation were related to industrial structure adjustments, resource depletion, accelerated urbanization, and the orientation of national policies, with industrial structure adjustments as the leading cause. Mastering the spatial pattern of brownfields can coordinate the planning of land use transformation and guide brownfield redevelopment.
Keywords: brownfield; spatial patterns; formation factors; China; meta-analysis

Research on "Human-Ecology" interaction under the influence of smart technology

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Abstract: In the review of urban ecological environment to interact with intelligent technology development, on the basis of the three stages of history, from the ability of urban ecological environment protection, promote urban ecosystem supply service mode innovation, create new experience of urban ecological environment, auxiliary city ecological environment management and the research from four aspects to the urban ecological environment changes under the influence of the intelligence technology. In the future, academic research on the multi-dimensional relationship between human and nature under the influence of intelligent technology should be strengthened, and how the urban ecosystem can be presented and utilized in a new way should be paid attention to, so as to build a smart sustainable urban planning framework based on "human-technology-ecology".
Keywords: smart technology; influence; urban ecological space; response of planning

Economic uncertainty, industrial policies and technical innovation of renewable energy enterprises: Evidences from the listed photovoltaic companies in China

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Abstract: The development of renewable energy is an important way to reduce carbon emission. Compared with traditional energy, renewable energy has been at a relatively weak market position under the constraints of R&D. Therefore, the application of industrial policies to support the development of renewable energy industry has become a worldwide consensus. In order to explore the effect of industrial policies and economic uncertainty on the technical innovation activities of renewable energy enterprises, this paper uses the data of photovoltaic enterprises in China and adopts the traditional and negative binomial fixed effect models(FEM) to test the R&D input and output of photovoltaic enterprises. The results show that economic uncertainty restrains the technical innovation activities of photovoltaic enterprises, and industrial policies such as subsidies and feed-in tariffs (FIT) can promote the technical innovation output performance of photovoltaic enterprises. In particular, the incentive effect of subsidies is mainly reflected in strengthening the R&D input of enterprises, while FIT don't give play to the effect of increasing the R&D input of enterprises. In addition, the economic uncertainty will also restrict subsidy to promote the output effect of technical innovation of photovoltaic enterprises, and it has no impact on the effect of FIT.
Keywords: economic uncertainty; industrial policies; renewable energy enterprises; technical innovation; fixed effect model (FEM)

Free trade zone and China's industrial green transformation: Theoretical mechanism and empirical test

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Abstract: When dealing with the two major issues of economic globalization and climate change, the industrial field is the main focus. The opening-up policy should not only ensure the competitiveness of the industry in the international environment, but also promote the green transformation of industry. Considering the establishment of Shanghai pilot free trade zone as a "quasi natural experiment", this paper uses an improved regression control method to evaluate the policy effect of Shanghai pilot Free Trade Zone on local industrial green transformation with provincial industrial data. Then, the theoretical impact mechanism of the pilot free trade zone on industrial green transformation are put forward, including green technology, environment risk and industrial structure, and the panel data of industrial sectors in 11 pilot free trade zones are further constructed for empirical analysis. The main conclusions of this paper are as follows: 1) the establishment of pilot free trade zone shows a positive driving effect on the green transformation of China's industry; 2) the upgrade of green technology and the optimization of industrial structure are the major approach to promote the green transformation of industry ; 3) the "negative list" management mode implemented brings certain environmental risks and inhibits the green transformation of industry, but this inhibition is less than the positive promotion of green technology and industrial structure. Finally, some suggestions for future free trade pilot zone are provided based on the research results.
Key words: pilot free trade zone; industrial green transformation; regression control method; mediating effect model; environment risk

Forecasting coal power overcapacity risk in China: A novel hybrid data-driven approach

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Abstract: Establishing a more complete forecasting system of industrial overcapacity risk will help to achieve scientific prevention and precise control of overcapacity, as well as promote high-quality economic growth. Unlike previous literature, we have proposed a new set of forecasting indicator and model systems for coal power overcapacity risk (CPOR) based on the perspective of industrial linkage and the idea of data-driven integrated modeling. First, grounded in industrial linkage theory, we included the upstream, downstream, complementary and alternative industries in a framework of the forecasting indicator system (FIS) for CPOR. Next, we used the filtering and association rule algorithm for dual feature selection of the forecasting variables, and we obtained an FIS of comprehension and emphasis. Second, due to the data's high dimensionality and sparseness, the cost sensitivity of decision problems, and the machine learning model's lower interpretability, we built a forecasting model system that covers "model construction → model evaluation → model interpretation". The empirical results show that our risk forecasting system effectively concerns the accuracy, expected losses, and reliability of forecasting outcomes. Further, we reveal the multi-source inducement of China's CPOR, identify the key overcapacity risk indicators under different risk levels, and explain the evolutionary law of the risk state. The findings provide comprehensive quantitative analytical tools and a thorough solution for the dynamic monitoring and forecasting of CPOR, as well as a reference and inspiration for other industries.
Keywords: data-driven; industrial linkage; overcapacity; risk forecasting; coal power industry

Are the official national energy data credible? Empirical evidence from statistics quality evaluation of China's coal and its downstream industries

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Abstract: The authenticity and quality of industrial statistical data directly affect all types of systematic research based on it. Considering the limitations of extant data quality evaluation literature on research objects and evaluation methods, we constructed a new data quality comprehensive inspection and evaluation model based on Benford Law-Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), selected coal-related industries as the research object, and conducted an empirical test along the research path of "Industry→Province→Indicator". The results showed that at an industry level, the quality of statistical data for China's coal-related industries from 2001 to 2016 was generally poor. Among the eight sample industries selected, the data quality for five industries, including coal, electricity, and steel, was assessed as poor or a slightly poor. Furthermore, at the provincial-level, there is significant spatial heterogeneity in the quality of statistical data of various industries affected by factors such as economic structure, marketization level and industrial diversity. Compared with other types of statistical indicators, industry financial indicators are more prone to data quality problems at the indicator level and the suspiciousness indicators of different industries show certain common characteristics and some industry differences. To improve the quality of industrial statistical data and reduce the possible adverse

impact of data quality problems, based on the research findings, we propose targeted countermeasures and suggestions on how to prevent data fraud, and effectively identify and rationally use suspicious data.
Keywords: industrial statistics; data quality; comprehensive evaluation; coal-related industries

Allocation of non-hydro renewable portfolio standard targets among China's provinces based on bi-level programming approach

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Abstract: The development of renewable energy power is a critical driving force for China's energy structure's reform. Formulating a scientific renewable portfolio standard (RPS) quota allocation scheme is a crucial guarantee for achieving the 2030 carbon peak and the 2060 carbon neutrality goal. Based on the complex dynamics of China's RPS quota allocation game process and the current industry management system, and considering the heterogeneity of the benefits between the central government and local governments, a new provincial non-hydro renewable portfolio standard (NHRPS) quota allocation model based on bi-level multi-objective nonlinear programming is required. Based on data from 30 provinces in China, an optimal distribution scheme that considers cost, environment, and fairness were obtained. The results show that because of the differences in energy substitution costs and emission reduction costs between provinces, the implementation intentions of various provinces show great differences in the implementation of the indicator tasks assigned by the central government. The comparative analysis results show that compared with the government's current distribution scheme, the bi-level optimized distribution scheme saves 4.222 billion yuan in subsidy costs, 259.512 billion yuan in energy substitution costs, and 79.139 billion yuan in emission reduction costs. Meanwhile, the Gini coefficient of the bi-level optimal distribution scheme is less than 0.2, which indicates absolute fairness. The NHRPS quota allocation model proposed in this research reflects the complex dynamics of China's RPS quota allocation scheme and formulates a more effective and reasonable decision-making tool and reference for the government to formulate an NHRPS quota scheme.
Keywords: renewable portfolio standard; bi-level multi-objective programming; quota allocation

Community environment sustainable development assessment based on emergy analysis

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Abstract: In the era of stock development, urban renewal has become a key variable affecting the process of carbon peak and carbon neutralization of international cities. As a first-tier city in the world, Beijing has a large backlog of community renewal needs. Sustainable community construction is not only an important support to promote green urban renewal, but also the only way to explore low-carbon urbanization. Emergy analysis, as an internationally recognized evaluation method, can comprehensively evaluate the behavior of research systems. In this study, the concept and method of emergy analysis were introduced into community renewal. Taking 36 community units in Long ZeYuan sub-district, Beijing as the research object, the emergy system map was drawn, the index system was constructed, and the social benefits, economic benefits and environmental benefits of the sustainable development of the community were directly quantified, and carry out targeted sustainable design research through quantitative results. The results show that each community is in the consumption stage of non-renewable resources, which also leads to the limitation of the sustainable development capacity of the whole street in the future. Through the in-depth analysis of the community emergy calculation results, it provides a theoretical basis and development ideas for the follow-up green renewal.
Keywords: urban renewal; emergy analysis; sustainable development; community renewal; long ZeYuan sub-district

The impact of different functional block morphology on solar energy potential in Nanjing

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Abstract: Enhancing the use of solar energy is considered an effective measure to reduce carbon emissions in the building sector and to enhance the sustainability of regional buildings in high-density urban areas. Urban block morphology has an important impact on solar energy potential. In this paper,

typical block morphology of industrial, residential, educational, office and commercial areas are extracted in Nanjing city as an example. Subsequently, the solar radiation simulation of the block morphology is carried out based on the Ladybug plug-in of the parameter platform Grasshopper. The solar energy potential of different blocks is compared and analyzed. In addition, the morphological parameters of each block were recorded for correlation analysis with solar potential. The conclusions show that the single-story factory block has the highest solar potential, followed by the high-density multi-story residential blocks. High-rise residential blocks, high-density commercial and office blocks have lower solar potential. In addition, it was found that building density and street canyon aspect ratio are key morphological parameters that influence the solar potential of block morphology, as the larger the roof area and the less shading between buildings, the larger the area of solar energy utilization in blocks. These findings will provide further insights into solar energy driven urban design and energy-efficient retrofitting of buildings in urban areas.

Keywords: solar energy potential; block morphology; functional areas; grasshopper; urban design

Prediction research of VaR and ES in crude oil market based on mixed data sampling and asymmetric Laplace distribution

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Abstract: Recently, the great fluctuation of the crude oil market has caused adverse effects on the economic environment, drawing more attention to accurate forecasting from researchers, investors, and policymakers. The traditional risk measurement methods mainly focus on the 1-day horizon Value at Risk (VaR), which is not enough to warn investors. And the Basel Accord III laid new emphasis on Expected Shortfall (ES) in 2019, making new requirements for risk management. In order to improve the accuracy in low-frequency risk forecast and take ES into consideration, we adopt a new method based on the Mixed Data Sampling (MIDAS) framework to jointly forecast the VaR and ES in the crude oil market through the Asymmetric Laplace density, named AL-MIDAS. It makes full use of the information contained in daily data to make direct low-frequency risk predictions, thus improving the accuracy of the predictions. And we take multi-day VaR and ES of WTI as the target and take WTI and USD index return as the independent variables separately to study the different impact of own historical data and influencing factors' data on the forecast. The results show that, based on the AL-MIDAS, it is a good performance with WTI own historical return; while the forecasting performance with USD index daily return is unstable. What's more, compared with the historical simulation method, the performance of the new method is better. Therefore, MIDAS should be used in risk management to improve management ability.

Keywords: mixed data sampling; value at risk; expected shortfall; joint elicitable; crude oil market

Dynamic analysis of China's PM2.5 concentration-Based on the perspective of functional adaptive clustering

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Abstract: Fine particulate matter (PM2.5) has typical time-varying characteristics, and the traditional discrete analysis method cannot describe its dynamic change process, which is not sufficient for in-depth information mining. Therefore, it is necessary to bring it into the category of continuous dynamic function for analysis. Based on the continuous dynamic perspective, this paper studies the temporal characteristics and category patterns of PM2.5 concentration changes in 74 sample cities in China from December 2014 to August 2021. Firstly, the intrinsic function of the temporal trends of PM2.5 was reconstructed by the discrete data information of actual observation. Secondly, the dominant trend of PM2.5 change was determined by functional principal component analysis (FPCA). Furthermore, the classification model of PM2.5 change was objectively divided by clustering analysis. Finally, functional variance analysis was used to test the significance of PM2.5 change difference under different types of modes, and the potential energy transformation rule of the whole and each type of modes was analysed based on the periodic period division of PM2.5 change function. There are three types of PM2.5 dynamic change patterns in China. The characteristics of the three types of PM2.5 dynamic change patterns are significantly different in the initial stage, and the decrease rate is different. The analysis shows that the three types of PM2.5 dynamic change patterns are mainly affected by the differences of industrial structure, economic development level, geographical location and policy. At the end of the stage, PM2.5 levels of different modes are close to each other and tend to have no difference. This paper expands the research perspective of PM2.5 evolution law and classification model, analyses the potential influencing factors according to the dynamic change characteristics of PM2.5, and provides reference for decision-making departments to formulate real-time and effective air pollution control plans.

Keywords: functional data analysis; time-varying characteristics; clustering analysis; fine particulate matter

Research on sustainable design of traditional villages based on the production-life-ecological function perspective: A case study of Zhoutie village

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Abstract: The historical value and cultural value of traditional villages are the most precious treasures in our country. However, under the background of modernization and urbanization, traditional villages are gradually losing their historical and cultural characteristics and being eroded by cities and small towns. How to improve the living environment of traditional villages to make them suitable for modern life and retain the historical context and local genes of traditional villages has become a difficult problem in the development of traditional villages. Based on the concept of sustainable design, this paper discusses how to protect and improve the ecological environment, living space and native culture of traditional villages from the perspective of 'Production-living-ecological'. Different from the traditional sustainable design, this paper presents a sustainable design method of up-down linkage, encouraging people and decision-makers designing together to create energy-saving, efficient and historically sustainable village space. Taking Zhoutie village as an example, this paper analyzes the overall pattern, spatial form, history and culture of the village by means of GIS, spatial syntax and field investigation, and puts forward practical sustainable development strategies, which are verified by Ecotect and other software. It is hoped that this study can inspire the sustainable design of traditional villages.
Keywords: 'production-living-ecological' perspective; sustainable design; traditional villages; up-down linkage

Environmental benefits of resource-based industrial agglomeration in the yellow river basin: Perspective based on proximity effect

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Abstract: In order to study the influence of proximity effect of resource-based industrial agglomeration on environmental pollution, this paper used a two-regime spatial Durbin model to examine the form of "Forces" produced by the resource-based industrial agglomeration among different provinces in the Yellow River Basin. Then the spatial lag of X (SLX) model is constructed to connect the positive and negative aspects of agglomeration externality (positive externality and crowding effect) from the perspectives of local effect and spillover effect. The empirical results show that both centripetal force and centrifugal force exist in the neighboring provinces, which aggravates the spatial self-selection effect of resource-based industries. Because of the negative proximity effect, the geographical neighboring provinces have opposite effect on air pollution control. At the same time, the agglomeration of resource-based industries between economically neighboring provinces produces centripetal force, which relieves the self-selection effect of resource-based industries and causes the same effect of air pollution control among economically neighboring provinces. What's more, while the positive externalities of the agglomeration drive the development of green technologies, which in turn reduce regional environmental pollution, the crowding effect squeezes the cost of pollution control. The polluting enterprises choose to migrate across the land, which aggravates the regional environmental pollution and weakens the positive role of industrial agglomeration in controlling environmental pollution. This is not conducive to China's long-term ecological civilization construction. The conclusion of this paper shows that to strengthen the control and guidance of regional industrial agglomeration, especially to reach consensus on the regulation and control of resource-based industrial agglomeration in the neighboring provinces, will be beneficial to China's environmental governance and the construction of ecological civilization.
Keywords: resource-based industrial agglomeration; proximity effect; SLX model

Does the green credit policy affect the financing cost of enterprises: An empirical study on Chinese A-share listed enterprises from 2008 to 2019

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Abstract: Green credit policy (GCP) is an important measure to realize green transformation of economy and society. This paper set the "Green Credit Guidelines" issued in 2012 as the research event, and panel data from 1359 companies of China from 2008 to 2019 as the sample, analyzing the impact and mechanism of GCP on enterprise financing costs by difference in difference method. The results show that: after the implementation of the GCP, the financing costs of high energy consumption and high pollution enterprises increased compared with energy saving and environmental protection enterprise. Specifically, GCP affects the cost of debt financing by changing the size of debt financing and commercial credits, and affects the cost of equity financing by changing the financial situation and the degree of environmental information disclosure. However, there is multi-dimensional heterogeneity in the emission of GCP. Compared with state-owned enterprise, the effect of GCP on the financing cost is more significant, and compared with medium-carbon and low-carbon emission regions, the effect of GCP on high-carbon emission regions is more significant.
Keywords: green credit policy; financing costs of enterprise; equity financing; debt financing; DID

Forecasting power demand in China with a CNN-LSTM model including multimodal information

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Abstract: The power industry is a basic industry in the national economy and a key industry for China to achieve the "dual carbon goals". Accurate forecasting of power demand is the primary basic work for the development of the national power master plan, coal power withdrawal, and renewable energy investment decisions. Therefore, using the modeling idea driven by multi-modal information fusion to construct a new integrated forecasting model of power demand based on CNN-LSTM (Convolution Neural Network, Long Short-term Memory) in a multi-source heterogeneous data environment. Firstly, CNN is used to extract implicit features from power demand numerical time series data and text data (including policy texts, news reports, and forum comments); Secondly, series feature and text feature are organically fused by series fusion method; Finally, the fused features are input into the LSTM model for prediction. The experimental results show that, on the one hand, the proposed multi-modal information fusion prediction model is superior to the widely-used single prediction model (e.g., ARIMA, CNN, and LSSVM) and combined prediction model (e.g. EEMD-ARIMA and EEMD-LSSVM) in terms of level accuracy and directional accuracy; on the other hand, it proves that the organic fusion of time series data and text data can effectively improve forecasting performance. The forecast results show that due to the influence of multiple factors such as China's economic restructuring and energy system transformation, China's power demand growth will gradually slow down or even show a downward trend in the next two years. This finding provides an important decision-making reference for the low-carbon transformation of China's power system.
Keywords: power demand; forecasting; multimodal information fusion; feature fusion; CNN-LSTM

Does carbon emission trading mechanism affect employment? Evidence from China

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Abstract: This paper uses DID model to analyze the effect of carbon emission trading mechanism on employment in industrial sectors in pilot regions, including Beijing, Shanghai, Tianjin, Chongqing, Hubei, Guangdong and Shenzhen. Then, this paper applies SYS-GMM model to analyze the nexus of carbon price and employment, and contributes to the literature by decomposing the mechanism effect into complementarity effect and scale effect. This is done by means of China Statistical Yearbook and statistical yearbooks of pilot regions. The results show that carbon emission trading mechanism has a significantly positive effect on employment in pilot regions' industrial sectors. Carbon price has a larger positive scale effect, which is enough to offset the negative complementarity effect on employment. Moreover, carbon price has a larger scale effect in industrial sectors with high market concentration ratio than low market concentration ratio, while a larger complementarity effect in industrial sectors with high energy intensity than low energy intensity. The results indicate that manufacturers with market power will increase factor input and use their market power to reduce abatement cost, so that the labor demand will be increased. Manufacturers where labor and carbon emission are complementary will also increase labor demand as

carbon price rises.
Keywords: carbon emission trading mechanism; carbon price; DID; SYS-GMM; complementarity effect; scale effect

Maximum output cleaning-cycle optimization at a 20 MW solar-power plant

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Abstract: In recent years, photovoltaic (PV)- power plant has increased markedly. The dust-caused loss of a 20 MW(p) PV power plant, located in the Baicheng area, was analyzed. The power generation data show that dust-caused power-loss has a linear dependency with dust deposition. A cleanliness management model is used to find the optimal cleaning-cycle to produce maximum output-power. The results show that, when the average light intensity is 260W/m^2, the 500kW array produces the maximum economic output per unit time, using mechanical cleaning and a cleaning cycle of 2.9 d, so as the 20 MW(p) PV power plant. For a 20MW solar PV power plant, the yearly income can increase RMB 1.32 million by selecting the optimized cleaning cycle.
Keywords: PV modules; dust deposition; maximum output cleaning -cycle; economic analysis

Does central environmental supervision improve total factor productivity? Evidence from China

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Abstract: The improvement of total factor productivity is the only way to promote the sustainable development of population and economic society, and innovative environmental regulation policy is an important means to solve the contradiction between environment and economy. In this paper, the effect and mechanism of environmental supervision on total factor productivity of enterprises are empirically tested by using the data of A-share listed companies from 2010 to 2019 and DID model. The results show that environmental supervision can effectively improve the total factor productivity of enterprises in pollution-intensive industries. Moreover, environmental supervision policy guides enterprises to increase the number of effective invention patents and improve the total factor productivity of enterprises while it induces enterprises to increase meaningless or inefficient R&D investment and reduce the total factor productivity of enterprises. Last, enterprises in areas with weak environmental regulations are more sensitive to central environmental supervision, and the innovation compensation effect of policies is stronger. The above results confirmed the effect of environmental supervision policy, which has important reference and enlightenment significance for the formulation and implementation of environmental regulation policy in the next stage.
Keywords: central environmental supervision; total factor productivity; DID; innovation compensation effect

Air pollution, human capital and the vitality of urban innovation

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Abstract: This paper matches Chinese city data with several micro databases, and uses regression discontinuity design (RDD) to separate the causal relationship between air pollution and urban innovation based on a natural experiment of centralized heating in northern winters, and its mechanisms are discussed from the perspective of human capital. The results show that: air pollution significantly reduces the innovation vitality of cities, specifically, a 1% increase in PM2.5 concentration will significantly reduce the innovation vitality of cities by 1.414%; Compared with non-invention patents, air pollution has a more obvious inhibitory effect on invention patents with higher innovation capacity requirements and technology content. A series of robustness tests prove that the core findings of this paper are credible. In terms of the impact mechanism, air pollution may undermine urban innovation vitality by increasing the emigration of high-skilled from cities and by impairing human psychological health. The study reveals the importance of environmental governance and provides empirical evidence that the government should actively implement the development concept of “Lucid waters and lush mountains are invaluable assets”,

attract and retain high-skilled human capital by protecting the environment, improve the local level of healthy human capital, and build innovative cities.
Keywords: air pollution; city innovation; migration of high-skilled; mental health; $PM_{2.5}$

Impact of green financing on the business performance of China's environmental protection listed companies

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Abstract: This paper summarizes and analyzes the impact path of green financing on corporate performance on the basis of existing basic theories related to green financing and corporate business performance. From the perspective of corporate financing structure, the endogenous financing rate, debt financing rate and equity financing rate are used as indicators to measure green financing of environmental listed enterprises, and the return on total assets is used as an indicator to measure the operating performance of environmental listed enterprises, and a multiple regression model is constructed to study the correlation between the specific structure of green financing and the operating performance of enterprises. On this basis, the panel data of 119 environmental protection companies listed in Shanghai and Shenzhen A-shares from 2011-2018 were selected for empirical analysis. The empirical results show that endogenous financing and debt financing of environmental listed companies have a significant positive relationship with their business performance, while equity financing has a significant negative relationship with business performance, proving that green financing has a significant impact on business performance. The empirical results show that endogenous financing and debt financing of environmental listed companies have a significant positive relationship with their business performance, while equity financing has a significant negative relationship with business performance, proving that green financing has a significant impact on business performance. In the context of a green economy, environmental companies should improve endogenous financing, maintain appropriate debt financing, and reasonably plan equity financing to contribute to healthy corporate development.
Keywords: green financing; corporate financing structure; business performance; environmental listed companies

Electrical energy production in EU and CO_2 reduction - needs and possibilities

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Abstract: In recent years European Union together with among others Japan and South Korea, has developed the Green Deal strategy, which should transform Union into a climate-neutral region. EU wants to reach this aim in 2050. Until 2030 is going to reduce the CO_2 emission by 55%. It requires massive investments in energy production, especially in these countries where the renewable energy sources are small, and according to the earlier EU assumptions for 2020 don't exceed 20%. The paper presents the structure of energy sources in European countries and the progress in their diversification in the light of the European Green Deal strategy in the last years. Even though electrical energy gives ca. 31% of CO_2 emission in EU countries, its number according to some scenarios can grow even up to 10% until 2030, so new sources of energy will be needed. The paper shows the amount of CO_2 emission for the different sources and how much carbon dioxide is emitted by individual countries. It paid attention for the carbon emission tax, which artificially increase the costs of energy production. It is a political tool in zero-emission strategy, but its open market value does not reflect the yearly policy of EU members. Taking into consideration the geological resources of fuels and technical possible investments, the paper shows the real possibilities of the change of energy production structure in the EU till 2030 and estimated associated costs.
Keywords: EU energy policy; climate-neutral region; CO_2 emission; energy source change possibilities; carbon emission tax; European green deal strategy

Dynamic dependence and risk spillover between exchange rate market and crude oil market: The factor copula model

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Abstract: As important financial markets, fluctuations in the crude oil market and the exchange rate market will be affected by the entire macroeconomics. In order to measure the interdependence more accurately and strengthen the risk management of the two markets, it is necessary to identify the common factors of the two major markets and identify the dynamic dependencies by factor analysis. For this purpose, this paper uses the two crude oil futures prices WTI and Brent as well as the exchange rates of 14 oil trading countries' daily yields from 2000 to 2020. By extracting the common factors and constructing the dynamic factor copula model to reveal the oil price-exchange rate dependences, and to measure the risk spillover effect. The two-factor copula model is more suitable for studying the dependence of exchange rates and oil prices by statistical indicators and graphs, so the two-factor copula model is used. Our findings indicate that the public factor better reflects the trend of the global economy. Considering the public factors, the oil price-exchange rate dependences in oil importers is slightly lower than in oil exporters, even though the dependence is weak in general. Affected by various factors, the risk spillover of the crude oil market to the foreign exchange market is higher than the latter to the former, indicating that the crude oil market fluctuates more significantly. Therefore, the supervisory authority should be concerned about cross-risk spillovers between financial markets and pay more attention to the dynamic changes in those public factors.
Keywords: factor analysis; oil price; exchange rates; factor copula model; CoVaR

Carbon emissions trading, regional heterogeneity, and green innovation: Evidence from a quasi-natural experiment in China

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Abstract: China's pilot carbon trading policy aims to force relevant enterprises to implement green technological innovation and then reduce carbon emissions in an efficient way. However, the green innovation effect of the carbon markets may differ in regions, depending on the specific economic structure and program design. Therefore, we try to estimate the heterogenous impacts of emissions trading on green technology innovation in several pilots through the synthetic control method and mediating effect model, based on the provincial panel data from 2000 to 2019. Our empirical analysis reveals the heterogeneous green innovation effects among the regions with diversified scheme designs. In specific, this market-based instrument helps to improve green innovation only in Hubei and Guangdong with active trading platform. In contrast, it has little effect in other regions because of the loose emissions cap related to the economic slowdown or the unnecessary inclusion of service sectors. In addition, the central findings remain robust when PSM-DID model is applied. The mechanism analysis suggests that the success in these regions may be related to the distinctive features of the market, including active transaction of carbon allowances and focus of regulation capacities on the energy-intensive emitters. Furthermore, the choice in benchmarking allocation approach also plays a positive mediating role between ETS and green innovation. The results of this paper offer some key insights into improving the policy design of a nationwide carbon trading market in China. This national-level market should include emissions from primary energy consumption in major energy-intensive industrial sectors but take no account of secondary energy consumption in non-industrial sectors. Policymakers should appropriately tighten the emissions control targets and strengthen the supervision mechanism for the incumbent firms' performance to increase the liquidity of the carbon market and then provide effective incentives and a stable market environment for the emitters' green technology innovation.
Keywords: emissions trading; green innovation; regional heterogeneity, synthetic control method; mediating effect; pilots in China

What are the differences between the influences of issuing green bonds on the short-term and long-term corporate financial performance? Evidence from China

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Abstract: As an important green financial instrument, green bonds have an significant impact on the green and sustainable development. The impact of green bonds on corporate financial performance is significant for the green transformation for enterprises. However, the impact of green bonds on corporate financial performance, especially their differences on the short-term and long-term corporate financial performance need to be further studied. Consequently, the mechanism of issuing green bonds on the short-term and long-term financial performance of enterprises is deeply analyzed, including the direct effect and indirect effect. Issuing green bonds not only directly affect the corporate financial performance by capital supply effect, green reputation effect, resource driving effect on directly, but also indirectly affect it through mediating variables-R&D investment, environmental information disclosure and agency

cost. With the sample of annual data of 860 non-financial listed companies from 2012 to 2020, the empirical results of the difference-in-differences (DID) model show that the issuance of green bonds significantly reduces the short-term financial performance of enterprises, while significantly improves the long-term financial performance of enterprises. The further empirical analysis based on mediating models find that the issuance of green bonds mainly reduces the short-term financial performance of enterprises by increasing agency cost, while improves the long-term financial performance by improving R&D investment and environmental information disclosure. Finally, this paper puts forward practical policy suggestions on how to use green bonds to promote corporate financial performance.
Keywords: green bonds; short-term financial performance; long-term financial performance; difference-in-differences; mediating effect

Evaluation of ecological benefits of urban forest based on i-tree eco model: Taking Changchun city center as an example

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Abstract: Urban Forest is one of urban ecosystems with the most significant ecological benefits, how to evaluate the ecological benefits of urban forest based on the regional characteristics of different cities, analyze their cost-benefit relationships, and make the layout and input-output of urban forest more economical and reasonable is important. This study uses the i-Tree Eco model, taking urban forest as the research object, to assessing the ecological benefits of urban forest from four aspects: carbon fixation and oxygen release, energy conservation, rainwater retention, and air quality improvement, and converts them into economic benefits. Through mathematical statistical analysis, the cost-benefit relationship of urban forest with different proportions of trees and shrubs was analyzed, and the impact range of urban forests of different layout types was compared. Conclusion: (1) Arbor species are the main factors affecting the ecological benefits of urban forests. When the proportion of arbor is 36%, the cost-benefit of urban forest reaches the average value, and the best cost-benefit arbor coverage rate is 29.81%; (2) The impact of urban linear forest is wider; (3) If the proportion of urban forest tree in the study area is adjusted to 36%, the ecological benefits can increase by 61 million yuan each year. The quantitative model evaluation of urban forest ecological benefits in this study provides efficient and convenient research paths and tools for exploring urban forest ecological benefits, economic benefits, and cost-benefit relationships under different geographical characteristics, which can provide quantitative support to contribute to balanced construction of urban ecological civilization and economy benefits.
Keywords: ecological civilization; urban forest; ecological benefit; economic benefit; i-Tree Eco model

Research on evaluation model of sustainable development level of urban street network system based on BP neural network

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Abstract: As the framework of the area, the urban street network system supports the overall development of the area. The street network system not only affects the type and intensity of surrounding land, but also affects the structure and form of urban space. Under the background of “Carbon Neutrality” and “Carbon Emission Peak”, the carbon emission of street transportation system has become an important proportion of regional carbon emission. Therefore, it is necessary to establish a low-carbon sustainable development evaluation system of street network. Firstly, 12 evaluation indexes of low-carbon sustainable development of urban street network system are selected from the aspects of road engineering, service level and environmental quality. Then an evaluation model is established based on BP (back propagation) neural network to calculate the grade of low-carbon sustainable development level of urban street network system. At the same time, the indexes of three different street network types from Dongzhimen District, Wanquansi District and Yizhuang District of Beijing are substituted into the evaluation model to operate. The evaluation results are regressed with the indexes. It is found that the street network types with clear structure level, moderate network density and multiple intermodal modes have a high level of low-carbon sustainable development. This study provides theoretical support for the evaluation and improvement of the sustainable development level of urban street network system under the background of realizing the strategic goal of “Carbon Neutrality” and “Carbon Emission Peak”.
Keywords: street network system; low-carbon; sustainable development; evaluation model; structure; density

How does emission trading reduce China's carbon work? An exploration using LMDI and Time-Varying DID approach

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Abstract: In order to adapt to the low-carbon and green environmental development trend, China has implemented emissions trading scheme (ETS) for seven regions since 2010, ETS is an effective market-based instrument to achieve lower CO_2 emissions. A number of studies have confirmed the effectiveness of the approach. However, there is incomplete research on the effect and influencing channels of emission trading on carbon intensity reduction. To explore these problems, the studies conducted an empirical analysis, using the log-averaged Divisia Index (LMDI) to decompose industrial carbon dioxide (CO_2) emissions for the seven pilot regions from 2006 to 2019 into economic size, economic structure, energy efficiency, and energy mix effects. Then, a difference-in-difference (DID) model evaluates the implementation effects of this ETS, Finally, using a mediating effects model to study the specific pathways affecting carbon emission reductions. The main conclusions are as follows: (1) China's emission trading pilots have driven a significant decline in the carbon intensity; (2) the change in industrial CO_2 emissions is mainly due to the energy scale and energy efficiency effects.
Keywords: LMDI; emissions trading scheme; difference-in-difference model; industrial CO_2 emissions; mediating effects model

Debating low carbon economy within the prosumers communities

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Abstract: The proposed presentation contributes to observation and analysis of grass roots discourse to investigate the social system surrounding energy technology and hardware. The presentation focuses on bringing together opinions and experiences of end-users and prosumers of energy systems and cross-references those with suppliers' discourse and programs. The discussion relates to the debate on the character of energy transition running within the field of energy policy research. In the discussion we relate to perspectives of evolutionary versus transformational energy transition (L. Stegemann &, M. Ossewaarde (2018) J. Szarka (2016) P. Żuk and K. Szulecki (2020). The body of reference material we draw upon has been collected within the energy landscape of Lesser Poland. It contains a limited number of 36 structured interviews complemented with surveys. Despite limitations, we find the sample appropriate for situating it in a broader context. One reason for this is region specificity: we describe a central European region heavily dependent on fossil fuels and distinctive for its conservative political and societal attitudes. The other is timing: the research documents a period when an intense campaign promoting participation in photovoltaic renewable energy sources collided with conservative government attempts to postpone social consultations on the shrinking coal mine industry. Local events synchronize with post-pandemic announcements of the New European deal echoed in media debates. Moreover, with its semi-peripheral situation, conservative attitudes and coal dependence, Poland is an ideal model for Comparative studies in Europe and non-European societies. The study adds a new perspective to debates on green growth hegemonic discourse in politics and business and relates it to the populist discourse of the media. It is our aim to analyse discourse on sustainable energy transformation at the grass roots. This study has different levels, at the level of academic analysis, it bridges qualitative research on the adoption of renewables with dense anthropological descriptions of an energy culture framework. The main case sample is complementary with source materials provided by the well-established line of prosumer studies and adoption studies covering various cultural milieus. The presented analysis should explain that vernacular narratives which we have examined are characterized by a tendency to dispense with complex argumentative style typical of the mainstream social actors. The voices do not merely reproduce and exploit "what has been said" in the media or politics, instead they are vigilant about "who engages in a discussion" and "who is entrusted to act." We speculate that social desiderata implied by vernacular discourse, although indisputably vague, often resonate with postulates described in Jürgen Habermas discourse ethics. We conclude that the ethics of authority-free discourse (herrschaftsfreier Diskurs), which, although by its nature is beyond the scope of mainstream social actors, may act as a game changer, releasing social energy directed towards the will to act and the will to make one's environment safe. We believe the study is relevant for energy practitioners and researchers interested in the social aspects of prosumerism. We believe that by focusing on potential points of conflict and highlighting the social demands of energy transition, the study can have profound societal benefit in the communication domain on energy transition. Moreover, with its specific source base, the study relates to current debates on fair energy transition and inclusiveness echoed in the media.
Keywords: energy transition; sustainable energy transition, energy cultures; photovoltaics adoption dynamics; green growth discourse; right-wing populism; vernacular discourse

Market-oriented adjustment of China's new energy vehicle industry policy and sustainable development of enterprises: Intermediary role of the business environment

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Abstract: During the implementation of the new energy vehicle (NEV) industrial policy, with the demand for industrial upgrading and the frequent occurrence of "compensation fraud", to achieve sustainable development of NEV, the Chinese government began to adjust the industrial policy in a "market-oriented" manner, which means that the NEV industrial policy was transformed into inclusive policy and functional policy. Also, the purpose of the NEV industrial policy pays more attention to the optimization of the business environment, and the main body is gradually transferred to parts enterprises. Based on this, this paper takes the parts enterprises listed in China's A-shares as the research sample to investigate the impact and mechanism of policy adjustment on the sustainable development of parts enterprises under the background of the post-subsidy era based on information transmission mechanism, market pressure mechanism, and uncertainty theory. The research results show as follows: inclusive and functional policies are conductive to alleviate the pressure and enhance the market confidence of enterprises, that is, the market-oriented policy adjustment is conducive to improving the sustainable development ability of enterprises by improving the business environment. Further analysis shows that the effect of policy adjustment on the sustainable development of non-state-owned enterprises is more significant than that of state-owned enterprises, that is, private enterprises are more inclined to market-oriented policy adjustment.
Keywords: new energy vehicle; policy adjustment; inclusive policy; functional policy; business environment; sustainable development

Research on the protection and activation strategy of industrial heritage under the background of urban cultural and creative space

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Abstract: With the advent of the knowledge economy, the cultural and creative industry has risen globally. As a new industry, it is an effective way to adapt to urban renewal and protect historical and cultural heritage. Industrial heritage is the intersection area that connects the city's memory and the new creativity, and is the junction of the city's physical space and cultural space. When facing industrial transformation, many industrial cities will choose to preserve their "industrial heritage" and transform them into cultural and artistic spaces to inject new vitality. However, the protection and utilization of my country's industrial heritage still have problems such as uniformity, serious homogeneity, low cultural expression, and insufficient sustainable development. This article will summarize the protection and activation of my country's industrial cultural heritage, analyze the existing problems in the protection and utilization of my country's industrial cultural heritage, and based on the urban cultural and creative space background, through the three types of cultural and creative spaces, industrial park museums and cultural and creative markets. The cultural display method of the route is analyzed in detail to facilitate the study of strategies for the protection and activation of my country's industrial cultural heritage. It is hoped that it can provide a certain reference value for the protection and activation of industrial cultural heritage in the future. Promote industrial heritage from solid state protection to spatial activation.
Keywords: cultural and creative space; industrial heritage; heritage revitalization; heritage protection

Pathways to economic development in distressed coal communities in Appalachia

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Abstract: West Virginia is a resource-rich state with a 200-year history of providing coal, natural gas, and petroleum to drive economic development in the United States. It is one of 13 States located in a mountainous region of the United States known as Appalachia. The Central Appalachian region produced 235 million tons (214 million tonnes) of coal in 2008, 20% of total U.S. coal production that year. Annual production fell to 46 million tons (42 million tonnes) in 2020 and may decrease in the future due to the down-turn in coal use for power generation driven by less-expensive natural gas and the growth of electric power generation by renewable energy. However, decreased demand for steam coal may be partially offset

by an increased export market for coking coal. West Virginia had 125,000 pick-and-shovel mine workers in 1950 who lived mostly in towns owned by the mining companies. By 2020, about 13,000 people were working in the mines, with 80% working in underground coal mines. Appalachian communities built primarily on the coal mining industry are now suffering economic hardship due to the shortage of high-paying job opportunities, failing infrastructure and reduced revenues that provide community services, and the loss of residents. This presentation will review both proposed and implemented measures supported by local governments community residents, the State of West Virginia, and the U.S. federal government to diversify job opportunities and increase economic development in distressed coal communities in West Virginia and the Appalachian region.
Keywords: coal communities; economic development; sustainable employment

A feasible pathway of the coal industry to achieve carbon neutrality through integrated life cycle innovation in China

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Abstract: China has proposed its independent contribution to mitigating climate change, coal reduction has become the mainstream voice. However, few studies have objectively considered coal from the perspective of integrated life cycle and the position in energy system. In the present study, we revealed that (1) Power generation & heating and iron & steel smelting are the highest CO_2 emissions sectors. In addition, coal chemical industry and power generation & heating are the two sectors with the highest contribution rate of CO_2 emissions. (2) Based on these, innovation of the coal life cycle was suggested by introducing electric furnace smelting scrap, hydrogen production using underground coal gasification (UCG), especially the underground coal gasification-integrated gasification combined cycle (UCG-IGCC). As a result, total coal consumption was reduced to 23.8% of the corresponding pre-renovation amount. The panel threshold model has proved that when the energy intensity falls in the interval 0.363-2.599, UCG-IGCC technology could be the complement in mitigating CO_2 emissions. (3) Finally, we show that the faster the cost of CCS (carbon capture and storage) decreases, the earlier UCG-IGCC technology could compete with renewable energy. As the replacement ratio of UCG-IGCC technology increases, the social carbon cost will significantly decrease.
Keywords: life cycle; UCG; CCS cost; threshold effects; renewable energy

Green finance, research and development investment and high-quality economic development

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Abstract: Green mountains are golden mountains and silver mountains. In the context of seeking high-quality economic development, we should maintain the dynamic balance between economic development and ecological environment. Based on the panel data of 31 provinces in China from 2010 to 2019, referring to Battese and Coelli's model, this paper uses the latest stochastic frontier approach method to calculate total factor productivity. The study found that green finance and research and development investment can significantly promote high-quality economic development, and green finance can promote economic growth by strengthening research and development investment. Through the sub regional research, it is found that the eastern region has the largest pulling effect on economic growth, the western region has an indirect promoting effect, while the economic growth effect of green finance in the central region has not yet appeared; Technology research and development only significantly promoted economic growth in the eastern and western regions. This shows that in today's slow economic growth and serious degradation of the ecological environment, the development of green finance is an important strategy to protect the ecological environment and promote sustainable economic development.

Keywords: green finance; environmental pollution; high-quality; sustainable

What really influences the development of renewable energy? A systematic review and meta-analysis

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Abstract: Promoting renewable energy is one key strategy to increase energy security and mitigate global

warming. What really influences the development of RE has aroused public attention worldwide. Numerous studies have identified and evaluated the critical influence factors (CIFs) for renewable energy development (RED); however, there is no consensus among the previous studies on these CIFs and their importance level. Given that, this study, for the first time, conducts a systematic review and meta-analysis of these CIFs. With evidence from 33119 observations in 67 studies, the systematic review identifies 44 CIFs. To further provide a synthesis of previous studies, a meta-analysis approach is used. Results demonstrate that: (i) 27 CIFs with statistical significance and their importance level are identified; (ii) the top three driving factors are industrial infrastructure investment, R&D and financial development, and the top three inhibiting factors are fossil-based energy consumption structure, policy uncertainty and population life; (iii) the publication year, country's economy and the RED links play a moderating role of the CIFs' influence mechanism. This study not only contributes to the existing RED knowledge body but also provides references to policy makers and practitioners in formulating policies and good practices to promote RED.
Keywords: renewable energy development; influence factors; systematic literature review; meta-analysis; energy transition

Residential heating using woody biomass in Germany - supply, demand, and spatial implications

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Abstract: In the coming decades, energy systems around the world will undergo a fundamental transition from fossil fuels to renewable energy sources to reconcile the conflicting demands of climate protection and energy security. Increased use of biomass is one way to increase the share of renewable energy not only in the energy sector but also in building materials as well as to promote bio-economy strategy. In Germany, woody biomass has been a long tradition as heating fuel since forest accounts for about 30 % of the land. It is predicted that biomass will continue to play an important role in the heating sector by 2050 in Germany as it is one way to increase the use of renewable energy and reduce CO2 emissions. However, low-carbon energy requires more land than non-renewable resources. The trade-off between wood fuel and carbon sequestration is critical in the context of climate change. Given the limits of land and planetary capacity, it is important to ensure that substituting fossil fuels with wood fuel does not result in the loss of biodiversity, natural forest, and agricultural land. Hence, the paper aims to balance holistic assessments of land requirements for biomass heating systems and their ecosystem services. For sound balancing, further research and better assessments are needed in this area to find holistic solutions on how to best use woody biomass for heating within available land while reducing emissions. Based on the types of fuel demand considered, the space requirement in terms of acreage is characterized as the corresponding area under consideration for a particular land use type. For pellets and wood chips, a share of agricultural and forestry areas is calculated. For solid wood logs, forestry land is given as a proportion of the wood depending on the predominant tree species. The formulas were applied for the federal level in Germany. It has been shown that the use of raw wood for fuel would exceed land resources. In comparison, wood pellets and chips are much better because their sources are not exhausted. In addition, the air pollution caused by modern pellet and chip boilers is much lower than that caused by wood log consuming fireplaces.
Keywords: renewable energy; land demand; wood fuel; carbon sequestration; ecosystem services

Spatial relationship between independent mining areas and urban development in coal resource-based cities: Examples from Jincheng, China

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Abstract: Independent mining areas and cities exhibit different dependencies depending on their development stages. With the depletion of coal resources, independent mining areas inevitably fall into the situation of coal exhaustion, while facing the challenges that urbanization has caused. Therefore, realizing the integration of independent mining areas and the city, promoting the sustainable development of the region has become the requirement of Territorial Spatial Planning. This study analyzes the types and characteristics of independent mining areas in the coal resource-based city of Jincheng, and explores the evolution of the spatial relationship between independent mining areas and cities, taking the three independent mining areas of Gushuyuan Mine, Wangtaipu Mine and Fenghuang Mountain Mine (referred to as the old three mines) as examples. The results show that the spatial relationship between the independent mining areas and the city has gone through the evolution process of association, mine independent of the city, city independent of the mine, integration. According to the theoretical guidance of territorial spatial planning, this study clarifies the need for redevelopment of independent mining areas

and proposes redevelopment strategies in the context of territorial spatial planning.
Keywords: territorial spatial planning; coal resource-based city; independent mining areas; mining areas and city integration; redevelopment

Research on the countermeasures to revitalize the modern industrial heritage of Yangquan city under the background of cultural and tourism integration

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Abstract: Yangquan is the “First City of the Chinese Communist Party” and a resource-based city founded on mining. Yangquan's industrial history is not only a record of the country's arduous industrialization process under the leadership of the Communist Party of China, but also a witness to the country's memory. However, in recent years, due to the impact of “reverse industrialization”, a large amount of valuable industrial heritage in Yangquan is facing a crisis of survival. Based on the history of industrial development and the city's cultural lineage, this paper systematically compares and analyses the characteristics of Yangquan's industrial heritage, assesses its current situation and problems of revitalization and utilization, and proposes measures for the activation and utilization of Yangquan's modern industrial heritage in the context of cultural and tourism integration, in order to provide a case study for resolving the contradiction between urban development and industrial heritage conservation.
Keywords: cultural and tourism integration; Yangquan; industrial heritage; activation and utilization

Design of solar concentrating shutter module based on light distribution

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Abstract: Building integrated concentrating technology is a new efficient and sustainable form of solar energy utilization, which can realize the hierarchical utilization of sunlight. Based on the linear Fresnel lens, a spotlight shutter module suitable for building integration was designed in this study. Direct light was concentrated for energy production, and diffuse light was used for daylighting by the shutter. In order to better balance the structural form, energy efficiency and light penetration of the shutter, the optical characteristics of the lens and the receiving surface at different distances and deviation angles were studied through the solar dynamic tracking experiment under real conditions. The results showed that the concentrated efficiency of Fresnel lens was 77.1% under the condition of vertical incidence. When the spacing in the range of 41mm-58mm, light concentrated efficiency was above 53.4% with the receiver width 10mm. Optical efficiency in 5mm region was the most sensitive to the deviation angle. The allowable deviation angle of 50 mm was larger than 55mm. The efficiency in a 10mm width was above 47% when the deviation angle was less than 4° and the spacing was 50 mm. Through the study of optical characteristics under different incident conditions, it was finally determined that the optimum spacing was 50 mm, width of the receiver was 10mm and the allowable deviation was 4°.
Keywords: experimental study; optical characteristics; sustainable design; hierarchical utilization; solar concentrating shutter

Spatial effects and influencing factors of urban carbon emissions in the Yangtze River economic belt

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Abstract: In September 2020, China set the goal of “carbon peak” by 2030 and “carbon neutral” by 2060. As an important economic development region, the Reduction of carbon emissions in the Yangtze River Economic Belt and the realization of the peak of carbon dioxide emissions as soon as possible play a crucial role in China's completion of the carbon dioxide emission reduction target as scheduled. Taking the Yangtze River Economic Belt as the research object, the total carbon emission, per capita carbon emission, carbon emission productivity and other core indicators of 108 cities from 2003 to 2018 were calculated. By establishing a spatial econometric model and testing the panel data of 108 cities, this paper empirically analyzes the spatial effects and influencing factors of urban carbon emissions in the Yangtze River Economic Belt. At the same time, a model is built to estimate the peak carbon emission of cities in the Yangtze River Economic Belt. Finally, differentiated carbon emission reduction policy suggestions are

proposed for the Yangtze River Economic Belt.
Keywords: carbon emission; spatial effect; Yangtze River Economic Belt

Research on dynamic concentrating skin design based on multi-objective optimization

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Abstract: Building skin can provide comprehensive functions of energy production, daylighting and shading with the transmissive concentrating panel integrated. A comparative study was conducted on the three variables of the size, rotation angle and number of concentrating modules based on the parametric modelling platform of Rhino-grasshopper, performance simulation platform of Ladybug tools and multi-objective optimization platform of Octopus. The optimal solution was designed, and the multi-objective optimization technical framework of the office space was constructed by solving the optimal relationship between the light environment quality and energy output efficiency of the solar concentrating skin. The results showed that the dynamic solar concentrating skin can effectively reduce the Daylighting Glare Probability (DGP) and increase the Useful Daylighting Illumination (UDI) while achieving energy output by comparing the office space with integrated solar concentrating shutters, ordinary shutters and no shutters. Then the optimal design interval of each variable of the solar concentrating skin was obtained through the scheme comparison. This study can provide a method for improving the balanced design of indoor light environment and building productivity efficiency, and provide a technical framework for the multi-objective optimization process. And it also can provide a reference for the integrated design of dynamic concentrating skin and building.
Keywords: sustainable design; dynamic solar concentrating skin; indoor light environment; multi-objective optimization; Pareto optimal

Study on sustainable design of rural residences in northwest arid area of China based on integrated application of renewable energy

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Abstract: Northwest arid area of China is located deep inland and has a typical temperate continental climate, which is characterized by low precipitation, high evaporation, and low humidity. House is one of the basic conditions for human existence, and human dwellings have been constantly updated with the development of society. With development of times, rural residents have higher requirements for performance and quality of houses. Although local traditional houses have advantages of being friendly to nature, adapting to environment, and low cost, most of the houses built by villagers have defects of imperfect building space, poor indoor thermal environment, and high heating energy consumption. How to improve the living quality of villagers while reducing consumption of fossil energy in residential buildings? Rural residences in the northwest arid area of China were taken as study object. Space optimization design strategy of local rural residences, which adapt to modern life and technological development, was explored in paper. A variety of renewable energy sources, including solar energy, biomass energy, wind energy, air energy, are discussed in their integrated applications to improve thermal environment of the rural residences. It was shown that appropriate building technology integration application can create an indoor thermal environment to meet human comfort at low cost.
Keywords: sustainable design; rural residences; northwest arid area of China; integrated application

Research on energy ecological efficiency and energy conservation potential and emission reduction potential of cities in the Yangtze River Delta under the background of carbon constraint

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Abstract: In order to achieve the 2030 carbon peak goal, 41 prefecture-level cities in the Yangtze River Delta region are making every effort to plan a carbon peak action plan. We take 41 cities in the Yangtze River Delta as the research object in this paper. Regarding carbon dioxide as an undesired output, we use the super-efficiency SBM model to measure the energy ecological efficiency of cities in the Yangtze River Delta from 2011 to 2019.We use the Malmquist index to characterize the changes in the energy eco-

efficiency of these cities. We calculate the energy conservation potential and emission reduction potential of these cities at the same time. We explore the path of energy saving and emission reduction based on the two-dimensional matrix method. We put forward corresponding policy recommendations at last. The empirical results show that the average value of energy eco-efficiency of 32 cities in the Yangtze River Delta region is lower than 1. The average value is 0.859, and the overall efficiency is low. Shanghai is the highest in the four regions, Jiangsu Province and Zhejiang Province are at the medium level, and Anhui Province is the lowest. According to the Malmquist index, Shanghai performed best, while Jiangsu Province and Zhejiang Province are slightly better than Anhui Province. The average energy saving potential in the Yangtze River Delta is 24.16%, and the emission reduction potential is 26.18%. The potential for energy conservation and emission reduction in the Yangtze River Delta is still relatively large.
Keywords: energy and ecological efficiency; energy saving potential and emission reduction potential; Super-SBM model; Malmquist index

Central government and local governments policy synergy dilemma and influencing factors in the process of coal de-capacity: A two-stage evolutionary game model

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Abstract: Policy synergy between the central government (CG) and local governments (LGs) can effectively reduce overcapacity and promote energy transition. This study investigates the CG-LGs' policy synergy dilemma and influencing factors in the process of coal de-capacity in China using a two-stage evolutionary game model. The results show that: first, in the policy formulation stage, reducing policy formulation costs and increasing public credit losses can prompt the CG to consider provincial heterogeneity, while reducing policy formulation costs and increasing political gains and administrative penalties can prompt LGs to actively negotiate with the CG to develop policies. Second, in the policy implementation stage, the positive net income of LGs can result in an ideal situation (i.e., the CG chooses the loose supervision strategy, but LGs still adopt the strict enforcement strategy). Reducing implementation costs, enhancing environmental quality, and establishing reasonable reward and punishment mechanisms prompt LGs to implement a de-capacity policy. Third, the CG's strategic choice in the policy formulation stage impacts the evolution of the strategies of the two subjects in the policy implementation stage. The above results promote policy synergy between CG and LGs and provide insights for policymakers for designing an effective coal production capacity governance model.
Keywords: policy synergy; de-capacity policy; two-stage evolutionary game model; central government; local governments

Ethical dilemma of Pro environmental behavior—A fence blocking my environmental protection

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Abstract: The majority of residents are now aware of environmental protection, but how to make them consciously implement environmental behaviour is still a problem that needs to be solved. The fundamental difficulty in achieving conscious pro-environmental behaviour stems from the contradictory relationship between the infinite nature of human development and the finite nature of ecological resources, which makes it necessary for people to face the problem of inconsistent beliefs or values on environmental issues. The resulting conflict acts as a "psychological fence" that prevents people from acting pro-environmentally. In order to explore how to help people cross the "psychological fence" and achieve self-awareness of pro-environmental behaviour, this paper firstly presents the specific structure of the "fence" through Study 1: based on dual inheritance theory and life history theory, it systematically explores the multiple spatial needs, multi-layered relationships, multiple spaces and multiple role conflicts that individuals consider when facing the choice of pro-environmental behaviour and the internal logic, and constructs a four-dimensional structure of "quality of life-relationship-spatial-role" for the ethical dilemma of pro-environmental behaviour. This is followed by Study 2: An analysis of the current situation of Ethical dilemma of Pro environmental behavior from the perspective of demographics and city clusters through 1565 validated questionnaires, which provides insights into the different characteristics of residents' ethical dilemma of pro-environmental behavior. It provides a theoretical and practical reference to help residents overcome the "psychological barriers" that prevent them from acting in an environmentally friendly manner, and to better promote the conscious implementation of pro-environmental behaviour.
Keywords: pro-environmental behaviour; ethical dilemma; city cluster

Is corporate environmental behavior beneficial to corporate internal value? Corporate environmental behavior, organizational citizenship behavior and the mediating role of work meaning

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Abstract: Corporate environmental behavior is often viewed as an altruistic initiative, yet companies remain skeptical of its ability to enhance their internal value. Abundant material living conditions, the dynamics of corporate organizations, and the ease of job changes have made it easier for employees to think about the value and meaning of work itself. Drawing on the theory of social identity, the current study explores whether and how employee perceived corporate environmental behavior (CEB) affects the realization of its intrinsic value. Considering employee's organizational citizenship behavior (OCB) as a direct agent for corporate intrinsic value, the current study focuses on the work meaning and person-organization value fit (P-O value fit) as the mediator and moderator, and constructs a theoretical model of perceived CEB and OCB. After analyzing the 249 samples collected in the questionnaire, we found that perceived CEB positively influenced OCB through the work meaning, and this positive effect was strengthened with a higher P-O value fit. These findings indicate that in the process of motivating employees to implement OCB, corporate should attach importance to the internal driving role of work meaning and the boundary-spanning roles of P-O value fit, to further enhance corporate internal value and correct manager's cognition deviation on the value of CEB.
Keywords: corporate environmental behavior; organizational citizenship behavior; work meaning; person-organization value fit; internal value

Does self-interested leadership enhance employee green behavior? The effect of environmental responsibility, self-interest motivation, and organizational ethical climate

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Abstract: Based on the hospitality, this research focuses on the logical contradictory characteristics of employee green behavior of "benefiting others but at one's own cost", and explores whether and how self-interested leadership, a negative leadership style, hinders employees from implementing green behaviors. In order to explore it further, this article tries to build a multilevel moderated mediation model from the perspective of social information processing theory. We investigated 107 work teams and 369 subordinates and their supervisors in several hotel enterprises in China through questionnaires, and the empirical results supported our hypothesis. It shows that environmental responsibility, self-interest motivation mediated the relationship between self-interested leadership and employee green behavior. It also indicates that organizational ethical climate negatively moderated the relationship between self-interested leadership and employees' environmental responsibility (self-interest motivation), and this ethical climate also negatively moderates the indirect effect of self-interested leadership on employee green behavior through employees' environmental responsibility (self-interest motivation). These results inform the practical circles that strengthening hotel employees' sense of environmental responsibility, weakening his or her self-interest motivation, creating an ethical climate in line with hotel green norms, and restraining leader's self-interested leadership style in organization should be effective ways of enhancing employee green behavior.
Keywords: self-interested leadership; environmental responsibility; self-interest motivation; employee green behavior; organizational ethical climate

Does top management team responsible leadership help employees go green? The role of green human resource management and environmental felt-responsibility

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Abstract: Drawing on social information processing theory, this study investigates the relationship between Top Management Team (TMT) responsible leadership and employee organizational citizenship behavior for the environment (OCBE) from a vertical perspective, and whether green human resource

management (GHRM) and employee environmental felt-responsibility can play a sequential mediating role between them. Totally, 102 middle-level managers and 527 employees in 102 Chinese teams voluntarily participated in this study. Drawing on above data, this study verifies that TMT responsible leadership was positively associated with both GHRM and employee environmental felt-responsibility. In addition, GHRM mediated the positive effects of TMT responsible leadership and employee environmental felt-responsibility. Also, GHRM can further promote employee OCBE through employee environmental felt-responsibility. Overall, the positive relationship between TMT responsible leadership and employee OCBE was sequentially mediated by GHRM and employee environmental felt-responsibility. Therefore, this study shows the way to achieve corporate environmental sustainability strategy.

Keywords: TMT responsible leadership; GHRM; environmental felt-responsibility; OCBE

A study on the mechanisms of moral norm-value fit on employees' pro-environmental behaviour: The mediating of anticipated emotion

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Abstract: Conflicts between culturally inherited moral norms and genetically evolved values in organizations pose challenges for employees to implement pro-environmental behaviors. This paper follows the research context of "moral norms and values fit - emotion - pro-environmental behavior", and uses dual-inheritance theory to explore the regular characteristics of employees' pro-environmental behavior in the context of organizational moral norms and employee moral values fit. Combining the results of the response surface: (1) With the higher fit between injunctive moral norms and moral values (IMN and MVs), the higher the anticipated emotion and pro-environmental behavior of employees; (2) Contexts in which high imperative moral norms and low moral values match (low IMN-high MVs), as injunctive moral norms gradually increase toward moral values, employees' anticipated emotion and pro-environmental behavior increase; (3) when injunctive moral norms exceed moral values and continue to increase (high IMN-low MVs), employees' anticipated emotion and pro-environmental behaviors will be inhibited; (4) low descriptive moral norms (DMN) have a negative moderating effect on this process. This paper aims to provide valuable theoretical and managerial implications for related research and enterprises by studying the mechanism of employees' pro-environmental behavior through moral norm-value fit.

Keywords: dual-inheritance theory; injunctive moral norms - moral values fit; descriptive moral norms; anticipated emotion; pro-environmental behavior

Agglomeration measure of photovoltaic industry and analysis of influencing factors

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Abstract: This paper takes 30 provinces (cities and autonomous regions) as the observation objects, and selects the photovoltaic data of each province from 2012 to 2019, using location entropy and ArcGIS analysis tools to analyze the spatial pattern of my country's solar photovoltaic industry agglomeration level, and using the fixed effect regression model to study the factors affecting photovoltaic industry agglomeration, The results show that: China's photovoltaic industry generally shows the characteristics of high-level geographical agglomeration, showing a trend of gradually decreasing from northwest to south; In terms of time sequence, the number of provinces with enhanced agglomeration level increases year by year. The regression statistical results of influencing factors show that energy demand, government support and investment level are the main factors affecting China's solar photovoltaic industry agglomeration, showing strong positive correlation, basically negative correlation with economic foundation, and each influencing factor has certain regional heterogeneity.

Keywords: photovoltaic industry; agglomeration degree; location quotient; space panel model

Information infrastructure and greenhouse gas emission performance in urban China: A time-varying difference-in-differences analysis

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Abstract: Owing to its network spillover effect, information infrastructure performs outstandingly in promoting economic growth and technological innovation, and has received widespread attention. However, the ecological performance of information infrastructure, especially its impact on greenhouse gas (GHG) emission performance, has been studied less. To investigate this issue, using panel data for 281 prefecture-level cities in China from 2003 to 2018, I treat the Broadband China policy as a quasi-natural experiment in information infrastructure and conduct a time-varying difference-in-differences (DID) analysis. The results show that: (1) Information infrastructure significantly improves urban GHG emission performance. This conclusion holds even after excluding pilot selection endogeneity, sampling bias, and other policy interferences. (2) Technological innovation, industrial structural upgrading, factor allocation improvement, and tertiary agglomeration are effective channels by which information infrastructure improves GHG emission performance. (3) The treatment effect varies by city size, digital economy level, and economic status. Specifically, information infrastructure exhibits significant emission reduction performance in cities with large size, advanced digital economy, and leading economic status, while this effect drops in other cities. This study provides insights into the infrastructure transition to a carbon-neutral manner in China and other developing countries.
Keywords: information infrastructure; greenhouse gas emission performance; broadband China policy; time-varying difference-in-differences; transmission mechanism; heterogeneity

Carbon emission and structure analysis of transport industry based on input-output method: China as an example

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Abstract: With the development of social economy and the improvement of people's living quality, transport energy consumption and carbon emissions in China are constantly increasing. At present, China's transport industry has become a key area of energy conservation and emission reduction because of its huge carbon emissions. In this study, we use the input-output method to analyze the carbon emissions caused by energy consumption in transport industry. Combined with the corresponding energy types, the carbon emissions of eight transport activities in 2018 were analyzed from the perspective of structural analysis. Then, this paper studies the relationship between carbon emissions of transport and other industries, and sets up three scenarios to predict the indirect carbon emissions of transport before 2035. The results show that in 2018, the direct and indirect carbon emissions of China's transport industry reached 197313.83 and 217950.38 kt respectively, and the carbon emissions from road transport are the highest among the eight transport activities. Direct carbon emissions caused by diesel oil consumption were the highest, while the indirect carbon emissions caused by coal consumption were the highest. Processing of petroleum, coking and processing of nuclear fuel is the industry most affected by transport activities. Among the twelve components, the spillover one component accounts for the largest proportion. Under SO scenario and TP scenario, it is expected to achieve carbon peak in 2030 and 2025 respectively. The accelerated decline of energy intensity and the adjustment of energy structure are all helpful to reduce indirect carbon emissions.
Keywords: carbon dioxide emissions; structure decomposition; input-output; transport industry

Shrinkage characteristics and planning strategy of Sanhui town in Chongqing from the perspective of smart shrinkage

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Abstract: Under the influence of global economic transformation, China’s economy has turned into a medium-low growth pattern, and the spatial distribution of population has also undergone structural changes, and more and more cities are facing the challenge of contraction. At present, most of the shrinkage phenomena in China occur in villages and towns, especially in small towns with exhausted resources. In this paper, Sanhui Town, Hechuan District, Chongqing, a typical resource-based small town, is selected as the research object. Firstly, the development process and influencing factors of Sanhui Town are sorted out, and the problems of population contraction, economic development and land use in Sanhui Town are summarized. Then, the theoretical concept and planning strategy of “smart contraction” are put forward. The research results not only seek solutions to the practical problems of shrinking resource-based small towns but also provide a way of thinking for the development of other towns in the future.
Keywords: smart shrinkage; Sanhui Town; planning strategy

Utilisation of industrial side streams as raw materials for 3D printed infra structures

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Abstract: Cement is very widely used concrete raw material due to its easy availability, good usability and because of its low price. In 2019, cement production was estimated to reach 4.2 billion tonnes whose environmental impact is large: about 4-8% worldwide carbon dioxide emissions. Therefore, low carbon alternatives for cement industry are actively sought after. The industrial side streams of process and mining industry such as ash, slag and tailings, offer an enormous and heavily underutilised local low carbon secondary raw material source In a 3 year project "Urban Infra Revolution" (2017-2020) funded by EU initiative Urban Innovative Actions, we developed local industrial side stream based 3D printable geopolymer composites for the use in urban infrastructures. During the project more than 20 industrial side streams were characterised and necessary pretreatment processes were developed for them. Five different geopolymer composite recipes where the circular material content varied between 68 to 99.6 %, were developed. Their mechanical properties were comparable to those of ordinary cement. It was seen that the environmental impact of geopolymer composites was highly recipe dependant and thus, the Global Warming Potential of different recipes varied between +40 to -98 %. The higher impact was mainly due to the activator used in the geopolymer composite recipe. As a pilot product a 100 m long noise wall was built out of 3D printed geopolymer composite elements in Lappeenranta, Finland. The 3D printable geopolymer composites offer a low carbon alternative option for applications where fast setting time and free form are a value adding factor, and where unnecessarily landfilled local secondary raw materials are available thus promoting transformation into circular economy.
Keywords: side streams; circular economy; cement industry; 3D printing

Visualizing and quantifying the dynamics in the effect of carbon information disclosure on enterprise value

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Abstract: In the face of the deterioration of the living environment caused by global warming, encouraging enterprises to complete the endogenous transformation of carbon emission reduction has become a necessary measure to achieve harmonious development of economy and environment. This paper takes 100 typical enterprises comprising the SSE Social Responsibility Index as the research sample, and explores the time-varying relationship between carbon information disclosure and corporate value from a continuous dynamic perspective. Firstly, based on the dynamic information of the carbon disclosure data, the carbon information disclosure evaluation index curve is constructed to objectively measure the development level of carbon information disclosure of enterprises. Then, depending on the functional dynamic regression, the time-varying trajectory of carbon information disclosure affecting corporate value is continuously portrayed. Finally, the dynamic influence of the relationship between the two was investigated from within the enterprises in terms of the nature of ownership and industry attributes, and from outside in terms of the moderating variables such as government regulation, media attention and environmental supervision. The study finds that: (1) carbon information disclosure has a significant impact on corporate value, but the intensity and strength of the impact varies across time. At the initial stage when enterprises explore the disclosure of carbon information, carbon information disclosure is not conducive to the enhancement of corporate value, but when the quality of carbon information disclosure reaches a certain level, the higher the level of carbon information disclosure, the higher the corporate value. (2) The moderating effects of internal factors, such as the nature of ownership and industry attributes, and external factors, such as government regulation, media attention and environmental supervision, have time-series characteristics. At the initial stage when the state advocates low-carbon emission reduction, the relationship between carbon information disclosure and corporate value is more significant among state-owned enterprises and highly polluting enterprises, media attention and environmental supervision will also enhance this relationship, but the opposite is true when a national carbon trading system is first established. However, government regulation always has a positive effect on the relationship between carbon disclosure and corporate value.
Keywords: carbon information disclosure; enterprise value; functional regression; moderating effects; time-varying relationships

Green credit policy and enterprise financing costs: Evidence from Chinese A-share listed companies from 2008 to 2019.

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Abstract: Green credit policy (GCP) is an important measure to realize green transformation of economy and society. This paper set the "Green Credit Guidelines" issued in 2012 as the research event, and panel data from 1359 companies of China from 2008 to 2019 as the sample, analyzing the impact and mechanism of GCP on enterprise financing costs by difference in difference method. The results show that: after the implementation of the GCP, the financing costs of high energy consumption and high pollution enterprises increased compared with energy saving and environmental protection enterprise. Specifically, GCP affects the cost of debt financing by changing the size of debt financing and commercial credits, and affects the cost of equity financing by changing the financial situation and the degree of environmental information disclosure. However, there is multi-dimensional heterogeneity in the emission of GCP. Compared with state-owned enterprise, the effect of GCP on the financing cost is more significant, and compared with medium-carbon and low-carbon emission regions, the effect of GCP on high-carbon emission regions is more significant.
Keywords: green credit policy; financing costs of enterprise; equity financing; debt financing; DID

Study on the spatial evolution and optimal strategies of coal-mining subsided wetlands in Xuzhou

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Abstract: A common environmental problem exists in coal resource-based cities in the eastern Huanghuai region of my country. Due to the high underground water level, the surface will sink and accumulate water after the mining of underground mineral resources, resulting in the formation of a large number of coal-mining subsidence wetlands. For a long time, coal-mining subsidence wetlands have led to poor ecological environment in the subsidence area, which has become an important restrictive factor affecting the natural ecological environment, economic development and social stability of the region. In view of this, this study takes the coal-mining subsidence wetland in Xuzhou as the research object, and on the basis of the current situation analysis, explores the space evolvement process, space evolution characteristics and evolution mechanism of the coal-mining subsided wetland, and clarifies the goal of the spatial optimization of the coal-mining subsidence wetland in Xuzhou City. This study proposes targeted optimization strategies for the spatial development of Xuzhou coal-mining subsidence wetlands. In order to provide theoretical guidance for promoting the ecological restoration of coal resource-based cities.
Keywords: coal-mining subsided wetlands; space evolvement; evolution mechanism; optimization strategy

Thermal characteristics of integrated solar concentrating window

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Abstract: In this study, a high transmission Fresnel point focusing module was designed, which can be used for building integration and realize the efficient utilization of solar energy. In order to find the best mechanical ventilation and natural ventilation form of solar concentrating integrated window and minimize the overall temperature of concentrating module to obtain better electrical performance of concentrating module and indoor thermal environment. In this paper, the temperature distribution data of condensing assembly under different working conditions are obtained by studying the thermal characteristics of condensing assembly under different ventilation forms. The results showed that the temperature of the condenser cell decreased significantly with the increase of active ventilation. The heat dissipation effect of air inlet from the bottom is better than that of side air inlet and top air inlet. The theoretical model and complete data under different working conditions are obtained, which makes a more quantitative evaluation of the impact of the building skin with integrated condensing components on the indoor light environment, so as to guide the integrated design and application of dynamic condensing skin.
Keywords: condensing module design; sustainable design; temperature distribution; active heat dissipation; passive cooling

The influence of green bond issuance on the short-term and long-term financial performance of enterprises: Evidence from China

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Abstract: Green bonds are of great importance for corporate financial performance. However, such issue, and especially the different consequences in the short- and long-term financial performance of enterprises, need to be further studied. Results show that the green bond issuance can affect the financial performance of enterprises both directly and indirectly through the mediator of R&D investment, environmental information disclosure, and agency costs. Based on annual data on 860 non-financial listed enterprises from 2012 to 2020, the results of difference-in-differences (DID) models show that the green bond issuance significantly reduces the short-term financial performance of enterprises, and improves their long-term financial performance. The results of the mediation models indicate that the green bond issuance mainly reduces the short-term financial performance of enterprises by increasing agency costs, and improves their long-term financial performance by improving R&D investment and environmental information disclosure. Furthermore, the impact of green bonds on corporate financial performance differs according to the region, enterprise ownership, and enterprise scale. Finally, this paper provides suggestions on making full use of green bonds to promote corporate financial performance.
Keywords: green bonds; short-term financial performance; long-term financial performance; DID models; mediating effect

A preliminary study on the innovative model of precision management of waste in non-waste community

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Abstract: Accurate classification and recovery of community waste have always been a huge bottleneck for urban governance and resource utilization. Using the Internet big data platform to construct the database of community waste and the action mode of community residents ' waste precise delivery, precise classification, transportation and docking with resource recycling enterprises are the systematic problems that need to be considered in the innovative model of waste precise governance. In recent years, the residents' communities in Xuzhou Tongshan District have been taken as the research object to explore the innovative model of waste management in waste-free communities. This paper puts forward the construction of waste logistics management system for accurate classification of waste sources, classification and identification of delivery terminals and time-sharing management, time-sharing transportation and timely transportation of waste, the monitoring of community property on waste classification, the construction of scheduling platform for time-sharing transportation, and the construction of databases for specific community waste types, so as to realize the innovative model of waste precise management.
Keywords: design strategy; resource utilization; waste treatment; non-waste community

The green finance policy coupling effect on low carbon economy: Taking China as an example

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Abstract: In the context of low-carbon economic development, controlling fossil energy consumption and promoting development in renewable energy are important paths for energy transition in diverse countries. Taking China as an example, this paper investigates the effect of the policy coupling of fossil energy use rights trading (FET), renewable energy certificate trading (RECT), and renewable energy subsidies (RES) on the low-carbon economy using a dynamic recursive computable general equilibrium (CGE) model. The main findings of this paper are as follows: (1) When using a game cross equity fixed-cost allocation model (Game-EFCAM) to allocate fossil energy use rights quotas among sectors, allocations differ in only a few sectors compared to the base period, and most sectors have relatively stable allocations compared to the base period. (2) The implementation of FET and RECT has a negative impact on per capita GDP. In the short term, and RES can mitigate the negative impact of FET and RECT on per capita GDP, but eventually, the government needs to guide the enterprise innovation to improve the industrial structure to realize the double benefits of energy policy. (3) The implementation of FET and RECT limits fossil energy consumption and also reduces the production possibility frontier of secondary industries with higher levels of fossil energy consumption. The implementation of FET and RECT thus

increases the proportions of tertiary industry and renewable energy. (4) The implementation of FET and RECT reduces carbon emissions. In other words, the implementation of FET and RECT reduces the negative environmental externality. RES can enhance the carbon reduction efforts of FET and RECT.
Keywords: low carbon economy; FET; RECT; RES; CGE

Optimal reduction and equilibrium carbon-allowance price for the thermal power industry under China's carbon-peak target: Analysis based on fractional Brownian motion and optimal control

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Abstract: Emissions trading and clean-energy technologies can help the power industry to reduce CO2 emissions and achieve carbon peak and carbon neutrality. In the context of carbon trading with thermal power enterprises as the main participants in China, this study applied fractional Brownian motion to the energy-switching cost for thermal power enterprises' strategies and established a stochastic optimization model for a compliance period. We deduced that the carbon-allowance price obeyed the mixed fractional Brownian motion model with the Hurst exponent and volatility coefficient estimated, and the validity of the estimated results verified. Then, we derived the Hamilton-Jacobi-Bellman equation for the optimal total compliance cost by combining the dynamic optimization principle and the fractional Itô's formula. In this way, we obtained the optimal emission reduction and equilibrium carbon-allowance price. Taking 2021-2030 as the compliance period, we conducted numerical simulations using real data under the premise of ensuring both power supply and economic growth. The simulation results showed the effects of different peak years on the optimal reductions and desired equilibrium prices of annual carbon allowances. Further, sensitivity analyses showed how the Hurst exponent, volatility coefficient, and depreciation rate affect optimal reduction, as well as how initial carbon allowance affect the equilibrium carbon quota trading price and the optimal reduction. Our findings could provide a reference to develop emission-reduction strategies for thermal power companies and carbon pricing in the carbon market.
Keywords: carbon peak; mixed fractional Brownian motion; optimal control; carbon-allowance price

Research on consumption-side carbon transfer and carbon unequal exchange - Under the perspective of domestic chain fragmentation

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Abstract: The inter-regional trade is accompanied by carbon transfer. Therefore, on the one hand, assessing ecologically unequal exchange in interregional trade is an important part of formulating the responsibility allocation mechanism for carbon emission reduction. On the other hand, exploring the driving factors of consumption carbon emissions would help local governments formulate targeted carbon emission reduction policies. Focusing on domestic value chain fragmentation, taking China's multi regional input-output tables in 2012, 2015 and 2017, this study not only introduces the pollution terms of trade and the inter-regional environmental inequality index to analyze the regional carbon unequal exchange in China, but also decomposes the driving factors of consumption-side carbon transfer and net carbon transfer in various regions of China. The main findings are as follows. (1) Trade has led to inter-regional carbon and value added transfer, with the more developed eastern coastal region having an absolute advantage, whereas the middle Yellow River, which is deep in the 'resource trap', is at an absolute environmental and economic disadvantage. (2) The ecologically unequal exchange between regions is serious. It shows a clear trend of 'strong in the east and south, weak in the west and north'. The eastern and southern coasts, middle Yangtze River, and southwest are in a favorable trade position, whereas the northeast, northern coast, middle Yellow River, and northwest are in an unfavorable situation of trade pollution. (3) The analysis of the decomposition results shows that the production structure and carbon emission intensity are important drivers to reduce China's carbon emissions, while the continuous rise of the per capita consumption demand is the biggest resistance. This study not only provides reference and suggestions for Chinese policy makers to reasonably allocate regional carbon emission reduction targets, but also provides research ideas for other developing economies in the period of rapid rise to reasonably calculate regional carbon emissions.
Keywords: domestic value chain fragmentation; consumption-side carbon transfer, carbon unequal exchange, decomposition

Challenges of post-mining and the knowledge transfer for the Chinese hard coal mining industry

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Abstract: The global energy sector is currently facing immense upheaval. On the one hand, trends such as sustainability and climate change are continually rising; on the other hand, the production of carbon dioxide and the conditionally recyclable basis of many resources for power generation is a major problem. Therefore, energy policy is forced to be adaptable for the dynamic energy situation. In China, the potential of renewable energies has been recognized for years and a rapid integration into the existing energy mix has been undertaken. Nevertheless, hard coal is and remains the easiest way to provide a secure energy supply. The transition to a low carbon economy is therefore a balancing act and requires a holistic approach ranging from classic post-mining management such as dealing with the eternity tasks, to after-use potentials for closed mines, to the effects of structural change for employees in this sector. Hence, an adjustment of the political framework conditions of the partly strongly diverging starting positions of the different provinces is required for a successful and sustainable change. Meanwhile, in Germany, the coal industry already ended in 2018. Therefore, an efficient management of the post-mining heritage has long been necessary, and the Research Center of Post-Mining in the heart of the Ruhr region (Germany) is particularly dedicated to this. Through the sharing of German experiences with China in the field of post-mining, a transfer of knowledge can be created and value can be added.
Keywords: hard coal mining; post-mining; transition; Ruhr area; management; after-use potentials

"Sensitive" or "insensitive"? - Evaluation of green development 2 performance of industrial enterprises based on index prediction

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Abstract: This paper classifies 458 industrial enterprises of China and fits the green development performance index of various industrial enterprises (GDI) from 2011 to 2019 based on the performance system of green development of enterprises. In addition, external shock variables are introduced to make in-sample prediction of various indexes with the method of Long Short-Term Memory (LSTM). Through the comparison of GDI with the prediction result and the growth rate of net green GDP (EDP), it tries to explore the index to external shocks. Moreover, the out-of-sample prediction is made by using the lag period of the index, and the policy implementation time point is identified according to the decline point and the extent. It finds that, first, the green development level of Chinese industrial enterprises shows an upward trend from 2011 to 2019, but the fluctuation is repeated and sharp. Based on the fluctuation trend and time point, it finds that the overall GDI fluctuation is mainly affected by the driven GDI, and the driven enterprises should be regarded as the starting point to improve the overall green development level of Chinese industrial enterprises. Second, the overall GDI is sensitive to external shocks, and the impact cycle of policy shocks is longer. Driven GDI is neither sensitive nor insensitive to external shocks, and the impact of market shocks is more durable. Based on this, it is considered that the green development of non-driving industrial enterprises is vulnerable to the influence of external environment, and the influence of current policies is more significant. Therefore, it is necessary to improve their anti-risk ability to ensure the rise of lower limit of the green development level of the whole industrial enterprises. Third, from 2019 to 2022, the green development level of overall Chinese industrial enterprises shows a rising trend. Compared with the push industrial enterprises, the fluctuation is more inertial, but the fluctuation range is gradually reduced compared with the previous fluctuation pattern.
Keywords: industrial enterprises; external shocks; index prediction; sensitivity analysis

Study on the evaluation system of the quality of slow walking spaces on university campuses

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Abstract: With the continuous development of environmental construction, the concept of sustainable development has become the core of all kinds of urban planning and design. The transformation and improvement of slow walking space is of great significance to the sustainable development of university

campuses. Therefore, it is necessary to evaluate the satisfaction of the quality of slow walking space on campus so as to clarify the direction and focus of planning and transformation. Beijing Normal University in Zhuhai is relatively well established in terms of the transformation of slow walking spaces. Therefore, this paper takes this campus as the research object and introduces the AVC three-force analysis theory to construct a spatial evaluation system for campus slow walking. The system consists of three project layers and eighteen indicator layers, based on the hierarchical analysis method and the introduction of the fuzzy comprehensive evaluation method to obtain a comprehensive score for the satisfaction of each factor. This study provides a quantitative basis for the construction of the evaluation system for the quality of slow walking space of Beijing Normal University in Zhuhai and a useful reference for the improvement of the slow walking space system in domestic universities.
Keywords: AVC three-force analysis theory; analytic hierarchy process; fuzzy comprehensive evaluation method; quality evaluation system for slow walking spaces

Carbon emissions trading, regional heterogeneity, and green innovation: Evidence from a quasi-natural experiment in China

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Abstract: China has implemented carbon trading pilot policy to force incumbent firms to conduct green innovation. However, there are significant differences in economic development, system design and policy enforcement among the eight pilot regions. To this end, we try to use the synthetic control approach to identify the heterogenous effect of regional ETSs on green innovation. Furthermore, we also test the regional-specific effect through the moderated regression analysis, take the roles of carbon market liquidity, ETS coverage and regional economic development into account. Finally, we adopt the dynamic regression model to verify the annual treatment effect of the ETS as well as the varying effect on green innovation from different pilot ETSs. The empirical results show that only Hubei and Guangdong ETSs have effectively promoted the green innovation, while the Tianjin ETS has a short-term promotion effect before the economic sluggish period. However, the pilot ETSs in other regions have not a positive effect on green innovation with the different evolution path. Meanwhile, only in Hubei and Guangdong can the pilot ETSs have a continuous positive effect on green innovation on year-by-year basis. The appropriate industrial coverage and emissions control target as well as the active trading platform have been identified as important factors to positively moderate the effect of regional ETS on promoting green innovation. Then the Chinese central government should take full account of the regional heterogeneity and then make full use of the national ETS to promote green innovation. The local regulators can have some flexibility to determine and adjust the appropriate emissions reduction target promptly. Furthermore, the policymakers should take the emissions from primary energy consumption in the major energy-intensive industrial sectors as the main coverage of the national ETS. In addition, the regulators can further strengthen the supervision on allowance trading and compliance behavior of the incumbent firms.
Keywords: emissions trading; regional heterogeneity; green innovation; synthetic control model; moderating effect model; dynamic effect

The transmission mechanism of the manufacturing industry production activities to carbon emissions from the input-output subsystem perspective: A case of China

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Abstract: Manufacturing is the industry in China that consumes the most energy and emits the most carbon, of which emission reduction effect largely determines the process of achieving carbon peaking and carbon neutrality. This study analyzes the direct carbon emissions and carbon emissions from final demand in China's manufacturing sector, and decomposes the carbon emissions from final demand into six independent parts using input-output analysis. Furthermore, this study analyzes the carbon emission path in manufacturing production activities, as well as the sensitivity analysis and scenario prediction of the factors impacting manufacturing carbon emissions. The results show that the direct carbon emissions and carbon emissions from final demand were respectively about 4.61 billion tons and 3.50 billion tons in 2018. Indirect spillovers and direct spillovers account respectively for 62.1% and 23.1% of the carbon emissions from final demand in the manufacturing industry. The direction and quantity of carbon emission transfer from various energy sources may be properly located using the manufacturing industry's carbon emission transfer route map. The CR scenario shows that the manufacturing industry will reach the peak of carbon from 2025 to 2030, with the corresponding peak between 4.02-4.06 billion tons, and carbon emissions in 2060 will be reduced by 40% compared with 2018.

Keywords: manufacturing industry; input-output analysis; carbon emission decomposition; scenario prediction

Spatiotemporal characteristics and influencing factors of renewable energy production in China: A spatial econometric analysis

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Abstract: Optimizing the distribution of renewable energy production requires knowledge of spatiotemporal distribution characteristics and an understanding of influencing factors of renewable energy production. Therefore, a spatial analysis of specific mechanisms of China's renewable energy production is required. Using panel data of 30 Chinese provinces from 2001 to 2020, we employed the spatial Gini coefficient and standard deviation ellipse method to investigate the degree of spatial agglomeration and characteristics of distribution of location of China's renewable energy production. Then, we explored spatiotemporal regularity, spatial correlation, and spillover effects of renewable energy production by applying Moran's I index and the spatial Durbin model (SDM). Results show that China's renewable energy production presents prominent spatial agglomeration characteristics, and the spatial agglomeration of solar power is significantly higher than those of other renewable energies. Renewable energy production is more evenly distributed in the geographical space. There is a significant positive spatial autocorrelation in China's renewable energy production, and areas are mainly in high-high and low-low clusters. Results of SDM indicate that China's renewable energy production has an apparent spillover effect. Gross domestic product (GDP) per capita, research and development (R&D) investment, transmission infrastructure, environmental regulation, and urbanization rate have significant positive total effects on renewable energy production. Unemployment rate, SO_2 emissions, and population, have significant negative total effects, while effects of energy intensity and CO_2 emissions are insignificant. The results of this study will be of great significance for decision-makers to accurately identify the spatial spillover effects of renewable energy production.
Keywords: renewable energy production; spatiotemporal distribution characteristics; spatial spillover effect; spatial Durbin model; influencing factors

Normal distribution probability based thresholding for segmenting remote sensing index images: A case study of the Xiaolongtan Mining Area, China

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Abstract: Coal resources are an important guarantee for socioeconomic development, but the exploitation of coal resources is often accompanied by serious damage to the ecological environment. There is therefore an urgent need to monitoring the ecological environment of mining areas. In the current monitoring processes, while the thresholding method segments remote sensing index images to extract target features, threshold values are usually determined by empirical judgment or other methods. Such subjectiveness undermines the accuracy of the method and its application for long-term monitoring. To address the issue, we propose a normal distribution probability based threshold segmentation method. It can greatly reduce the influence of subjective factors and improve the accuracy of feature extraction. This method was tested to Landsat 8 data over the Xiaolongtan mining area, southwest China for determining the threshold values of normalized difference vegetation index (NDVI), modified normalized difference water index (MNDWI), and normalized difference coal mine index (NDCMI) for extracting vegetation, water, and coal respectively. The test result was consistent with our field observation of the mining area. It is concluded that the proposed probability-based threshold segmentation method is practical and effective and can be used for monitoring the ecological environment of mining areas.
Keywords: thresholding segmentation; NDVI; MNDWI; NDCMI; coal; mining areas

Spatiotemporal variation of urban thermal environment and its reasons from 2000 to 2020: A case study of the central urban area in Huai'an City, China

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Abstract: It is critically important to understand the spatiotemporal changes of urban thermal environments since urban heat island (UHI) effect is one of the most worrisome urban environments and impedes urban sustainable development. Taking Huai'an central urban area in China as a case, Landsat images from 2000 to 2020 were used. We first estimated land surface temperature (LST) and land covers based on google earth engineer (GEE) platform. Then explored the spatial pattern and laws of thermal landscape level transition and urban expansion pattern using geo-informatics Tupu method and urban landscape Analysis tools. Last, discussed the influence factors on urban thermal changes including urban expansion pattern, and changes of impervious surface and vegetation. The results showed that (1) SUHIs mainly located on Industrial land, high-density area of low building and National Economic Development Zone, and moved towards south and east in the study period consisting with the direction of urban expansion. (2) The Tupu units of thermal landscape transition presents a law of adjacent thermal landscape, and transferring difficultly between cross-level thermal. (3) The edge expansion was the main dominant to intensify urban heat effect, vegetation in new urban area make disturbance in short-term thermal environment change. This research can attribute a better understanding on the urban thermal environment and reasons along with urbanization.
Keywords: Land surface temperature; surface urban heat island; urban expansion type; land cover indices; Huai'an central urban area

Logistic curve hypothesis and verification of economic development and cumulative carbon emissions – Based on provincial panel data in China

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Abstract: Since the industrial revolution, human beings have created huge wealth and caused unprecedented climate change, which has seriously restricted the sustainable development of society. The Chinese government has solemnly promised to achieve the dual-carbon goal. Through literature review, practical judgment and theoretical analysis, this paper believes that in the whole process of economic development, the dependence of economic development on carbon emissions first increases and then gradually decreases. Based on this, a new research hypothesis is proposed: there is a Logistic curve relationship between economic development and cumulative carbon emissions. This paper selects GDP and time as two indicators to measure the stage of economic development, and conducts empirical analysis based on panel data such as GDP, time and consumption of major energy products at the provincial level in China. The results show that: from 1995 to 2019, with the continuous development of economy, the cumulative carbon emissions in China ' s provincial scale show an obvious Logistic growth law in time series, which is also related to the long-term implementation of goal-oriented macro-control in terms of economic growth and carbon emission limitation by the Chinese government. In addition, this paper contributes a method to grasp the inflection point of carbon peak and predict future total carbon emissions.
Keywords: economic development; cumulative carbon emissions; carbon peak and carbon neutralization; time series; logistic growth model

Delimitation of urban growth boundary and carbon emission effect in Jiangsu Province based on FLUS model

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Abstract: The delimitation of urban growth boundary has always been the focus and hotspot of urban

expansion regulation research. In recent years, the application of Flus model provides new ideas and methods for the delimitation of urban growth boundary. However, the existing literature mostly focuses on the research area of city and county, and pays more attention to the specific delimitation of urban growth boundary, and less on the provincial level and the expansion effect after delimitation. In this regard, this paper takes Jiangsu Province as an example , selects three periods of land use data in 2010, 2015 and 2020 and factor data such as elevation, slope, population, GDP and traffic accessibility factors as the basic database, uses the Flus model to simulate the land use change in Jiangsu Province in 2030 and delimit the urban growth boundary, and calculates the carbon emission effect after delimiting the urban growth boundary based on the carbon emission coefficient of various land types. This study comprehensively considers the delimitation of urban growth boundary and its carbon emission effect at the provincial level, which is conducive to the regulation of urban expansion in Jiangsu Province and provides some reference for realizing the goal of carbon peak and carbon neutralization.
Keywords: FLUS Model; Jiangsu Province; urban growth boundary; carbon emission

Research progress and prospect of mining heritage based on Citespace

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Abstract: The data and information, retrieved in the past ten years with “mining heritage” as keywords, was visualized and analyzed through the theory of knowledge graph by Citespace software. Different maps were illustrated, such as the keyword spectrum, the keyword time-zone view analysis map, co-occurrence map, emergence diagram. Research hotspots and forecast prospects were further summarized, so as to promote the theoretical progress and practical optimization of mining heritage. It could be found that mining heritage should focuses on its ecological restoration, value evaluation, comprehensive utilization of underground space, and research on tourism development models. This study believes that the future of mining heritage should be developed from the following aspects: 1. Strengthen the research on the management of mining heritage ecological environment design, implementation and reform; 2. Strengthen the research on the goals of mining value, and promote the establishment of a “National Mining Heritage List”; Natural resource tourism development, exploration of the development mechanism and integration model of cultural tourism; 4. Systematized research on the tourism development strategy of mining heritage; 5. Strengthen the heritage perception of cross-regional and cross-industry types related to mining heritage, such as coal transportation Genetic corridors, etc.
Keywords: mining heritage; tourism sources; conservation and reuse; Citespace; progress and prospect

Topic 4: Energy Science and Technology

Supercritical MeOH liquefaction of plastic waste into transport fuel

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Abstract: Plastic waste has grown at a dramatic rate over recent years, resulting in an emerging global environmental issue of white pollution. However, it also represents a potential and untapped resource for its rich carbon and hydrogen content. This work converts plastic waste into high quality oil by employing supercritical methanol. Polypropylene (PP) was liquefied at the temperature range of 330~400 °C and reacting time of 0~70 min to evaluate the effect of temperature and time on liquefaction. The results show that both increasing temperature and reaction time could promote the PP conversion, thus increasing oil yield. Among parameters tested, conversion rate could achieve as high as 95.2% at 400 °C for 70 min. The oil composition was investigated by GC-MS, exhibiting that the compounds mainly include hydrocarbons and oxygenates. Reaction time leads a slight difference in the oil composition while temperature leads more significant variation. 72.83% and 71.55% of hydrocarbon in oil were obtained at 400 °C for 60 min and at 370 °C, respectively. With temperature and time increasing, long chains were further cracked into short chains and the carbon distribution became more concentrated. These results implied that supercritical methanol could work well as a solvent to liquefy plastic into high quality oil, which provides

a feasible way to solve the plastic pollution problem.
Keywords: plastic waste; supercritical methanol; polypropylene; hydrocarbons

Protrusions induction by carbon black on surface of activated carbon to enhance its catalytic activity

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Abstract: Catalytic methane decomposition is considered as a promising hydrogen production technology without CO_2 emission. Catalyst is generally required to reduce reaction temperature, among which, carbon-based catalysts are widely studied due to their excellent catalytic performance and low cost. Activated carbon (AC), although presents high initial activity, suffers from fast deactivation; In comparison, carbon black (CB) shows low activity but good stability, and its catalytic performance maintains ability inspires a novel method for AC optimization. According to the physical property difference of AC and CB, a novel catalyst is prepared by doping CB on the surface and in the pores of AC. And surface property modified by HNO3 is also recommended, because the increase of functional groups further improves the adsorption performance. The results illustrate that AC_N+BP2000-20:3 show advantages in hydrogen yield, weight increase velocity and carbon yield. Meanwhile, not only the initial activity is improved by a large margin, but also the deactivation time is progressively prolonged. The analysis results show that CB loading significantly increased the number of micropores, which is the key factor for the high initial catalytic activity. And the protrusion, induced by CB, are characterized by unique graphene edges defect, which provides active sites and furtherly promotes the reaction.
Keywords: catalytic methane decomposition; activated carbon; carbon black; HNO_3 modification; defect structure

Correlation coefficients method of power converter's fault diagnosis for switched reluctance motors in electric vehicle

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Abstract: The power converter plays a very important role in switched reluctance motor (SRM) systems which is recommended as a key technique for electric vehicles (EV). But the power converter is also a vulnerable part most prone to be faulted. Therefore, this paper proposes a novel on-line fault diagnostic algorithm of power converters for switched reluctance motor drives based on correlation analysis. In order to obtain the fault signatures from the phase currents, two main fault types of the power transistors in an asymmetric bridge power converter are described and analyzed. The principle of the proposed method is to diagnose faults by comparing the faulty and healthy phase current waveforms. First, the phase currents are shifted into the same phase, then the correlation coefficients of phase-shift currents in the turn-off and reference region are computed as the feature coefficients to detect the faulty phase and to localize the short-circuit faulty device, respectively. The proposed scheme only uses the phase currents that are available from the main control system, and it is suitable for variable speed and load operation, and variable angle modulation system. Simulation and experimental results show the effectiveness and practicality of the proposed fault diagnostic method.
Keywords: switched reluctance; fault diagnosis

Multi objective optimization design of u-type modular double-stator switched reluctance motor in electric vehicles

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Abstract: Switched reluctance motor (SRM) and its control system, after decades of development, has been better established. Its inherent merits such as simple and sturdy structure and high reliability could contribute to its excellent running performance and high performance/cost ratio for electric vehicle application. A U-type modular double-stator SRM (DSSRM), which has the merit of high power density is

optimized in this paper. Taking average torque, torque smoothing coefficient and efficiency as objectives, sensitivity analysis on DSSRM is investigated and discussed to select significant geometric variables. On the basis of the initial structural parameters, the multi objective optimization design is processed by adopting a fuzzy iteration optimization algorithm with weight determination. After the determination of decision result of each structure parameter, the best dimension scheme of the DSSRM is concluded. Moreover, the final scheme proves to perform better than the initial scheme by finite element (FE) analysis. Finally, a prototype motor is manufactured and the experimental results validate the improvement of the DSSRM performance.
Keywords: switched reluctance motor; electric vehicle application; multi objective optimization

A-site disubstituted of $La_{1-x}Sr_xNi_{0.8}Fe_{0.2}O_3$ perovskite on catalytic activity and reaction mechanism of coal tar cracking

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Abstract: The effect of strontium doping in $La_{1-x}Sr_xNi_{0.8}Fe_{0.2}O_3$ perovskite catalyst was investigated for tar catalytic cracking in the COREX process at 700 °C. O_2-Temperature programmed desorption (O_2-TPD) and X-ray photoelectron spectroscopy (XPS) results show that $La_{0.8}Sr_{0.2}Ni_{0.8}Fe_{0.2}O_3$ (Sr 0.2) has more active oxygen species and higher oxygen mobility. The performance of Sr-doped catalysts is higher than $LaNi_{0.8}Fe_{0.2}O_3$, producing less tar and carbon deposition. Moreover, Sr 0.2 exhibited the highest gas yield of 34.6 mmol/g_{coal}, H_2 yield,of 27.5 mmol/g_{coal}, 100% tar removal rate, and the lowest carbon deposition of 19.4 mg/(g·h). Prediction of the reaction mechanism for catalytic cracking is proposed based on the XPS and O_2-TPD results. The perovskite serving as a bridge for oxygen migration and simultaneous oxygen supplementation sustains catalyst activity and durability. Coal tar can be converted into more gas by oxygen supply from catalysts. The appropriate amount of Sr in the perovskite is favorable to high catalytic activity and anti-carbon deposition at high temperatures. This work could provide some guidance for the highly efficient cracking of tar.
Keywords: perovskite catalyst; Sr doping; coal tar; reaction mechanism

Resin-enhanced rocking-chair capacitive deionization

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Abstract: Capacitive deionization (CDI) has been developed as a functional technology for the desalination of brackish water. The technology achieves desalination by moving salt ions out of solution into electrode pores, through the passage of electrons in an electrochemical cell. CDI is renowned for its environmental friendliness but limited by the slow rate of desalination. The Rocking-chair CDI (RCDI) cell was developed as an advanced CDI cell aimed at increasing the rate of desalination. RCDI cells eliminate the subsequent discharging cycle after desalination, that is present during conventional CDI, by enabling simultaneous desalination and discharging in a single cycle. However, in this work we show results from a new cell design that is an advancement on the RCDI design. By incorporating ion-exchange resin beds in the conventional RCDI cell, we show an increased rate of desalination that offers a pathway to minimizing the energy cost of desalination. We also explicate the faradaic reactions occurring that influence the ongoing capacitive storage in both compartments of the cell.
Keywords: capacitive; deionization; desalination; rocking-chair; resins

A transverse flux single-phase tubular switched reluctance linear generator with two stator poles

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Abstract: A tubular switched reluctance linear motor (TSRLM) with two stator poles in cross section and interlaced structure is proposed in this paper. According to the design principle of RSRM and LSRM, the initial geometry dimensions of the TSRLM are decided. Aimed at better performance of TSRLM, the sensitivity analyses on four main parameters are conducted, and the average thrust of the TSRLM is

improved. Compared with its counterpart, more advantageous performance of the TSRLM with interlaced structure is validated by electromagnetic analysis on FEA and dynamic simulation results from MATLAB/SIMULINK. Its thrust per unit volume may be a little smaller than other similar motors, but the TSRLM proposed in this paper can operate with high reliability and long life owing, which is superior to other tubular linear motors. Compared with TSRLM with similar structure, the advantage of this motor is that it has two stator poles and a special interlaced structure. This special structure provides more space for winding placement, it contributes to reduce copper loss of the motor.
Keywords: tubular linear switched reluctance motor; finite element method; electromagnetic analysis; sensitivity analysis

A novel 3-phase tubular permanent magnet linear generator for wave power generation

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Abstract: This paper proposes an air-cored 3-phase tubular permanent magnet linear generator (3P-TPMLG) with a novel structure intended for wave power generation. First, the concrete construction and initial dimensions of the 3P-TPMLG are given through design principles and experience. Second, the basic working principle and the operational process of the mover are discussed according to relevant equations and the isolines distribution of magnetic vector potential at several typical mover positions. Third, the 2-D and 3-D machine models established by finite element analysis (FEA) software FLUX and electromagnetic field analysis are presented. Furthermore, two pivotal parameters are optimized to improve operating conditions and output performance of 3P-TPMLG. Finally, output parameters of 3P-TPMLG are solved separately by FLUX under the constant velocity and the sinusoidal velocity. In accordance with verification by finite element dynamic simulation, 3P-TPMLG has good power output at both constant velocity and sinusoidal velocity. Meanwhile, when the reciprocating frequency is 80 Hz and the proportion of permanent magnet length in half pole pitch is 7/10, the comprehensive evaluation of the generator is optimal. The novel structural 3P-TPMLG for wave power generation can realize symmetrical three-phase power generation when the mover performs reciprocating linear motion at a sinusoidal velocity. Besides, the relative comparisons with other TPMLGs prove that the 3P-TPMLG has the advantages of high efficiency, high power-generation density, and low construction price.
Keywords: novel structure; tubular permanent magnet linear generator; wave power generation; electromagnetic field analysis; symmetrical three-phase power generation

Switched reluctance motor drive for electric vehicles with a front-end DC/DC converter

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Abstract: This paper proposes a novel topology of power converter in switched reluctance motor drive for electric vehicles, which include a front-end DC/DC boost-buck inverter and a classical half-bridge power converter based on the splendid characteristics of the switched reluctance motor. The equivalent circuit modes and the control strategies in the driving state, braking state, and charging state are described. In the driving state, the front-end DC/DC converter works in boost mode, the dc-link voltage is reduced for the reduction of the phase current ripple at low rotor speed state, the dc-link voltage is increased for the reduction of the commutation time, enhancing the efficiency of the system and the rated output torque capacity at high rotor speed or heavy load. In the braking state, the front-end DC/DC converter works in buck mode, the mechanical energy can be converted into electrical energy through the asymmetric power converter and be fed back to charge the battery through the front-end DC/DC converter. In the charging state, the power factor correction circuit can be constituted, the buck mode of the front-end DC/DC converter is used for charging the battery, the harmonic proportion are reduced substantially, the phases

of the voltage and current are close, the power factor is enhanced to 0.99. The simulated results and the experimental results have verified the effectiveness of the proposed novel topology.
Keywords: switched reluctance; electric vehicles; motor drives; power factor correction; inverter

Migration of coal-chlorine in chemical looping combustion

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Abstract: This work focuses on the behavior of coal-derived chlorine in chemical looping combustion (CLC) and the potential adverse impacts of primary gaseous chlorine on Cu-based oxygen carrier (OC). The inactivation mechanism of the sol-gel-derived CuO/Al_2O_3 OC is investigated. Systematic experiments are conducted in a batch fluidized reactor. First, in CLC of coal, chlorine distribution including HCl, Cl_2, Cl adsorbed in tube and Cl in solid phase are studied under various bed inventories, temperatures and gas atmospheres. The main gaseous Cl from coal is HCl, which shows a high reactivity towards CuO and is partially physically absorbed by Al_2O_3. Unconverted HCl is 15.63±0.20%, which could result in corrosion of the CO_2 transportation line and compression equipment. Then, a mixture gas with 400 ppm HCl are fed to evaluate the corrosion of various OC components, i.e., Cu-Al (whole OC), CuO (active phase) and Al_2O_3 (inert support phase). It is found that part of HCl is converted to Cl2 via the Deacon reaction ($4HCl + O_2 = 2H_2O + 2Cl_2$) and oxidized by CuO ($CuO + HCl = CuCl + Cl_2 + H_2O$). The coal ash exhibits a dichlorination function, forming KCl and $CaCl_2$. The CO_2 atmosphere and high temperature in fuel reactor show a promotion on the conversion of coal-Cl to HCl. Under a high concentration of HCl, the active phase CuO of the OC is partially lost, producing the gaseous copper chlorides, i.e., CuCl and $(CuCl)_3$. Besides, the solid-phase copper chlorides also degrade the oxygen donation capacity of the OC. Finally, the migration path of coal-chlorine during CLC is summarized. This work will contribute to the development of Cl-resistance OCs and control approaches for Cl emission.
Keywords: chemical looping combustion; coal; chlorine; oxygen carrier

Synergistic effect on chlorine and inorganics removal during co-hydrothermal carbonization of polyvinyl chloride and lignocellulosic biomass

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Abstract: Polyvinyl chloride (PVC) and lignocellulosic biomasses are typical solid wastes. Synergistic effect chlorine and inorganic removal were investigated during the co-hydrothermal carbonization (co-HTC) at 260 °C for 30 min. The solid products were characterized by Fourier Transform Infrared Spectrometer and Scanning Electron Microscope. It is found that the mass yield, dichlorination, and removal of inorganics demonstrated synergistic effects in the co-HTC process. The dechlorination efficiency (DE) of bamboo green (BG), wheat straw (WS), corn stalk (CS), and corn cob (CC) with PVC was in the range of 70.46-87.01%, which was higher than the predicted value of 67.14-72.56%. During the co-HTC process, the lignocellulosic biomass fragments wrapped on the surface of the molten PVC suppress polymerization, and the hydroxyl functional groups on the surface of the lignocellulosic biomass promote the substitution reaction with the C-Cl bond in PVC. The amount of insoluble lignin in various lignocellulose biomasses influence whether or not there is a beneficial synergistic effect of dechlorination between lignocellulose and PVC. Meanwhile, during the co-HTC process, the removal efficiency (RE) of inorganics was greatly improved and demonstrated a beneficial synergistic effect. The increase in RE of inorganics is primarily due to the release of HCl from PVC, which accelerates biomass degradation and enhances the acidity of the reaction system. Overall, these findings have the potential to provide more comprehensive theoretical guidance for the conversion of difficult-to-treat waste into clean and sustainable energy.
Keywords: co-hydrothermal carbonization; polyvinyl chloride; lignocellulosic biomass; synergistic effect; dechlorination; inorganics removal

Interpretation of soot formation and chemiluminescence in counterflow diffusion flames based on C/O ratio space with application to oxy-combustion

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Abstract: Oxy-combustion is a clean combustion technology that can reduce greenhouse emissions by increasing oxygen concentration and replacing N_2 with CO_2. This paper constructed a mechanism coupled with the OH*/CH*/C_2*/CO_2* formation and quenching reactions to simulate counterflow diffusion flames. Different stoichiometric mixed fraction (Z_{st} = $[1+(Y_F W_O \nu_O / Y_O W_F \nu_F)]^{-1}$) with the same adiabatic flame temperature (2279 K) was set by adjusting the CO_2 concentration on the oxidant and fuel side. Soot formation and chemiluminescence were interpreted based on the carbon-to-oxygen (C/O) ratio space. Because compared with the physical space and the mixture fraction space, the C/O ratio space is not affected by boundary conditions and flame configuration. With Z_{st} increases (0.064 to 0.4), the soot zone shrinks and moves toward the oxidant side, but chemiluminescence and temperature move in opposite directions. The peak temperature decreases by 50 K, while the soot volume fraction (SVF) decreases by 85% due to a significant decrease in the concentration of soot precursors (A1, etc.). The reduction of chemiluminescence is much lower than SVF, making chemiluminescence apparent in high Z_{st} flames. In C/O ratio space, the soot precursor boundary starts at 0.50. Due to the high concentration of oxidizing components, A1 is almost non-existent at positions less than 0.5, the very low polycyclic aromatic hydrocarbons concentration is not conducive to soot formation. While the chemiluminescence is mainly distributed in the range of 0.45-0.55 between the radical pool (< 0.5) and the soot precursor zone (> 0.5), because the CH_2, CH, and C_2H produced by the oxidation of C_2H_2 are distributed here, which are the reactants producing chemiluminescence radicals.
Keywords: oxy-combustion; soot formation; chemiluminescence; C/O ratio; counterflow diffusion flame

The attrition study of copper-supplemented iron-based oxygen carrier for chemical looping combustion

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Abstract: Durable, reactive, and cost-effective oxygen carriers (OCs) are imperative for the commercial application of Chemical looping combustion technology. However, the attrition of the oxygen carriers increases the process complicity and cost of the electricity. While popular materials such as iron, nickel, and copper-based materials have been studied extensively, the simultaneous enhancement of OC durability, reactivity and matchability of heat of reaction between OC and fuel has received little attention. A mechanical mixing method followed by calcination (1200-1300°C) was used to fabricate the copper-supplemented red mud oxygen carriers. Preliminary results show that the addition of small quantity of CuO improved the oxygen transport capacity of Red mud oxygen carrier under wet conditions by controlling the reduction degree of Fe_2O_3, which is applicable to the real application of coal combustion with primitive moisture. And the improved oxygen transport capacity can decrease the flowrate of oxygen carrier in continuous fluidized bed reactor, which could benefit to reduce the risk of attrition. According to XRD results, CuO was found to partly change into $CuFe_2O_4$ by calcination of 5% of CuO with red mud, which can stabilize Cu content more effectively than a single phase of CuO-based oxygen carriers due to the immiscible interaction between Cu and Fe. Progress on the attrition study of the fabricated OC's in fixed bed reactor (TGA) and 0.5 kWth fluidized bed reactor with a reactive environment will be discussed.
Keywords: chemical looping combustion; attrition; mechanical strength; red mud; copper

Bipolar power converter and control of switched reluctance generator system for renewable energy storage

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Abstract: In order to better store renewable energy and better realize electromechanical energy conversion, a bipolar power converter and control of switched reluctance generator system is implemented. Compare the full bridge power converter with the asymmetric half-bridge power converter (AHBPC), this new strategy has several advantages including low cost, modularization, reduced number

of switching pulses which consequently reduced the switching loss. This paper introduces two excitation modes of three-phase full-bridge power converter, three-phase three-beat mode and six-phase six-beat mode. The current path, power switching state and phase current direction of each excitation interval under the two excitation modes are described in this paper. The operation characteristics, advantages and disadvantages of the two excitation modes are compared in this paper. The effectiveness of the corresponding control strategy is verified by simulation and experiments on a prototype SRG system.
Keywords: renewable energy; switched reluctance generator (SRG); three-phase three-beat; six-phase six-beat; bipolar operation; three-phase full-bridge power converter

Simulation of fuel granulation behaviours and analysis of fuel distribution characteristics in iron ore sintering

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Abstract: The efficient utilization of fossil fuels is one of important ways to achieve “carbon peak” in iron and steel industry. It is essential to implement the refined utilization of fuel to carbon reduction during the iron ore sintering. Therefore, it is prior to find out the partition laws of fuel in granules with various sizes and sinter layer for high-efficiency fuel combustion. Based on the improved Litster’s granulation model, this paper simulates the aggregation behaviours of fuel with different granules and study the influence laws on fuel distribution of different sizes granules with fuel ratio and fuel particle size distribution of raw materials. The simulation results show that fuel distribution of different granules is affected by the size distribution of granules, and the fuel content of coarse and fine granules is lower than 15%, while that of 3-5mm size is higher than 35%. With the decrease of fuel ratio in ore blends, the fuel distribution of granules presents that the fuel content of coarse granules decreases and the fuel content of fine granules increases. As the fuel content with -0.5mm particles increases, the fuel distribution of granules presents different variation. In addition, the fuel distribution of sinter layer is further simulated with ratio and fines of fuel, which indicates this model can provide a theoretical support for the control of fuel particle sizes in ore blends.
Keywords: iron ore sintering; granulation; fuel distribution; particle size; process simulation

Preparation of Al@Al_2O_3 macrocapsules for high temperature thermal storage

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Abstract: High-temperature metallic phase change materials (PCMs) are promising thermal storage materials, which can play important roles in high-temperature thermal storage systems, such as solar thermal power generation. The high-temperature metallic materials have the advantages of high thermal storage density and high thermal conductivity, but the volume expansion during the high-temperature phase change process and the melting corrosion of the container have limited their further development. Therefore, it is important to develop reasonable encapsulation technology to solve the problems of leakage and high-temperature corrosion of metallic PCMs. In this paper, we report a new method to encapsulate Al to form macrocapsules of Al@Al_2O_3 for thermal energy storage. The capsules contain pores inside the core, which can act as the buffer space to accommodate the volume expansion of Al core during heating and melting, thereby avoid the cracking of Al_2O_3 shell. Under optimal preparation conditions, the Al core of the macrocapsule has a high latent density of 343.0 J/g and a melting temperature of 655.4 °C. In the temperature range of 400-900°C, the large capsules have a high thermal storage density up to 702.8 J/g. The macrocapsules also show good cyclic thermal stability as investigated by the 50 times of melting and solidification. This study provides an approach to further development of metallic base phase change macrocapsules using encapsulation techniques for promising application in high temperature thermal storage.
Keywords: thermal energy storage; phase change materials; thermal management; phase change capsules; heat storage

Process for metal enrichment from end-of-life lithium-ion batteries

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Abstract: Designing an eco-friendly and cost-effective process that is ready for commercial implement prior to the time frame of 2025-2030 is urgent for recovering valuable materials, e.g., Li, Co, Ni, etc., from the end-of-life lithium-ion (EoL Li-ion) batteries aiming waste treatment and reduce CO_2 emission from metal extraction from ore. This is because (1) by coupling with Li-ion battery energy storage, power-generation utilities are entering into achieving carbon neutral (e.g. net zero) electricity production with expanded renewable power generation; and (2) 2.1 million EVs have been sold globally in 2019 with the total stock of 7.2 million EVs, and the year-to-year increase in EV registration is approximately 40%.[1. https://www.iea.org/reports/global-ev-outlook-2020] Under such a scenario, by assuming that the average lifespan of the Li-ion batteries is 8-10 years, it is expected that, by 2030, recycling of approximately 200 kilotons of EOL Li-ion batteries globally will be necessary to sustain economic growth and protect environment.[2. https://spectrum.ieee.org/lithiumion-battery-recycling-finally-takes-off-in-north-america-and-europe]

To address this urgency, a thermal-conversion process assisted by H_2 has been invented and developed at University of Kentucky (UK) by utilizing a H_2-fueled reactor to effectively recover the metal elements/alloys from the EOL Li-ion battery followed by separating the individual species in a continuously stirred reactor. Such a process offers the significant advantage versus the existing technologies, which is no in need of strong acids and reducing agents in the process. Using $LiCoO_2$ as an example is sketched in **Figure 1**. $LiCoO_2$ powders are reduced in a H_2-fueled fluidized bed reactor at an elevated temperature. The product is a solid mixture of Li_2O and Co. Since Li_2O is highly soluble in H_2O and Co is magnetic at room temperature, a continuously stirred reactor is subsequently used to separate the elemental Co solids from the Li(OH)-concentrated brine.

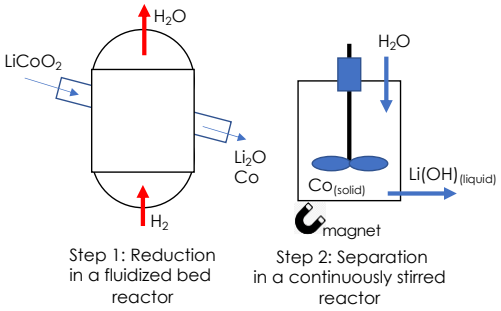

Figure 1. The UK patent pending process to recover valuable materials from the EOL Li-ion batteries.

In this meeting, UK will present (1) the metal recovery results using a bench-scale process, (2) improving the process performance by altering the operating parameters, e.g., gas flow rate, temperature, etc., and (3) disclosing the underlying mechanisms for decomposing lithium oxides under reducing environments.

Synergistic effect to enhance ammonia decomposition over the Co_5Ni_5/Al_2O_3 catalyst

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Abstract: Catalytic ammonia decomposition is considered as an attractive method for onset hydrogen production but is limited by the lack of efficient none-noble catalysts. Nickel based catalysts is found to be the most active among all the none-noble metals. However, its catalytic activity is hardly satisfactory at mid-temperatures. In this work, we propose several bimetallic M_5Ni_5/Al_2O_3 (M=Co, Fe, Cu) as catalysts to decompose ammonia at 700 °C and the gas hourly space velocity of 30 000 ml/(g_{cat}.h). Co_5Ni_5/Al_2O_3 shows nearly 100% NH_3 conversion and the hydrogen generation rate of 1947.9 mmol/(g_{cat}.h). The conversion is ~20.8% higher than that of the monometallic Ni_{10}/Al_2O_3 catalyst. DFT calculations imply that the recombinative desorption of N is the rate-limiting step of ammonia decomposition over Ni-based catalysts and the addition of Co can decrease the energy barriers for this step. NH_3-TPD manifests that bimetallic Co_5Ni_5/Al_2O_3 displays the minimum acidity sites on the surface. The acidity sites have been reported to be detrimental to the electron conduction. Therefore, the high catalytic activity of Co_5Ni_5/Al_2O_3 can be explained by the synergy between Ni and Co to decrease the surface acidity sites, thus reducing the rate-limiting N-N recombinative desorption step. This work provides a feasible method to design efficient none-noble catalysts to decompose ammonia for onset hydrogen generation.
Keywords: ammonia decomposition; none-noble metal catalyst; hydrogen production; synergistic effect

Facile synthesis of porous AlN@C supporting material for stabilizing phase change material

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Abstract: Impregnation of Phase Change Materials (PCMs) into a porous medium is a promising way to stabilize their shape and to improve the thermal conductivity, which are essential for thermal energy storage and thermal management applications, such as electronic devices or batteries. It has attracted many researchers to study in this filed and a lot of porous mediums have been designed and investigated. However, the composite phase change materials still face the energy density and anti-leakage capability antagonistically coupled, which limited the PCMs applied in large scale. In this work, we adopted a new calcination method at a lower temperature to prepare the porous AlN@C medium as a supporting material to stabilize the paraffin. The SEM and BET results indicated the AlN@C with a hierarchical macro-nanoporous structure, which have large PCMs loading capability and favourable capillary adsorption. The composite PCMs showed a high paraffin loading (53-62 wt%), and constant thermal response after 100 heating-cooling cycles. The infrared thermal response and thermal conductivity test showed the composite PCMs has good thermal transfer properties. The leakage test indicated the composite PCMs showed good shape-stabilized properties. This work might provide a facile method for synthesizing high-efficient porous medium, which can shape-stabilize the phase change materials with potential applications in the thermal energy storage and thermal management.
Keywords: phase change material; thermal energy storage; porous material; anti-leakage

Anisotropically enhanced heat transfer properties of phase change material reinforced by SiC-coated biomass carbon fibers scaffold

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Abstract: Phase change material (PCM) is one of the most promising candidates for thermal energy storage and management, with the potential to improve energy efficiency and mitigate the mismatch between peak energy supply and demand, demonstrating a variety of applications in solar heat storage, thermal management systems and buildings. However, the low thermal conductivity and leakage of PCM seriously restrict their applications. In this work, 3D porous carbon scaffolds as-consisted of SiC-coated biomass carbon fibers were prepared, which were used as the thermal conductive skeleton and shape stabilizer for paraffin PCM. In particular, the porous carbon scaffolds were designed with 1D arranged carbon fibers and multi-scaled porous structure, hence the prepared composites had good anisotropic heat transfer and good anti-leakage properties. High thermal conductivity values of 0.61 W m^{-1} k^{-1} in the axial direction (> 3 times of paraffin) and 0.48 W m^{-1} k^{-1} in the lateral direction were obtained for the composite with a filler ratio of 10.4 wt%. The composite also presented high heat storage capacity (186 J g^{-1}) and well-behaved thermal cycling stability. PCM as-supported by biomass carbon have high heat storage capability and anisotropic heat transfer properties, indicating great potentials in thermal energy storage and thermal management applications.
Keywords: thermal energy storage; heat transfer enhancement; thermal management; phase change materials

Copper based phase change microcapsules for high-temperature thermal storage

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Abstract: Due to the rapid development of high-temperature thermal energy storage (TES) applications such as industrial waste heat recovery and solar thermal utilization, it is urgent to develop reliable phase change materials (PCMs) used in high-temperature energy systems. High-temperature PCMs based on molten salts suffer from inherent low thermal conductivity and large undercooling. Metals are perfectly suitable as the high-temperature PCMs because of their high thermal conductivity and high heat storage density. However, due to the volume expansion of metals during high temperature phase change, the packing of metallic PCMs to resolve their leakage and high corrosive problems has not been completely solved. This study reports that Cu@Al_2O_3 high-temperature macro-encapsulated PCMs over 1000 ℃ are fabricated successfully. Copper powders are used as raw material which are spherulitized to millimeter-sized core balls with the help of binder, subsequently the surface of the porous core balls is cladded with alumina shell. Cu@Al_2O_3 macrocapsules with voids are prepared by high temperature sintering at 1200 ℃. The raw core balls consisted of Cu powders are not densified which contained many gaps and pores, acting as the buffer spaces to the volume expansion during high-temperature sintering and melting of Cu. The melting temperature and latent heat of the core metallic PCM are 1063 ℃ and 205 J/g, respectively. After the melting and solidification cycling test, the intact capsules could be well retained without crack or leakage, and the thermal performance of the core nearly remains equivalent after the

cycle. The results demonstrate that the as-prepared Cu@Al_2O_3 macrocapsules are applicable as high-temperature PCMs which can accelerate high-temperature thermal energy storage systems.
Keywords: thermal energy storage; phase change capsule; phase change material; thermal management

Design carbon nanofibers @Ni-Co with different morphologies for high-performance supercapacitors

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Abstract: Designing electrode materials with special morphology is crucial for further improving the performance of supercapacitors. The carbon nanofibers (CNFs) are fabricated using a blend of polyacrylonitrile (PAN), nano-SiO_2, and a loose medium component (LMC) of coal via electrospinning. And using the CNFs as precursors, two electrode materials with different morphologies were synthesized by the hydrothermal method. The structure of electrode materials can be easily controlled by using different additives. Among them, the morphology of PPCNFs@ Ni-Co is similar to the combination of fibers and large petals. And PCNFs@Ni-Co has a unique microstructure, such as small petals evenly distributed on the surface, and the surface of CNFs are wrapped in small flakes. When evaluated as electrodes for supercapacitors, a high specific capacitance of 1400 F g^{-1} can be obtained at a current density of 1 A g^{-1}. Even as the current density increases to 20 A g^{-1}, the electrode still has a high specific capacitance of 990 F g^{-1}, showing an excellent rate capacity. This result is attributable to the material's dispersed flake structure and the synergistic effect with CNFs, which facilitates the transport of electrolyte ions and electrons. In addition, the compound produced also exhibited higher catalytic activity in CO oxidation by the thermal decomposition of N_2, which also indicates that the material has excellent applications in air purification.
Keywords: supercapacitors; CO oxidation; carbon nanofibers; Ni-Co; electrospinning; morphologies

Methane capture to ensure safety of mining works and electricity production - A case study

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Abstract: Methane is captured from the mines to ensure the operational safety of the mine and the continuity of mining operations. Capturing and using methane gained increasing interest in the past number of years. Many factors affect methane capture and its concentration in the air-methane mixture. The quality of the gas is important for the possibility of use and durability of the installation. At the same time, hard coal deposits are one of the largest sources of anthropogenic methane emissions. Methane emissions increase in the case of active mining activities. Methane is a significant greenhouses gas with a global warming potential (GWP) 28 times larger than carbon dioxide over 100 years. Therefore, methane capture becomes an important challenge. There are many potential utilization methods of coal mine methane. An interesting solution that allows increasing the efficiency of methane use is cogeneration systems (CHP). Cogeneration systems can use internal combustion engines or turbines to generate electricity, and the waste heat is used to heat and/or cool mine facilities. The use of the captured methane depends on the quantity and quality of the gas produced. Therefore, to increase the efficiency and safety of methane capture, it is necessary to control and measure the concentration of methane in the captured mixture. The subject of the paper is capturing methane to ensure the safety of mining works in conditions of methane hazard. Additionally, captured methane from the coal seams drainage is used for electricity production. The article analyses the possibility of producing electricity using gas engines fuelled with methane captured from the active hard coal mine Budryk in Poland.
Keywords: hard coal mine; methane capture; methane hazard; mining safety; electricity production.

Social aspects of smart grid development in Poland

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Abstract: The transition to energy clusters requires not only a purely technical reconfiguration of the power system, but also entails various social challenges. The purpose of the presentation is to indicate the social determinants of cluster energy and smart grid in Poland. **Purpose:** In the presentation we pay

attention to the social dimension of creating a functional smart grid. In the report we also present the role of demonstration projects as arenas that set directions for future cluster configurations. We answer the following questions: ● What local power grid configurations are emerging from demonstration projects? ● What negotiations and disputes are taking place within these projects? ● What ideas about the future of such d networks are invoked and mobilised by different actors? ● What user roles are preferred in demonstration projects? **Methods:** The theoretical inspiration that frames the work of our research team is SAF. Fligstein's approach is concerned with the emergence and change of orders of social life at the meso level - in our case, the change in the functioning of energy at the local scale. In our research we use discourse analysis, scenario interviews and field research conducted in four energy clusters in Poland. **Results and Conclusion:** As part of the results, we present possible paths for the development of energy clusters and recommendations for the development of cluster energy in Poland.
Keywords: smart grid; socio-technological changes; niches; heterogeneity of technologies

Research to design a PSIM based controller for an inverter-fed permanent magnet synchronous motor (PMSM)

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Abstract: The purpose of this research is to design a PSIM based controller for an inverter-fed Permanent Magnet Synchronous Motor (PMSM). The dimensioning and assembly of the controller are resented. The controlalgorithm used for the PMSM is Field Oriented Control (FOC). The report includes the theory of the control algorithm and its design. A PSIM based model is designed with the dimensioned components to analyse the behaviour of the controller. The model gives the opportunity of tuning the controller and verifying it with simulations. The model is then converted to be SimCoder compatible, enabling the simulation to begenerated into a code. A Digital Signal Processing (DSP) development board is provided by Powersim Inc. The generated code is imported to the DSP, enabling it to run the controller. Similar behaviour is observed when comparing the test results with the simulations. When simulating the controller with the PMSM, all reference speeds are reached with a maximum deviation of ±0:42%. Using PSIM proved to be an intuitive and educational way of designing the motor controller.
Keywords: field oriented control (FOC); vector control or field oriented control (FOC); synchronous motor (PMSM); controller with the PMSM

Enhancing aerodynamic performance of vertical axis wind turbine using leading-edge micro-cylinder

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Abstract: Vertical axis wind turbines (VAWTs) are experiencing a regained interest for use in large-scale offshore wind energy generation. However, the aerodynamic performance of lift-type VAWTs is lower than that of horizontal axis wind turbines. Setting a micro-cylinder in front of the blade leading-edge as a passive flow control approach is proposed to improve the aerodynamic performance of VAWTs. Numerical simulations combined with response surface methodology are conducted to find the optimal parameters of the micro-cylinder. The response surface optimization is performed on the DOE/Sanida 17m VAWT. The optimization variables of the response surface optimization model are the dimensions and positions of the micro-cylinder and the objective is the maximum tangential force of the VAWT. The optimal power coefficients of the VAWT with micro-cylinder are increased by 66.2%, 17.7% and 3.2% for tip speed ratios of 2.2, 2.49 and 3.09 compared with those of the original VAWT. The flow filed analyses show that the large-scale flow separations around the blade at large angles of attack are supressed by the vortex shedding from the micro-cylinder, which leads to an obvious improvement of torque coefficient for the VAWT with micro-cylinder.
Keywords: vertical axis wind turbine; aerodynamic performance; numerical simulation; response surface methodology

Syngas evolution and energy recovery from the polypropylene and polystyrene blends via CO_2-assisted gasification

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Abstract: Plastic pollution has become an enormous challenge for human beings and the environment due to its widespread use and low degradation. The treatment of plastic waste by gasification technology has attracted more and more attention. However, the syngas evolution and energy recovery of the plastic mixture during CO_2-assisted co-gasification are less studied. The co-gasification of the polypropylene (PP) and polystyrene (PS) blends at different proportions was carried out in a fixed-fed reactor at 1173K. The gas flow rate, yield, and recovered energy of gaseous products were quantitatively investigated. The experimental results of CO, H_2, hydrocarbon (C_xH_y) yields and energy output in comparison with weighted results from the gasification of individual compositions indicated that co-gasification had positive effects on the yield and energy output. The maximum synergistic effects on CO and H_2 yields were obtained under a 2:3 mixing ratio of PP/PS (2P3S), and the synergistic effects of energy output also reached the optimum level. However, the synergistic effects in the whole gasification process gradually weaken as the PP ratio increases. Total syngas with a calorific value of 24.2-28.4 kJ/g was generated through CO_2-assisted co-gasification, which was much larger than the energy output of individual feedstocks. And the syngas with the highest energy output of 28.4 kJ/g had CO and H_2 mole fractions of 93.4% and 1.5% under a 2P3S mixing ratio, respectively. The CO_2 consumption belonged to each gram of these blends was a range of 1.0-1.8g in the process. These results support the feasibility of converting plastic mixture to high calorific value syngas through CO_2-assisted gasification and reducing the greenhouse effect by consuming CO_2.
Keywords: synergistic effects; polypropylene; polystyrene; energy recovery; CO_2 consumption

Synthesis of CNT@CoS/NiCo layered double hydroxide with hollow nanocages for enhanced performance supercapacitors

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Abstract: The CNT@CoS/NiCo layered double hydroxides (LDH) with hallow rhomboid-decahedral nanocage structure was prepared by mechanical stirring and etching precipitation method. The electrochemical test results show that the CNT@CoS/NiCo-LDH exhibits high specific capacitance of 2794.6 F g^{-1} at 1 A g^{-1} in 6M KOH electrolyte, which is superior to other materials with the addition of nickel source. As an assemble device, CNT@CoS/NiCo-LDH reveals high specific capacitance of 114.1 F g^{-1} (at current density of 1 A g^{-1}) and excellent stability with 87% after 1000 cycles. The device exhibits a relatively high-energy density of 35.64 Wh kg^{-1} at a power density of 750 W kg^{-1}, and even at the high-power density of 3750 W kg^{-1}, the energy density of CNT@CoS/NiCo-LDH material can still maintain 26.38 Wh kg^{-1}. Hence, the superior pseudocapacitive performance of CNT@CoS/NiCo-LDH can be ascribed to the synergy among three materials as well as the excellent three-dimensional structure obtained by changing amount of nickel source.
Keywords: supercapacitor; nanocomposites; electrochemical properties

Experimental investigation of temperature distribution in a short planar solid oxide fuel cell

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Abstract: Solid oxide fuel cells (SOFCs) is a promising electricity generation device owing to its high efficiency, zero emission, fuel flexibility and so on. SOFC surface temperature distribution is a key parameter for SOFC stack design. There are many problems in the commercialization of SOFC, such as cost, durability, carbon deposition and so on, and the thermal stress induced by the uneven temperature distribution in the SOFC is an important factor that reduces the durability and performance of SOFC. In this study, a three-cell planar SOFC short stack is prepared and the temperature distribution in the middle cell is measured by thermal-couples embedded in the anode diffusion layer. In order to avoid of the influence of furnace, the tested SOFC stack is enfolded by a thick thermal insulation material. The results show that the temperature in the SOFC is much higher than the furnace temperature, implying that the effect of furnace on the fuel cell is neglectable. The temperature difference in the cell is not obvious, and the difference increases with the increase of operating current when the operating current is 18A, the maximum temperature difference in the cell is 8 °C, and when the operating current is 30A, the maximum temperature difference in the cell is increased to 14 °C.
Keywords: solid oxide fuel cell; temperature measurement; temperature distribution

Preparation and electrochemical study of cottonseed shell porous carbon/carbon nanospheres composites

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Abstract: It is of great significance for the application of composite materials based on two biomasses as electrode materials in supercapacitors. In this paper, cottonseed shell/ carbon nanospheres composites (GPCs@TQ-1) were prepared by hydrothermal treatment of cottonseed shell pyrolytic carbon and glucose, and then one-step activation with KOH. The samples were characterized by SEM, TEM, Raman spectroscopy, XRD, N_2 adsorption and desorption. The electrochemical properties were investigated by constant current charge and discharge, electrochemical impedance spectroscopy and cyclic voltammetry. The microstructure and electrochemical properties of the carbon composites were studied by means of structure characterization and electrochemical tests. The results showed that the specific surface area of GPCs@TQ-1 was 2281.39 m^2/g when the glucose content was 10 g, and the surface morphology of glucose nanospheres was obvious. Under the current density of 0.5 A/g, the specific capacitance can reach 308.8 F/g; when the current density was increased to 5 A/g, the specific capacitance was 263.9 F/g, which showed excellent ratio performance. After 5000 charge and discharge tests, the capacitance still remained at 90.93%. In addition, when assembled into a symmetrical supercapacitor, the output power reached 1246 W/kg, and the energy density was 4.5 W·h/kg.
Keywords: biochar; carbon nanospheres; composite materials; supercapacitors

In situ perfusing Sb particles into porous N-doped carbon microspheres and their electrochemical properties in potassium ion batteries

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Abstract: Antimony-based materials with low platform and high theoretical capacity have been considered as a promising candidate of anode material for economical and high-performance potassium ion batteries (PIBs) in the recent decades. Unfortunately, they are still affected by the sluggish kinetics and poor cycle stability, meanwhile, the large radius of the K^+ ion leads to the aggregation of particles. Herein, we developed an in-situ perfusing method to construct Sb nanoparticles into the hierarchical porous N-doped carbon (HPNC) microspheres restriction structure, which was proved to be a reasonable and efficient way to enhance the electrochemical properties. Meanwhile, it was acknowledged that electrolyte optimization (KPF_6 and KFSI) exerted significant influence on greatly enhancing the electrochemical performance. With the hierarchical porous structure and the electrolyte composition design, Sb@HPNC exhibits an outstanding reversible capacity of up to 507 mAh g^{-1} at a current density of 0.1 A g^{-1} over 100 cycles and excellent long-cycle stability of 262 mAh g^{-1} at 1.0 A g^{-1} over 700 cycles. We expect this work can offer a reference for the development and exploration of advanced alloy-type electrodes for PIBs.
Keywords: potassium ion battery; antimony; electrolyte optimization; hierarchical structure

Hybrid I2/N719-dye/TiO2 photoelectrode for photo-assistant rechargeable lithium iodine batteries

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Abstract: An integrated battery system, which integrates solar power and rechargeable battery in the same unit, is an effective solution for the shortage and inefficiency of power energy. We initially present an integrated photo-assistant rechargeable lithium-iodine (Li-I_2) battery system by using hybrid iodine@activated carbon/N719-dye/titanium dioxide (I_2@AC/N719-dye/TiO_2) composite as dual functional photoelectrode. In this integrated battery system, the photovoltage generated on the hybrid photoelectrode compensates the charging voltage of the cell, which decreases the charging potential by ~ 100 mV under chronoamperometry test. Exactly, under illuminated condition, the integrated Li-I_2 battery extending the charge/discharge capacity from 171/166 mAh g^{-1} to 204/193 mAh g^{-1}, respectively, with a higher energy efficiency of 93 % (output electric energy/input electric energy) than that of Li-I_2 battery

(that is ~ 87 %). Furthermore, the accelerated redox kinetics of lithium polyiodine conversion are also revealed by the enhanced electrochemical behavior and density functional theory calculation. We believe that such design with the integrated photo-assistant rechargeable Li-I_2 battery can hew out a new way to realize the application of efficient solar energy conversion and storage.
Keywords: hybrid iodine photoelectrode; photo-assisted; lithium-iodine batteries; integrated battery

Nitrogen and sulfur Co-doped 3D graphene framework for high performance sodium ion batteries

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Abstract: The traditional wisdom holds that expanding the interlayer spacing of carbon-based materials to achieve more Na ions insertion via hetero-atom doping is an effective way to increase their sodium storage as the anode of sodium-ion batteries (SIBs). However, the relatively low diffusion control capacity indicates the contribution of capacity derived from insertion/extraction of Na ions and Na ion electrolyte complex is much smaller than expected. In this paper, it is demonstrated that although the interlayer spacing can be expanded by hetero-atom doping, the capacity increase mainly comes from the adsorption of Na ions and reversible reaction between -C-S_x-C- covalent chains and Na ions, rather than the insertion of Na ions or co-insertion of Na ions electrolyte complex. What's more, the mechanism is exclusive to ether-based electrolytes and would be inhibited in its ester counterparts. Kinetic analysis verified that the synergetic effect of N/S co-doping could not only largely enhance the Na ion diffusion rate but also reduce the electrochemical impedance of nitrogen and sulfur co-doped 3D graphene frameworks (NSGFs). In addition, postmortem techniques, including SEM, ex-situ XPS, HTEM and ex-situ Raman spectra, all demonstrated an even and ultrathin inorganic-rich SEI film, and the extremely physicochemical stable structure of the 3D graphene matrix. Therefore, NSGFs electrodes exhibit a high specific capacity of 834.0 mAh g^{-1} at 0.1 A g^{-1} and remarkable rate performance of 261.1 mAh g^{-1} at 5A g^{-1} in ether electrolyte. Furthermore, the NSGFs electrode presented stable long-term cycling at a high current density of 1 A g^{-1}. This work sheds light on the mechanism of improving the electrochemical performance of carbon-based anode by heteroatom doping in SIBs and provides a new insight for designing high-performance anodes of SIBs.
Keywords: sodium-ion batteries; graphene; doped

Microfluidic evaporator with porous photothermal evaporation layer for sample concentration

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Abstract: Microfluidic devices have been wide applied in biochemical detection, medical analysis and material synthesis, etc. In these on-chip operations, sample concentration is essential for improving reaction efficiency and reducing reaction time. Evaporation induced concentration is simple and efficient for various types of samples. However, the closed microfluidic chambers severely hinder the vapor discharge therefore limit the on-chip application scenario of the evaporation-based concentration. Moreover, the instability of the gas-liquid interface during the evaporation process strongly disturbs the flow and fluid control in the microfluidic structures. Here we designed a microfluidic evaporator with porous photothermal evaporation layer for sample concentration. By utilizing a porous structure with photothermal conversion ability, high-efficient evaporation can be achieved and the disturbance of the flow stability can be minimized during the phase change process. Effects of the hydrophilicity of porous layer, light intensity and solution flow rate were investigated. The concentration rate could be regulated by changing the light intensity and the solution flow rate. The designed microfluidic evaporator exhibited efficient concentration performance with low selectivity for different sample types. We believe this design has a great potential to be applied in other microfluidic platforms as integrated front-end unit or directly end-use purpose.
Keywords: microfluidics; photothermal; evaporation; porous layer; two phase flows

Waste utilization of sewage sludge and red mud based on chemical looping catalytic oxidation

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Abstract: The effective and integrated utilization of multiple waste is an important method to reduce carbon emissions. In this work, we propose a multi-waste utilization method based on chemical looping catalytic oxidation (CLCO) that can simultaneously treat industrial solid waste (red mud) discharged from alumina extraction in the aluminium industry, solid sediment material (sewage sludge) generated from water and wastewater treatment processes, and ventilation air methane (VAM) from coal mining. Red mud is used as oxygen carrier (OC) after calcination and crushing, sludge after drying and crushing is used as fuel for reduction process and VAM is used as gas for oxidation process. The experimental results of 80 cycles show that the carbon conversion and CO_2 selectivity of the reduction process are stable at 85% and 99%, respectively. And SEM and XRD indicate slight sintering and agglomeration of oxygen carriers. The mechanical strength test results show a minor decrease in particle strength after 80 cycles of OC. Although the reactivity of red mud as OC is not as good as that of artificially prepared OC, this deficiency is acceptable considering its cheapness and high yield. It is worth noting that the products of sludge combustion (mainly silica) are massively deposited in the reactor and mixed with OC, which may greatly affect the performance of OC, and the method of separation of the two should be further considered in future work.
Keywords: chemical looping catalytic oxidation; sewage sludge; red mud; ventilation air methane; waste utilization

A review of district energy for building decarbonization

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Abstract: Building energy consumption accounts for around 25% of China's annual energy consumption. Under the background of fully implementing the goal of “carbon peak and carbon neutrality”, developing low-carbon buildings is a promising approach for the construction industry to realize the goal of “double carbon”. Meanwhile, district energy, which can effectively improve the share of renewable energy in the energy mix, cut the energy cost and reduce environment impact, has received increased attention. Building a district energy system nearby existing buildings can effectively eliminate building carbon emissions and help achieve the goal of “double carbon”. This paper reviews the efficient utilization of district energy in buildings. Firstly, it discusses the components and functions of the district energy systems, and then expounds how to improve the system performance from four perspectives: Source, Network, Load, and Storage. It was observed that the technologies of multi-energy complementary, demand response and energy storage based on optimization algorithms can be applied for peak shaving and promoting the share of renewable energy, thus reducing building carbon emissions. Finally, the study discussed the current status and future trends of district energy system in China. The paper concludes that a digital twin city which is capable of perception, diagnosis, prediction and intelligent control will be the direction future cities.
Keywords: district energy; optimal operation; distributed energy system; building decarbonization; digital twin cities

Influence of the coupling state of fuel-support gas-pyrolysis gas on coal bed combustion rate and emissions

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Abstract: The coal used in layer combustion (sintering, coking, smelting, bulk coal combustion, etc.) accounts for 40% of my country's coal consumption. At present, the combustion rate of this part of coal is generally low, resulting in the concentration of original pollutant emissions from combustion. And the corresponding management costs remain high. Existing research has not paid much attention to the coupling state between combustible particulate matter and combustible gas emitted by laminar combustion, combustion gas and fuel, and the influence mechanism of this coupling state on combustion rate and emissions is also unclear, forming a supporting laminar combustion method. The theoretical blank area of emission reduction technology innovation. In this regard, this paper takes coal bed combustion as the research object, adopts three different furnace types, constructs different coupling states between combustion participants, measures the variation characteristics of combustion emissions, and studies the combustion coupling state to improve the combustion rate of coal bed combustion Mechanisms with Coal Combustion Emissions. The results show that different combustion coupling states

enhance the combustion rate of combustible particulate matter and combustible volatile matter in combustion emissions by constructing different degrees of orderly coupling between fuel-supporting gas-pyrolysis gas, thereby improving the coal layer. burn. A good orderly coupling can achieve huge emission reductions of combustible emissions. Among them, the CO emission level can be reduced by 3 orders of magnitude, reaching 42.7 ppm; the non-methane total hydrocarbon and CH4 emission levels can be reduced by 1-2 orders of magnitude, reaching 42.7 ppm respectively. 2.5 ppm, 0.5 ppm; the emission level of fine particulate matter can be reduced by 2 orders of magnitude to 2.7 mg/m3; the above four original emission levels are lower than the maximum emission standards stipulated by the state. SO2 is related to fuel substances, NOX is related to combustion temperature, and the combustion coupling state has no significant improvement on the emission levels of the two.

Key words: combustion coupling state; intake mode; air passing rate; coal combustion emissions

Research on mixed production decision of new energy vehicle manufacturers under the "dual-credit" policy

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Abstract: The "dual-credit" policy puts forward higher requirements for the technological innovation and production decision of new energy vehicles. This paper takes the new energy vehicle manufacturer as the research object, and analyzes the optimal decision problems of mixed production of three new energy vehicles under the two decision modes of battery self-standard and battery outsourcing, and under the constraints of cost, range, fuel cell power and integral price. The research shows that: 1) under the two decision-making mode the price, production and profit of the new energy vehicles will increase accordingly with the increase of the integral price; 2) under the "dual-credit policy", pure electric vehicle and fuel cell vehicle are affected by the range and fuel cell power respectively and have an optimal solution 3) with the same consumer preference, cost, integral price, etc., the mixed production under self-standard decisions can make more profits compared with outsourcing decisions.

Keywords: "dual-credit" policy; new energy vehicles; mixed production; endurance; battery power

Preparation of CNT@CoSx/ Nico-LDH nanocomposites and study on supercapacitor performance

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Abstract: The rhombododecahedral CNT@CoS/ NiCo-LDH composite electrode material was prepared by mechanical stirring and etching precipitation method. The electrochemical test results show that the CNT@CoS/ NiCo-LDH-100 exhibits high specific capacitance of 2794.6 F g^{-1} at 1 A g^{-1}, which is superior to other materials with the addition of nickel source. When the current density increases to 5 A g^{-1}, the capacitance retention is 60.1%. In the two-electrode system, the specific capacitance of CNT@CoS/ NiCo-LDH-100 is 114.1 F g^{-1} (1 A g^{-1}) and excellent stability with 87% after 1000 cycles. The device exhibits a relatively high energy density of 35.64 Wh kg^{-1} at a power density of 750 W kg^{-1}, and even at the high power density of 3750 W kg^{-1}, the energy density of CNT@CoS/ NiCo-LDH material can still maintain 26.38 Wh kg^{-1}. Hence, the superior pseudocapacitive performance of CNT@CoS/ NiCo-LDH can be ascribed to the synergy among three materials as well as the excellent three-dimensional structure obtained by changing amount of nickel source.

Keywords: supercapacitor; composite material; electrochemical performance

Topic 5: Intelligent Equipment and Technology

Development of non-destructive testing techniques for fusion reactors

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Abstract: A stable supply of electricity is one of the most important issues for sustainable development. Whereas fission-based nuclear power has played important roles in many countries, the rapid increase in nuclear power plants worldwide implies that procuring their resources would be more competitive in the future. In contrast, fusion-based nuclear power has such a very attractive feature that its resource is realistically infinite. Studies for realizing fusion-based nuclear power have a long history; there are still many challenges for the realization. An experimental reactor that does not generate electricity is being constructed in EU within the framework of an international collaboration project; the present schedule expects the first-generation commercial reactor, whose output is several hundred megawatts, becomes available around the middle of this century. Nuclear fusion reactors have many unique components, which implies that new non-destructive techniques are necessary for the safe operation of the reactors. However, the number of studies about non-destructive techniques for fusion reactors is very limited. In this presentation, we will introduce some of our studies on the development of non-destructive testing techniques for assuring the integrity of important components in fusion reactors.
Keywords: nuclear fusion; power source; non-destructive inspection; eddy current testing; ultrasonic testing

Innovation design and applications of robotic manipulators in intelligent manufacturing system

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Abstract: Due to the potential high rigidity, high accuracy, and high loading capacities of parallel manipulators, research and development of various parallel mechanism applications in engineering are now being performed more and more actively in every industrial field, and it is considered a key technology of robot applications in industry in the future. In this talk, the rational of using parallel robots for parallel robotic machines is discussed and explained. A comparative study is carried out on some successful parallel robotic machines and conventional machine tools. Meanwhile, the latest research activities on parallel manipulator and its innovative design in the Laboratory of Advanced Robotics and Mechatronics at York University are introduced, they are: parallelization of serial robots, parallel robotic machines, reconfigurable robotic manipulators, reconfigurable modular moving robots as well as the applications of parallel manipulators in micro-motion device, parallel robot based sensors, exoskeleton, rehabilitation robot and rescue robot.
Keywords: parallel robots; performance evaluation; parallization; reconfigurable robots

Intelligent driving and unmanned vehicle technology of mine transportation equipments

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Abstract: As one of the most important parts of smart mine, the mine transportation should be a safe, efficient and unmanned intelligent system which integrating many advanced technologies such as intelligent driving, intelligent operation and unmanned vehicle. Firstly, this report will briefly review the parallel and crossover development between mine transportation equipments and urban transportation devices over the past years, and summarize the current status of mine transportation intelligent technologies. Then, some new intelligent driving technologies such as permanent magnet direct driving, explosion-proof hybrid driving, magnetic levitation driving, friction-magnetic composite braking and multi-motor collaborative control of mine transportation equipments will be introduced. What is more, some intelligent operation technologies including standardized loading and unloading, robot handling and inspection, digital twin remote control will also be introduced respectively. Finally, the research progress of unmanned driving technology in the field of coal mine transportation vehicle including trackless rubber-tyred vehicle, monorail crane and mining dump truck will be deeply discussed.

Automatic design of blasting passport in AutoCAD for gate road in underground mining

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Abstract: Traditional blasting design is mainly based on experience, blasting passport in AutoCAD is drawn manually, this causes time-consuming, costly, waste of manpower. For this reason, the development of a reliable software for gate road blasting design is an ideal way to solve the current problems. However, in Vietnam the work is still far from enough, because until date there are no software can resolve both process of calculation blasting parameters and automatically drawing blasting passport in AutoCAD. Therefore, in order for developing a suitable model to solve the problems in the current gate road construction, it is necessary to create an algorithm linking between blasting parameters calculation process and drawing blasting passport in AutoCAD process. This paper introduces an automatic algorithm linking between blasting parameters calculated by Delphi programming language and AutoCAD to help drawing automatically. Through the characterization of input data for gate road, calculation of geometric parameter and algorithm of blast-hole pattern for each section was introduced in details. The algorithm was applied to automatic blasting passport design for gate road in underground mining with two popular cross-section forms of trapezoid, semi-circle arch which verified the feasibility of the algorithm.
Keywords: blasting for gate road; blasting design; blasting model; drawing in AutoCAD

Intelligent fault diagnosis and anomaly detection with deep learning

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Abstract: Today's real-world physical systems such as smart buildings and factories, as well as many advanced machineries such as cranes and mining equipment, are becoming large and complex data-intensive systems. Constant monitoring and analysis of the data streams generated by the multitude of interconnected sensors and actuators in these systems can be useful for intelligent fault diagnosis or for detecting anomalies due to possible cyber intrusions, using advanced machine learning approaches such as deep learning. However, detecting anomalous patterns in multivariate time series, which is the fundamental data type for understanding dynamics of the underlying processes in these real-world systems, is a challenging problem. The deep learning models need to address various issues such as accounting for the complicated temporal and spatial dynamics of the sensors present in these complex systems, and addressing possible variations in the working conditions between training and testing time, or across different machineries and cyber-physical systems, through domain adaption. We present our ongoing efforts in intelligent fault diagnosis under varying working conditions based on domain adaptive convolutional neural networks, and multivariate anomaly detection with self-learning graph convolutional networks for cyber-physical systems.
Keywords: intelligent fault diagnosis; anomaly detection; cyber physical systems; convolutional neural networks; deep learning

Development and application of coal mine robot

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Abstract: Of those working in the coal mining industry, more than 60% of them are in hazardous and heavy-duty positions in China. The coal mining industry is the most urgent need to carry out a large-scale "machine replacement of human" high-risk industries. China's coal mine robot research and development started late, the earliest to achieve a breakthrough in the development of coal mine rescue detection robot. In recent years, the development of various types of coal mine inspection robots and robots for coal mining, excavation and transportation is more mature. With the in-depth research on coal mine robots, the application of key technologies such as complex mechanism design, autonomous environment perception, autonomous learning and control operations, and special design in coal mine environments has made coal mine robots more and more adaptable and reliable. In the future, coal mine robots will continue to develop in the direction of intelligent information fusion of multi-sensor, multi-robot collaborative work, as well as intelligence, miniaturization and modularity.

Visible light communication and its applications in mining industry

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Abstract: With the explosive increase of internet traffic, the next-generation of communication, a.k.a.

6G, is coming and envisioned to meet the full connectivity demands of the future digital society. Visible light communication (VLC) is considered to be an important role in 6G thanks to its huge spectrum, high energy efficiency and security. Generally, there are two kinds of typical VLC, namely photodiode-based VLC and camera-based VLC, where both two can share the same transmitters piggybacked on LED lighting infrastructure, but the receivers are photodiodes and cameras respectively. The former can normally achieve very high data rate over 10 Gbps but to be easily affected by the nonlinearity of LED, whereas the latter provides only kbps level data rate due to the low sampling ability of camera under communication mode. To address aforementioned issues and push VLC into realistic applications, many researchers including our group take efforts to suppress the nonlinearity of LED and boost the data rate in VLC. Therefore, in this talk, we will first introduce the fundamental principle of VLC, and share our work on mitigating the negative effect of LED nonlinearity in photodiode-based VLC and improving the data rate of camera-based VLC, we finally present application cases of VLC as well.
Keywords: visible light communication; optical camera communication; LiFi; 6G

Optical techniques in measuring surface topography in mining industrial manufacturing

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Abstract: The presentation concerns the analysis of surface measurement using optical techniques and methods. The presentation will show such measurement techniques as Focus Variations, Interferometry, Confocal and the Confocal Fusion method will be discussed. All techniques will be presented on examples from industrial practice. Each technique has its own advantages and disadvantages and are not usually used as universal measurement techniques.

Life cycle management of electromechanical equipment based on digital technologies

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Abstract: Energy infrastructure is a major factor in sustainable economic development, world and social stability in the world, especially during periods of economic development. The transformation of energy and transport infrastructure affects the achievement of the goals of the transition to a low-carbon economy. However, due to excessive energy consumption, the physical wear and tear of infrastructure is growing at a high rate. Creating a secure infrastructure for the future is essential to achieving sustainable development and ensuring energy efficient consumption of energy. The use of digital and information technologies has a positive effect on the development of energy efficient management of energy industry facilities and will create prerequisites for the growth of investments in the modernization of infrastructure and its re-equipment. Therefore, an important role in the management of the life cycle of the energy infrastructure is the management of the reliability and energy efficiency of the equipment of electromechanical and electrical complexes of consumers. In the report, based on the analysis of modern structures and algorithms for controlling the electric drive, the most promising areas in the field of digital technologies were selected, which will have a significant impact on the energy efficiency and reliability of the electromechanical systems of oil producing enterprises. The existing methods of monitoring and predicting the technical conditions of electromechanical equipment are analyzed and the expediency of creating an intelligent system for diagnosing electromechanical systems is substantiated. To control the level of energy efficiency, it is proposed to assess the technical condition and energy characteristics of operating modes based on the analysis of electrical parameters. The results of experimental studies and simulation modeling are presented. A technique for determining the type of damage and classifying the operating modes of a group of electromechanical consumers based on the analysis of electrical parameters data using artificial intelligence tools for classifying and searching for the level of damage is considered.

Mechanical model of performance prediction for cutter of tunnel boring machine

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Abstract: Tunnel boring machine (TBM) has been widely used in mining roadway and various tunnel engineering. However, there is lack of rock breaking prediction models for guidance resulting in the rock breaking theory lagging behind engineering practice. To reveal the rock breakage mechanism of constant cross section (CCS) cutter of TBM, a new analytical model of TBM rock breakage in half space under linear compression of CCS cutter was proposed. The rock breaking mechanical model of the wedge-shaped body of CCS tool was constructed, the shear and tensile rock breaking criteria based on the load transfer mechanism were put forward, and the optimized analytical formula for CCS double-cutter was deduced, and the rock breaking mechanism of CCS tool formed a composite wedge was revealed. Results show that after the composite wedge being formed by the CCS cutter, the composite wedge further compresses the rock mass resulting in tensile failure of underneath rock based on the plane stress analysis. In case of two CCS cutters loading condition, the rock between them is squeezed by 2 isosceles triangles, resulting in subsequent shearing and tensile failures. Furthermore, the wedge prediction model of the rock breaking was proposed underneath the CCS cutter, and it was verified in laboratory linear compression test to obtain validity. The conclusions obtained in this study not only provide a theoretical basis for TBM rock breaking under 3D conditions, but also provide a technical basis for the parameter design of TBM cutting in practice.
Keywords: tunnel boring machine; constant cross section; mechanical model; linear compression; load transfer

Design of underground multi-axis hydraulic manipulator control system based on embedded Linux

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Abstract: Robot intelligent system is an important direction for the future development of coal mine. Multi axis hydraulic manipulator system can be used for the handling and grabbing of underground pipelines, supports, explosion-proof equipment and other heavy objects, and can effectively improve the work efficiency, safety and intelligent level in the process of mine construction and maintenance. However, there is little research on relevant control systems, This paper takes the underground multi axis hydraulic manipulator as the research object, selects the i.mx6q four core chip based on cortex-a9 architecture as the main processor, and completes the hardware design of the multi axis manipulator, such as related control circuit, communication interface circuit and peripheral auxiliary circuit; According to the motion control requirements of multi axis manipulator, the kernel architecture transplantation based on Linux embedded operating system is completed, and the application software such as communication processing, sensing signal processing, motion control, motion feedback, I/O control and program upgrade interface of control system are realized; The underground multi axis manipulator control system developed in this paper can realize the actions of underground multi axis manipulator, such as grasping, lifting, stacking and rotation, fill the vacancy of domestic research, and help to improve the intelligent level of coal mine.
Keywords: coal mine intellectualization; multi-axis manipulator; control system; embedded; Linux operating system

Data-driven modeling and control for mineral preparation processes

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Abstract: The deep integration of new generation information technology and manufacturing is triggering far-reaching industry transformation. Coal separation, as an important part of the clean utilization of coal resources, is gradually moving from automation and informatization to intelligence, to comply with national “dual-carbon” development strategic plan. However, in the actual production, it is often faced with the problems, such as difficult detection of operation indices in the product quality and output, time-varying working conditions, unclear mechanism, difficult design of control methods, complex control structures and difficult verification of control systems, which pose new challenges for intelligent coal separation. This report focuses on the actual demand for intelligent coal separation, takes the heavy medium separation process as the background, combines data and knowledge, integrates intelligent behaviour and intelligent methods, modelling and control, and introduces them into the intelligent coal separation process. Additionally, the intelligent modelling method of coal separation process, the operation optimization structure and design methods, and the hardware-in-the-loop experimental research platform are introduced, and the opportunities and challenges brought by the next

industrial Internet are discussed.
Keywords: industry transformation; coal separation; heavy medium separation

Airborne electromagnetic exploration system pneumatic vibration isolation system design

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Abstract: An airborne electromagnetic exploration system must effectively capture low-frequency signals. Because natural field source signals are faint, an airborne electromagnetic exploration system must have excellent vibration isolation and noise reduction performance to collect low-frequency signals satisfactorily. In this paper, first, the cylinder-type pneumatic vibration isolation system is constructed based on the pneumatic transmission concept. The nonlinear dynamic model is established based on thermodynamics and aerodynamics. Second, Matlab/Simulink is used to simulate its dynamic performance so that the time domain and frequency domain characteristics of its vibration are simulated and analyzed. Meanwhile, the influence of the auxiliary chamber volume and orifice area on its vibration isolation performance is investigated, providing theoretical guidance for selecting optimal design parameters. Finally, laboratory experiments and airborne electromagnetic exploration system flight tests were carried out. The simulation results show that, according to the design parameters, the resonance frequency of the pneumatic suspension can be as low as 0.5Hz, and the amplitude ratio of the resonance point is less than 1.8. In addition, the cylinder-type pneumatic vibration isolation system performed admirably in both laboratory and flying tests, which has good vibration isolation performance and can quickly attenuate and efficiently isolate significant vibrations. As a result, it satisfies the requirement for vibration isolation systems in airborne electromagnetic exploration systems.
Keywords: airborne electromagnetic exploration; vibration isolation; dynamic model; pneumatic suspension

Application of intelligentization in coal preparation automation system

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Abstract: With the development of science and technology, all industries are promoting computerization. Intelligence is an advanced technology by information collection and automation. The processing industry also has the conditions for intelligent construction. By introducing the automated subsystem and the information subsystem of the processing plant, we talk about the development stage and the conditions for investing in intellectuals. The purpose of this research is to optimize the structure of production system.
Keywords: intelligent coal preparation plant; automation system; information system; big data analysis

Design of UWB antenna for geological imaging radar in coal mine

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Abstract: In this paper, a miniaturized ultra-wideband antenna array is designed to meet the needs of geological imaging in coal mine. The antenna array is a planar array composed of 7 radiation elements, 3 transmitting and 4 receiving. Each radiation element is composed of two Vivaldi slot line antennas arranged crosswise, which can realize bilinear polarization detection. The antenna design was simulated by HFSS. According to the simulation results, the VSWR was <2 and gain was >3dB every Vivaldi slot. Finally, the antenna was tested in a microwave anechoic chamber, and the test results show that the VSWR and gain performance of the antenna are consistent with the simulation results, which meet the design requirements of geological imaging system.
Keywords: geological imaging radar; UWB; Vivaldi; antenna array

Research status and prospect of transparent mine geological information system

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Abstract: Nowadays, with the development of transparent mine geological software system in our country, it has gradually reached the goal of holographic model construction and dynamic updating, which is characterized by multi-source data comprehensive geological modeling. In order to meet the needs of comprehensive geological guarantee for accurate and intelligent coal mining, higher requirements are put forward for the model construction accuracy and geological disaster prediction function of the system. The accuracy of the previous geological models on the formation structure is only up to the formation group or limited to coal seam, roof and floor, which is far from meeting the needs of geological quantitative analysis and numerical simulation of water hazard prevention and control. It is urgent to carry out characterization and modeling of the sand and mudstone mono and spatial distribution of the main water-containing/water-retaining layer in the formation. Through the research of subdivision algorithm of high precision geological model and embedded secondary development of quantitative analysis function, to realize the dynamic simulation and accurate prediction of geological disasters under high intensity intelligent fully mechanized mining.
Keywords: transparent coal mine; geological information system; 3D geological modeling; embedded development; numerical simulation

Warning model of coal mine ventilation disaster based on the combination of k-neighborhood-gray correlation method and its application

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Abstract: The abnormality of the mine ventilation system can reflect the risks and hidden dangers existing in the mine production system. By combining the basic information of the demonstration mine with the ventilation monitoring data and production status, the k-nearest neighbor is used to study the abnormal change characteristics of monitoring data of mine ventilation system in different ventilation periods, and a ventilation hazard warning model was constructed and the models were compared and validated. In addition, the dominant factors of the warning level were obtained by combining the gray correlation method. The results show that under different ventilation periods, the accuracy of the warning model is over 95%, which has good application and promotion value. The speed is the main indicator that affects the warning level. The research of this paper can provide theoretical support for realizing the intelligent management of mine risk in advance and short-term early warning.
Keywords: coal mine ventilation; disaster warning; k-nearest neighbor; grey relational analysis; intelligent management

Bearing fault diagnosis of coal mine electromechanical equipment based on empirical mode decomposition neural network

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Abstract: An effective fault diagnosis method is of great significance to improve the safety of mine production. Despite the considerable success of the deep learning the absence of components failure data limits the performance of the model. In this paper, a fault diagnosis method is proposed to solve the problem of lacking in fault data. In the method, a transfer learning strategy is presented to confusion actual and laboratory data distribution from the perspective of model to solve fault data lacking. Fault diagnosis experiments conducted on test bed are carried out. And actual working condition data are collected from scraper conveyor. The proposed method obtains % fault diagnosis accuracy in actual bearing data sets, which the generalization performance outperforms traditional methods.
Keywords: bearing fault diagnosis; empirical mode decomposition; neural network

Design of ultra-wide band and high precision indoor positioning system based on TW-TOA

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Abstract: TOA (time of arrival) is a classical location scheme of UWB location scheme, which is a time-

based location scheme. Based on this, the TW-TOA scheme is designed in this paper. The two-way ranging method is used to realize the communication between positioning devices. The transmission time and receiving time of messages are loaded into data for communication, so as to complete the ranging process between two points. The positioning results show that the TW-TOA scheme in this paper can complete the precise UWB positioning, and the positioning accuracy is between 10cm and 30cm according to the system. Compared with the existing positioning scheme, this scheme reduces the consumption of time synchronization module, and reduces the power consumption of the whole system through message timing transmission.
Keywords: TW-TOA; UWB

Exploration and application of 5G communication technology in different mine environments

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Abstract: Coal mining has always been the top priority of China's energy mining, and its working environment is very special. Therefore, during the mining period, we should attach great importance to the safety of mining personnel and avoid the risk of safety accidents to the greatest extent. With China's coal mining institutions are also gradually introducing automation technology to improve mining efficiency, reduce the participation of mining personnel, and ensure stable and efficient mining in an extremely special coal mining environment. In recent years, China's relevant departments are also strengthening the R & D of intelligent technology and gradually realizing the deep integration with coal mining, so as to improve the intelligent level of coal mining, so as to enable China's coal industry to obtain high-quality development. This paper analyzes and studies the characteristics of 5G communication technology, and explores the application path of 5G communication in different mine environments, so as to realize the high-quality mining and development of coal mines.
Keywords: application; exploration; mine; 5G communication

Mine wireless networks technology and applications

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Abstract: The application of big data has begun to play an important role in the construction of smart mines, which will surely promote the rapid development of the integration of industrialization and industrialization in mines, thereby improving the production efficiency of mining enterprises. With the deepening of the construction of smart mines, the accumulation of massive data has become a new ecology, and data has become the means of production and potential productivity factors in the production and management of mining enterprises. In order to make full use of and exert the commercial value and potential of massive data productivity, this talk starts from the analysis of the current situation of smart mine big data, studies the concept, characteristics and application of mine big data, briefly describes big data technology and methods, puts forward the basic plan of big data application platform according to the needs of smart mine, and analyzes the key technology and specific applications that can provide reference for the construction of smart mines.

Design of "signal, gathering and closing" system for underground transportation in coal mine

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Abstract: In order to accelerate the intelligent development of coal mine, improve the intelligent construction level of coal mine and promote the high-quality development of coal industry, China Coal Xinji Liuzhuang Coal Mine plans to carry out intelligent upgrading and transformation. The intelligent upgrading of auxiliary transportation is mainly in the aspect of roadway rail transportation. It is required that the underground car yard and transportation roadway are equipped with locomotive transportation monitoring system or transportation "signal, centralized and closed" Control system, in order to consider the upgrading and capacity expansion of mine auxiliary transportation in the next step, our mine gives priority to the installation of "signal, centralized and closed" system. The "signaling, centralized and closed"

system plays an important role in reasonably dispatching locomotives, improving transportation efficiency, ensuring traffic safety, and realizing the systematization and standardization of roadway transportation. “Signal, centralized and closed” system can realize real-time dispatching communication between dispatching and mobile operators, and between mobile operators and mobile operators; Remote control or automatic control of turnout and car stopper; The locomotive driver drives according to the signal light instruction without switching; The video monitoring system is set in the main transportation roadway, which can remotely view the operation site and other functions. This paper introduces the design scheme of “signal, collection and closure” system of underground rail transportation in Xinji Liuzhuang Coal Mine, China coal, and analyzes the advantages and disadvantages of the system, which lays a theoretical foundation for the implementation of the next scheme.
Keywords: coal mine; signal centralized closing; turnout; track; transportation

Discussion on automatic deviation correction and adjustment of lower belt surface of belt conveyor

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Abstract: In 2020, the “9.27” belt conveyor fire accident in Songzao Coal Mine of Chongqing energy investment Chongqing New Energy Co., Ltd. taught us a great lesson. While learning the lessons from the accident, we should carefully analyze the cause of the accident, analyze the process of the accident, investigate the potential accident hazards of the belt conveyor of our unit and implement rectification. The belt surface of the belt conveyor is composed of sulfide, carbide and other chemical components. Combustion or friction will produce a large amount of toxic and harmful gases such as sulfur dioxide, carbon monoxide and carbon dioxide, causing injury or suffocation to the human respiratory system. Belt surface deviation, wear, H-frame, tripod or belt surface rubbing bottom plate scattering will cause belt smoke or fire, produce toxic and harmful gases, and cause injury or death to human body.
Key words: automatic deviation correction; chip mounted temperature sensor; mechanical regulation; electromechanical regulation

Autonomous water leakage detection in rock tunnel face images using deep learning techniques

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Abstract: Detecting and assessing the water inflow on under-construction rock tunnel sites to improve productivity and safety has formed an integral part of computer vision (CV)-based research in infrastructure engineering. Nevertheless, conventional CV methods are explored for automated interpretation of target images, which requires excessive image pre-processing and complex feature extractor. As such, a novel approach, known as faster region-based convolutional neural network (Faster R-CNN), was proposed for automatically detecting water inflow state, including, dry state (DS), wet state (WS), flowing state (FS), and gushing state (GS). The detection framework was trained, validated and tested by feeding 5,320 images (with 648×691 pixels) collected from under-construction rock tunnel face of the Mengzi-Pingbian High Speed project in Yunnan, China. Then, the trained model was evaluated in terms of computation cost and detection accuracy by applying detection speed, training time, missing rate, and mean average precision (MAP), respectively. The results show that the proposed method can indeed detect water leakage damages accurately and efficiently. This study lays the foundation for employing deep learning (DL) methods in water leakage damage detection meanwhile addressing similar issues for construction management.
Keywords: faster region-based convolutional neural network; image detection; deep learning; water inflow

Fusion positioning method of anti-impact drilling robot based on multiple inertial units and visual image

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Abstract: Anti-impact drilling robot is the key equipment for underground rock burst relief in coal mine and the accurate position and attitude determination is the basis and premise for realizing unmanned

pressure relief operation. By analysing the characteristics of mobile robot and coal mine equipment positioning technology at home and abroad, a position and attitude calculation method of anti-impact drilling robot based on spatial array inertial units and visual image is proposed, as shown in Fig. 1. The data fusion model of spatial array inertial units is established to derive the fusion equations of angular velocity and proportional acceleration, and the position and attitude calculation process of spatial array inertial units is designed. By analysing the actual operating conditions of the anti-impact drilling robot, the curve motion trajectory is simulated, and the position and attitude calculation method is simulated and analysed. The simulation results show that the proposed method is better than the original method and the differential method in terms of displacement cumulative error and attitude angle average absolute error. On this basis, a binocular vision position estimation model based on continuous frame images is established, and an error elimination method based on visual correction is designed. An experimental platform for monitoring the position and position of drilling robot is built, and the feasibility and superiority of the proposed method are verified. This method can continuously and reliably monitor the position and attitude of anti-impact drilling robot and has high popularization and application value.
Keywords: anti-impact drilling robot; position and attitude calculation; spatial array inertial units; binocular vision; error correction

Review of energy efficient truck haulage options using battery-trolley systems

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Abstract: Truck haulage takes up the majority of the total energy consumption in open-pit mines. Facing the global decarbonisation upgrading of hauling systems, it is critical to examine the factors that contribute to the energy-efficiency of truck haulage, such as payload, rolling resistance and operators. Among the emerging technological options developed to reduce energy consumption for lower carbon footprint mining systems, innovative trolley-assist technology presents a promising one. From its application cases, trolley-assist has demonstrated great potential for emission reduction, although some teething problems are also encountered. With continuous improvement efforts, the problems have been gradually resolved. Battery technology advancements are shaping the evolvement of trolley-assist from diesel-battery hybrid truck based patterns towards purely electrified battery truck based ones. Battery-trolley is novel and capable to achieve further significant emission cut for surface mining operations associated with safety, productivity and operational improvements. However, it faces challenges in automating the battery charging/swapping and dispatching of the trucks, which requires more research endeavours to get tackled. This article reviews the critical factors affecting energy efficiency of truck haulage, emerging technologies for improvements with trolley-assist being focused on, and gives a forecast over the future intelligent low-carbon electric truck hauling systems in open-pit mines.
Keywords: energy-efficiency; haulage operations; trolley-assist; battery-trolley; intelligent open-pit mines

Belt conveyor speed regulation and efficiency improvement based on image processing

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Abstract: Belt conveyor is an important equipment for coal transportation in mines. With the growing distance and increasing power of belt conveyor, the research on energy saving of belt conveyor is getting more and more attention. In this paper, the belt conveyor speed regulation is studied by using image processing technology. First, a single frame image from the belt conveyor monitoring video is obtained and image pre-processing is performed. The image pre-processing, enhances the features in the image that are beneficial to the study and greatly reduces the difficulty of further processing of the image. Then the coal aspect ratio of the belt conveyor is calculated based on the inverse perspective image. Finally, the belt speed level is divided and matched with the corresponding coal aspect ratio interval, and the speed regulation value can be obtained according to the calculated coal aspect ratio, and the belt conveyor speed regulation based on image processing is completed by combining with the developed speed regulation rules. This paper is applied to the speed regulation of the main lane transportation system in C coal mine. Comparing the energy consumption of the main lane transportation system before and after speed regulation, the results show that: after speed regulation, the energy saving efficiency of the main lane transportation system is 6.4%, which can save the coal mine about 409,000 RMB per year. It also reduces the mechanical wear and tear of the belt conveyor and extends the replacement cycle of parts.

Keywords: belt conveyor; image processing; belt speed adjustment; efficiency improvement

Topic 6: Occupational Safety and Health

Experimental evaluation of respirator performance against nanoparticles

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Abstract: The main goal of this study was to investigate multiple factors (faceseal leakage, combustion material, particle size, breathing flow rate, and breathing frequency) that affect the performance offered by negative pressure respiratory protection devices, including an elastomeric full facepiece, an elastomeric half-mask, an N95 filtering facepiece respirator (FFR), and a surgical mask. Challenge aerosols included NaCl particles and combustion particles generated by burning different materials. This research effort consists of three related studies. In study one, the effects of faceseal leakage and origin of challenge aerosol (combustion of wood, paper and plastic) on the performance of a full facepiece and a half-mask elastomeric respirator were tested. The study revealed that the origin of challenge aerosol significantly affects the particle penetration through unsealed and partially sealed half-mask. Increasing leak size increased the total particle penetration. In study two, the effect of particle size on the performance of an elastomeric half-mask respirator against combustion aerosols was examined. For the partially sealed and unsealed respirators, the penetration through the faceseal leakage reached maximum at particle sizes > 100 nm when challenged with plastic aerosol, whereas no clear peaks were observed for wood and paper aerosols. The particles aerosolized by burning plastic penetrated more readily than wood and paper. Study three was focused on the effect of breathing frequency on the total inward leakage (TIL) of an elastomeric half-mask respirator donned on an advanced manikin headform challenged with combustion aerosols. The frequency effect was less significant than flow rate. The greatest penetration occurred when respirators were challenged with plastic aerosol at 30 L/min and 30 breaths/min. Overall, the results presented in this dissertation provide an extensive database, which is useful for respirator manufacturers, regulatory agencies, respiratory protection researchers, and end-users operating in various occupational environments.
Key words: gas explosion; polyurea; Petrochemical existing building; blast resistant plate; field test

Experimental and numerical study of polyurea coated shelter in petrochemical enterprises

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Abstract: Most of the materials involved in petrochemical plants are flammable and explosive hydrocarbon liquids and gases. Once leakage occurred, fire and explosion accidents often caused heavy casualties and economic losses. However, most existing buildings close to the production facility only consider the fire protection requirements, not designed to withstand blast loading. Polyurea is a specific chemically cross-linked elastomeric copolymer. Due to its superior physical and mechanical properties, it is extensively used as a protective coating in many industrial applications, such as vehicles, ships, and buildings. Polyurea coated shelter can be used to replace the low strength buildings which cannot meet explosion resistance requirements. The main frame and wall of the shelter were studied by combining the field gas explosion test with the equivalent single degree of freedom (SDOF) and 3D finite element simulation. It was found that only a few members of the main frame entered the stage of plastic deformation, and the ductility ratio and support rotation met the requirements. The uncoated blast resistant plate approached the ultimate failure state after explosion load. The middle square steel and the surrounding fixed bolts had a significant effect on the overall blast resistant ability of plate structure. Under the same test conditions, the structure of the polyurea coated blast resistant plate was intact and the maximum deformation was reduced by 72%. The research results provide an effective method for the blast resistant reconstruction of such buildings.

Microstructure characterization and unsteady response of methane explosion

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Abstract: Methane explosions are common accidents in different applications, such as coal mines, metal mines, and natural gas pipelines. They may induce severe casualties and infrastructure damage. However, studies on micro structure of methane detonations are still very limited and hence the underlying controlling mechanism is not clear hitherto. In this study, used supercomputers and detailed chemical reaction mechanisms. And two-dimensional simulations with Eulerian-Lagrangian approach are carried out to study methane detonation propagation. The governing equations of gas and liquid phases are solved with RYrhoCentralFoam, which is developed based on the fully compressible non-reacting flow solver rhoCentralFoam in OpenFoam 6.0. Detailed chemical mechanism is used for methane combustion. Moreover, unsteady response of methane detonation is studied. General features of gas phase and detailed detonation frontal structures are well captured. Incident detonations are discussed, about the evolutions of frontal structure and detonation propagation speed. Results for methane\air mixtures reveal that upon collision of two triple points a pair of forward and backward facing jets is formed. The drastic growth of the forward jet found to have profound role in re-acceleration of the detonation wave at the end of a detonation cell cycle. For irregular detonations, the transverse waves found to have substantial role in propagation mechanism of such detonations. In regular detonations, the lead shock ignites all the gases passing through it, hence, the transverse waves and hydrodynamic instabilities do not play crucial role in propagation mechanism of such regular detonations. In addition, the mechanism of methane detonation was analyzed in detail, including the changes of various components. The research results have a reference for understanding the mechanism of methane explosion and the prevention the explosion.
Keywords: methane explosion; microstructure characterization; reaction mechanisms; unsteady response

Study on new dust collector based on Coanda effect

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Abstract: Dust is one of the main disasters in underground tunneling. This research developed and tested a novel dust prevention technology. The technology was systematically studied in laboratory and field conditions. Based on the basic principle of Coanda effect, design the basic structure of the new dust removal device, with a small amount of compressed air as power supply and through a uniform layout on the circular hole high-speed jet for driving the center air movement together to form entrainment effect. The external dusty air is then inhaled and the dust is removed by water spray. According to variables of inlet inclination $\theta 1$, outlet inclination $\theta 2$, and the number of compressed drainage gas nozzle n. The optimal structural parameters of dust removal equipment were determined through numerical simulation and laborary experiments. The experimental results show that when the inlet angle is 15° and the outlet angle is 5°, the Conda effect is the most obvious, and the suction rate of the dust removal device is the largest. With the continuous increase of the number of gas orifices, the suction rate showed a trend of first increasing and then decreasing. Furthermore, the optimal position of spray nozzle is determined by numerical simulation. In field tests, the new technology increased respirable dust and total dust suppression efficiencies by 69.4% and 21.6%(Rear 20m of drilling machine), respectively, compared to that of original dust removal device, and the new technology effectively improves the atmosphere in mechanized underground coal mines, contributing to a safer and healthier working environment.
Keywords: dust control; Coanda effect; dust removal device; dust suppression efficiency

Quality evaluation of high-density residential areas based on urban residents' sense of spatial pressure

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Abstract: Using SPSS statistical method and mental health theory, this paper studies the impact of spatial oppression on Residents' mental health in high-density residential areas in China. From the three

aspects of mental health theory, sustainable development theory and high-density residential area theory, this paper makes a systematic and complete quantitative analysis on the cognition of high-density residential area residents to alleviate spatial oppression. The factors to alleviate space oppression include green plants, ground pavement, building facade and waterscape. Four high-density residential areas with different slopes in Xuzhou were taken from five different angles, and finally 20 photos were obtained. Using PS technology to integrate 20 photos with four elements, collect data through questionnaire survey, and classify and count the data with SPSS software. Finally, the residents' aesthetic preference for these four elements and the preference to alleviate psychological pressure are obtained. From the perspective of spatial oppression, this paper puts forward the problem of alleviating the psychological health of residents, so that the proposition of spatial oppression is no longer limited to single buildings and commercial buildings, which can help residents in high-density residential areas have a better experience in the interior of the residential area, and provide new ideas and guidance for the internal environmental landscape design of high-density residential areas.
Keywords: quantitative evaluation; high-density residential; spatial stress

Combination between kinematic analysis and distinct element modelling in pit slope stability for dimension stone quarries: Case study at dimension stone quarry Nui Trai, Binh Dinh Province, Vietnam

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Abstract: In Dimension stone extraction of Vietnam, cutting methods, such as disc sawing and diamond wire sawing are usually deployed, because they do not make joint appearance in rock mass during cutting operation, loading to forming larger pit angle to recover more extra reserve but increasing unstable risk of pit slope when joint sets-existed rock mass (joint sets characterized by dip directions, dips and spacings). The pit slope direction is necessary to be defined to mitigate failure risk in blocky and hard rock. The paper suggested determining the pit slope directions with high failure risk to abandon in design stage or to give comprehensive solution of improving the stability when the slope in operation stage. This could be done by combination between failure Kinematic Analysis (KA) and Distinct Element Modelling (DEM) for dimension stone quarries. The paper collected Discontinuous Fracture Network (DFN) at Nui Trai Quarry for the KA of failure modes with Dips software in various pit slope directions to preliminarily show which slopes to be unstable ability under consideration of the spatial relation between joint sets and pit slopes. When pit slopes with high risk of failure is shown by the KA, they will be necessary to be analysed more deeply with the DEM, with which the DFN, pit slope directions and joint properties combined using 3DEC software. The data inputted into the software was joint sets derived from the Dips and rock mechanics at Nui Trai quarry. Combination between the two methods above will decrease the time consumption and the cost in the comprehensive stability assessment.
Keywords: kinematic analysis; distinct element modelling; dimension stone quarries

Experimental study on evolution characteristics of coal seam parameters under true triaxial cyclic mining

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Abstract: In order to further explore the evolution characteristics of coal seam parameters in circular mining, physical simulation tests on the influence of cyclic stress on coal seam parameters under different initial gas pressures were carried out by using a large true triaxial physical simulation test rig, and the evolution characteristics of gas pressure and coal seam strain with the number of cycles and gas pressure were discussed. The test results showed that in the process of cyclic loading and unloading, the coal body is broken, new pores and fissures are generated, and more free gas is absorbed, which makes the pressure of the coal body decrease; Both the strain and gas pressure of coal seam change with the loading and unloading of cyclic load, and the changes of the two parameters reach the maximum value at the first loading; With the increase of the number of cycles, the increase and decrease of the gas pressure during loading and unloading show an increasing trend, and the closer the distance to the pressure device, the greater the change; With a lower initial gas pressure, the greater increase of pressure caused by the first loading. However, in the subsequent loading and unloading process, the greater initial gas pressure cause the greater gas pressure change.
Keywords: cyclic loading and unloading; initial gas pressure; strain; change in gas pressure

Forecasting methane content along the depth of Mao Khe coal mine using experimental data analysis

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Abstract: The paper analyzes the danger of methane (CH_4) and realizes the classification for coal mines of the Quang Ninh coal basin of Vietnam according to the methane category of Vietnam's safety standards for coal and shale mining. The relative methane emission and the relation between coal seam methane content and its change with depth at the Mao Khe coal mine are estimated. Using experimental data analysis to determine methane content at different mining depths and yield a set of equations which reflect the relation between methane content and coal seam depth, serve to predict the variability of methane content with the depth at the Mao Khe coal mine.
Keywords: methane hazard; relative methane emission; degassing; explosion of methane-air mixtures; Mao Khe coal mine

Regulation and control of ventilation in underground workings with the use of VentSim software

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Abstract: With the development of the mining industry, underground mine ventilation networks are becoming more and more complex. Furthermore, the requirements for them are increasing. Therefore, for designing, regulating airflow, selecting ventilation devices, and conducting rescue operations, IT tools are necessary. This approach allows for digital modeling of airflow, determining air condition and the parameters of the ventilation network components. A proper design of the preparation and extraction of the deposit should consider the selection of ventilation and air-conditioning methods at each stage of the mining operation. Design errors or inaccurate estimation of the threats' impact (mainly: climate, fire, and methane threats) may lead to safety risk, increase the costs of extraction by limiting the scope of works, or ultimately stop the mining work. The article presents a procedure to develop a model of a hard coal mine ventilation network with the use of VentSim software. The methods of determining the coefficients of aerodynamic resistance of ventilation network elements and the methods of determining the thermodynamic parameters of air are determined. It allows for a more accurate representation of the designed mining works. Forecasting airflow for future states is critical to human safety and the continuity of the operation. The implementation of VentSim software in underground mines allows for the improvement of safety in underground workings. It also allows for planning mining works, ad hoc regulation of the ventilation network, or making decisions on eliminating the risk during a fire action. The article compares the results of airflow simulation using the VentSim program with actual measurements in underground mining excavations for various security and rescue operations.
Keywords: underground mine ventilation; air distribution; climate forecast; flow modeling; environmental simulation

Exploration and practice of relationship between individual operation safety and physical behavior based on the big data analysis (Human being-Environment- Safe production)

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Abstract: “Smart mine” is a digital intelligent system that can complete the accurate real-time collection, network transmission, standardized integration, visual display, automatic operation and intelligent service of all the information based on the digitalization of mining enterprises. Combined with the construction of smart mine, we conduct site staff individual body language collection, analysis, training and eventually form normalized training set summary. Then we use a body language detection and behavior analysis method based on deep learning to analyze and compare the video monitoring of employees' body movements during operation with the training set prepared in the previous stage. Through real-time comparison and analysis, some body movements that may lead to unsafe accidents are captured and analyzed, then audible and visual alarm signals are sent to remind the operating staff in real time. In this way, we effectively prevent safety accidents caused by non-standard body movements during

the operation of employees, and reduce the illegal operation of employees scientifically and effectively. Secondly, some advanced exoskeleton equipment will be used to assist employees in positions with high labor intensity and high risk. Meanwhile, the body movements of employees will be collected, analyzed, processed and excavated continuously, so as to find the key factors that affect the improvement of safety and efficiency during operation, by which targeted training and improvement could be carried out. It is of practical significance to enhance the operation safety of individual employees, promote the cultivation of standard operation behaviors of them and ensure the safety of mines.

Physicochemical characteristics and wetting influence model of original coal dust produced from underground mining sites

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Abstract: The physicochemical characteristics of coal dust significantly influence its aerodynamics and toxicology properties. Now, in characterizing the physicochemical properties of coal dust, lab-crushed coal dust samples were mainly used rather than the original coal dust (OCD) produced in underground mining sites. Therefore, the research results do not accurately reflect the natural properties of OCD. In this study, 18 OCD samples were collected from various underground mining sites in north China. Subsequently, the proximate component, maceral content, surface element, carbon functional group, particle size distribution, surface pore structure, and wettability properties of the OCD samples were characterized, and 35 parameters were obtained. The results show that the OCD samples had a smaller particle size with an average size of 26.49 μm, and the respiratory particles counted for an average of 21% of total dust in 18 samples. Additionally, the OCD samples had developed pore structure. The average values of specific surface area, pore volume, and pore size of the 18 samples were 8.24 m^2/g, 22.85×10^{-3} cm^3/g, and 11.82 nm, respectively. Finally, the wetting influence model of the OCD was established using the methods of factor analysis and multiple linear regression analysis; according to the model, it was observed that the pore structure and chemical composition of the OCD were two key factors affecting its wettability, their cumulative contribution value reached 53.74%. This study is of significance in analyzing the toxicity of the coal dust produced in underground mines and improving the wetting property of coal dust.
Keywords: coal dust; physicochemical properties; wettability; particle size; pore structure

Mechanism of room temperature oxidation of active sites and its practical application

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Abstract: Thermal decomposition of coal widely exists in the process of coal fire propagation, sealed fire zone, magma erosion and torrefaction of low rank coal. The risk of spontaneous combustion of coal was found to be significantly enhanced after thermal decomposition. In this paper, isothermal flow reactor and infrared spectroscopy were combined to study the thermal decomposition process of coal samples and the oxidation process of coal samples after thermal decomposition. Results showed that the thermal decomposition process of coal sample will lead to the decomposition of oxygen-containing functional group structures such as carboxyl and carbonyl, which can produce a large number of active site structures. These active sites can stably exist and accumulate under inert gas conditions. Once in contact with oxygen, oxidation reaction can occur even at room temperature, release heat and produce a large number of gas products such as CO and CO_2. On this basis, the viewpoint of room temperature oxidation of active sites of thermally decomposed coal is therefore put forward. It is considered that the room temperature oxidation of active sites is the initial heat source leading to self-heating or even uncontrollable spontaneous combustion of thermally decomposed coal. Compared with the raw coal sample, the coal sample after thermal decomposition does not need to go through the preparation period with very slow oxidation rate, but directly enters the self-heating period due to the room temperature oxidation and heat release of the active sites, which is the main reason for higher spontaneous combustion risk of the thermally decomposed coal than the raw coal.
Keywords: thermal decomposition; room temperature oxidation; initial heat source

Qualitative and quantitative investigation into the impact of seam orientations on spontaneous combustion management and control

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Abstract: Spontaneous combustion of coal in the active goaf area has been reported in several Australian underground coal mines during normal production cycles. The onset of spontaneous heating in underground goaf areas is dictated by many operational and environmental parameters, including proactive inertisation and geologic variations. Based on site-specific conditions of an Australian underground coal mine where seam gas is predominantly composed of carbon dioxide (80%) with a total emission rate of 2 m^3/s, extensive computational fluid dynamics (CFD) simulations were conducted. The simulation results revealed that seam orientation played a significant role in gas distribution in the goaf area and the determination of proactive goaf inertisation strategies. Regardless of seam orientations investigated in the simulation, nitrogen performed better than boiler gas and carbon dioxide in shrinking the oxidation zone area and reducing the likelihood of spontaneous combustion. In addition, a total inert gas injection rate of 1.5 m^3/s was recommended to effectively manage spontaneous heating, and the ratio of oxidation zone area to goaf area was approximately 10%, which dropped by approximately 15% compared to scenarios without inert gas injection.
Keywords: spontaneous combustion; CFD modelling; seam orientations; proactive goaf inertisation

Identification and assessment of occupational risk factors in construction process

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Abstract: In view of a large number of occupational safety accidents in the construction stage of China's construction industry, this paper studies the key risk factors and their influence on construction safety in the process of construction projects by using the Analytic Hierarchy Process (AHP). And through the empirical analysis of a real estate project in Shaanxi Province, the feasibility and effectiveness of the AHP in the analysis and evaluation of construction safety management are verified. The results show that: (1) the risk factors affecting the construction safety management safety mainly include human, material (building materials, mechanical equipment, etc.), technology, management and environmental factors. (2) Among all risk categories, “human factors” have the highest impact on unsafe behavior of construction, followed by “engineering environment”, “construction material factors” and “mechanical equipment”. (3) At the level of impact indicators, the important index factors that affect the occurrence of accidents are “safety culture quality and safety technology level of decision makers”, “the natural environment of construction site”, “quality acceptance of material entry”, and “loading and unloading safety control of mechanical equipment”. Finally, based on the research results, targeted suggestions for can be put forward to provide decision-making reference for accident prevention and safety inspection in the construction production process.
Keywords: construction process; safety management; identification of key risk factors; occupational risk assessment (ORA)

Lab studies of multi-scale pore fractal characteristics of different rank coals

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Abstract: As organic porous medium, coal has a naturally well-developed pores and cracks system with obvious fractal characteristics, which is the main place for gas storage and migration. Understanding the fractal characteristics of the pore structure is helpful to reveal the gas storage and migration mechanism, hence to provide theoretical support for the prevention and control of gas disasters, the development and utilization of coalbed methane resources, and the geological storage of greenhouse gases. High-pressure mercury injection (HPMI), low-pressure nitrogen adsorption (LPGA-N_2) and scanning electron microscopy (SEM) were used to characterize multi-scale pore structure of coal samples with different ranks. Based on the Frenkel-Halsey-Hill (FHH) fractal theory, the Menger sponge model and the Pores and Cracks Analysis System (PCAS), the pore volume complexities (D_v), the coal surface irregularities (D_s) and pore distribution heterogeneities (D_p) were accessed, respectively. Combined with high-pressure isothermal gas adsorption experiment, the effect of the three fractal dimensions on the gas adsorption ability was also analyzed. The results indicate that the pore structure of coal mass has obvious fractal

characteristics, and the fractal dimension of pore structure reflects the complexity of the dual pore networks. The pore structure fractal dimension is largely affected by the coal metamorphism degree. As the metamorphism degree increases, the fractal dimension D values of coal pore structure show an asymmetric U-shaped trend, i.e., gently decrease first and then sharply increases. The three fractal dimensions have different effects on the gas adsorption ability of coal. Langmuir volume V_L has an obvious positive correlation with D_s values, but less correlation with D_v and D_p. While, Langmuir pressure P_L is mainly affected by the combined action of D_v and D_p.
Keywords: multi-scale pore structure; fractal characteristics; different rank coals; gas adsorption ability

Effects of heat recirculation on the combustion stability of coal mine low concentration methane in porous media

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Abstract: China has abundant coal seam gas resources. The main combustible component of coal seam gas is methane, which is the second largest greenhouse gas after carbon dioxide. There is a large quantity of coal mine methane emissions in China caused by the energy activities. Therefore, utilization and mitigation of coal mine methane especially for the low concentration methane (LCM) have great significance to the "dual carbon" target of Chinese coal mines. Generally, Porous-Media Combustion (PMC) is a new type of combustion technology, which is suitable to the low concentration methane due to the enhanced heat exchanges caused by the porous media. In present work, coal mine low concentration methane combustion in porous media were studied and the effects of pores density, inlet velocity and wall heat losses, as well as the flashback and blow-off limits, the uniformity of temperature distributions were analyzed considering the external and internal heat recirculation by experimental and numerical method. And, a local thermal non-equilibrium (LTNE) model was established using modified effective thermal conductivity of the porous media based on the volume average theory (VAT). Results show that, for the foam ceramics media, the blow-off limit would be increase with the pores density of foam ceramics under relative higher methane concentration conditions. However, under ultralow methane concentration conditions, there is no significant effects of pores density on the blow-off limits. Compared with honeycomb porous media, foam ceramic performs a broader stable combustion range. With the enhanced external heat recirculation by dual-channel porous medium combustor, the preheating process of the inlet gas would be greatly shortened and the uniformity of temperature distributions are improved, that is helpful to the combustion stabilities.
Keywords: coal mine low concentration methane; porous media combustion; stability; heat recirculation; temperature distributions

Perovskite CsPbBr3 quantum dots-embedded ZnO nanocrystals-based gas sensors for detection of a lung disease biomarker: Heptanal

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Abstract: Background: Nowadays, lung diseases become more and more serious no only due to some dusty occupational environment but also the polluted atmosphere. Considering the latent period of lung diseases and the high difficulty of medical image for early screening, breath analysis shows a high potential for lung disease screening. Volatile organic compounds in breath changes according to pulmonary lesions, which could be detected by sensors. **Aim:** To design a breath sensor for lung diseases detection with good sensitivity, response time and anti-interference. **Methods:** Metal halide perovskite $CsPbBr_3$ is a promising sensing material due to high carrier mobility. However, perovskite easily reacts with the water vapor in breath. In this work, inorganic $CsPbBr_3$ quantum dots (QDs) were embedded into ZnO nanocrystals through a facile room-temperature *in situ* coating strategy for enhancing its gas response and water resistance (See Figure 1). During the *in situ* coating process, n-Octanoic acid was used as the buffer layer for reducing the lattice mismatch between $CsPbBr_3$ and ZnO. **Results:** The perovskite $CsPbBr_3$/ZnO heterostructure not only worked at room temperature and moisture, but also displayed a normalized sensitivity (0.36) together with response time (36.5 s) and recovery time (5.3 s) towards 200 ppm heptanal. A low heptanal concentration (20 ppm) and good water resistance was detected by the sensor based on this material (See Figure 2 and 3). In contrast, no response was achieved in the sensors fabricated with the single $CsPbBr_3$ QDs or ZnO films. **Conclusions:** Our study suggests that the metal halide perovskite embedded ZnO might play an essential role in detecting the biomarker of lung diseases.
Keywords: lung disease; breath tests; gas sensing; heptanal detection; quantum dots; perovskite

material

Analysis of crystalline silica aerosol using portable raman spectrometry: Feasibility of near real-time measurement

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Abstract: A Raman spectroscopy-based method has been developed for measurement of trace airborne concentrations of respirable crystalline silica (RCS). Three aerosol microconcentration techniques were investigated for effective coupling of collected particulate samples with micro-Raman spectroscopy: (i) direct analysis on a particulate filter after focused aerosol collection using a converging nozzle; (ii) analysis of dried particulate deposit on a filter obtained directly from the aerosol phase using the Spotsampler device; and (iii) analysis of a dried spot (similar to 1-3 mm diameter) obtained by redepositing the particulate sample, after low temperature plasma ashing of the filter sample. The deposition characteristics (i.e., spot diameter, shape, and deposit uniformity) of each technique were investigated. Calibration curves were constructed and detection limits were estimated for a-quartz using the A(1) Raman Si-O-Si stretching bending phonon mode at 465. The measurement sensitivity could be substantially improved by increasing the signal integration time and by reducing the particle deposition area. Detection limits in the range of 8-55 ng could be achieved by microconcentrating the aerosol sample over a spot measuring 400-1000 mu m in diameter. These detection limits were two to three orders of magnitude lower compared to those attainable using current standardized X-ray diffraction and infrared spectroscopy methods. The low detection limits suggest that near real-time measurements of RCS could be achieved with limits of quantification ranging from 2 to 18.5 mu g/m3 (at 10 min collection time and 1.2 L/min), depending on microconcentration technique used. The method was successfully extended to the measurement of alpha-quartz air concentration in representative workplace aerosol samples. This study demonstrates the potential of portable micro-Raman spectroscopy for near-real time measurement of trace RCS in air.
Keywords: Raman spectroscopy; respirable crystalline silica; dust monitoring; real-time measurements

Air curtain technology and equipment for workplace dust control of unable enclosed spaces

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Abstract: Dust collection in unable enclosed space is the difficulty of dust control in workplace. In this study, the air curtain technology was used to collect dust. The problem of large air volume and poor effect of traditional suction dust collection method is solved. The generation and attenuation characteristics of air curtain, the generation and industrial application of cyclone air curtain technology, and the supporting dust removal technology are introduced. The complete set of technology can significantly improve the dust collection efficiency, which can be increased to 95%, and solve the problem of low dust collection efficiency of traditional dust hood.
Keywords: air curtain technology; dust control; unable enclosed spaces

Effect of slenderness ratio on the compressive performance of fibre reinforced polymer standing support

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Abstract: Laboratory tests were conducted to evaluate the influence of slenderness on the performance of fibre reinforced polymer (FRP) standing supports subject to uniaxial compression. The FRP standing support consist of external FRP tube and internal infill cylinder made of coal rejects and cementitious grout. 21 cylindrical specimens with diameter of 100 mm and various heights ranging from 200 mm to 600 mm were prepared and tested. Test results indicated that all FRP standing supports exhibited strain hardening yielding. While the strength of the FRP standing supports stabilized at around 47 MPa when their height to diameter (h/d) ratio was not greater than 5, it declined by approximately 13% when the h/d ratio was 6. The strain at peak strength of the FRP standing supports generally decreased as the h/d ratio increased, dropping from 3.57% at the h/d ratio of 2 to 2.16% at the h/d ratio of 6.
Keywords: laboratory testing; FRP standing support; slenderness; strain hardening yielding; coal rejects

Research on the recognition method of medical equipment experience based on cognitive psychology

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Abstract: Aiming at the diversification of evaluation criteria caused by the subjectivity, ambiguity, contextuality and other characteristics of user experience in the process of medical equipment experience design, a method for identifying user experience based on cognitive psychology is proposed. Taking the information cognition of the ECG machine interface as an example, taking the fogging of goggles under epidemic medical conditions as the main variable, using the response time and accuracy rate as the evaluation index, and combining the subjective experience of the user to obtain the survey and experiment results, it is more reliable to reveal The real thoughts and attitudes of users, quantitative research on user experience, and use scientific and reasonable indicators to identify the experience. Based on this method, through the intervention of big data, artificial intelligence and other new technologies, the identification standard of user experience is digitized, so as to objectively and accurately guide the design process, and provide a certain reference and reference for improving user experience design.
Keywords: COVID-19; cognitive psychology; experience recognition; big data; ECG machine

Effects of underground street planting on spatial visual health based on eye movement analysis: A case study of Nanjing city

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Abstract: The purpose of this study is to quantitatively analyze the relationship between green plant allocation and visual health of underground street space. In this paper, from the perspective of environmental psychology, 40 subjects were asked to observe 10 scenes, and the SBE method and intelligent interactive eye movement experiment were used to study the effects of green plants on the visual health of underground space. The results show that the presence of green plants can obviously improve the visual health of underground street space. The effect of green plants on visual health of underground space is very different from that of aboveground space. The optimal green visual rate of underground street is about 8%, which is much lower than that of aboveground street. When too many green plants are too large, the visual health of underground street will decline obviously. The results indicate that attention should be paid to the layout design of green plants when improving the visual health of underground streets.
Keywords: underground street; eye movement analysis; visual health; green rate

Effect of natural light introduction on visual health comfort of underground pedestrian street based on eye movement analysis

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Abstract: The health and comfort of the visual environment is increasingly prominent in the current development, and the closed underground pedestrian streets are often accompanied by the artificial light environment such as bright light, uneven light, glare and other uncomfortable. Therefore, this study set out to explore the impact of the design of underground skylights on the visual health and comfort of the underground pedestrian streets. Using subjective questionnaire scale and eye-movement tracking technology, about 30 subjects observed 20 picture scenes, recorded eye-movement data, and then filled in the corresponding questionnaire. Through the combination of subjective questionnaire and eye movement data, it is found that the introduction of natural light into the skylight design can significantly improve the visual health comfort of underground pedestrian street. Skylight design has a good effect on relieving the closed and depressed feeling of underground pedestrian street. The skylight design of underground pedestrian street has a wide vision and the skylight openings are concentrated and not scattered, which is better for the visual comfort and satisfaction, which is conducive to improving the cognitive feelings of non-visual effects.
Keywords: underground pedestrian street; eye tracking analysis; visual health; skylight; natural light

Research on multiple-target visual warning coding forms of mine gas monitoring interface

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Abstract: In order to explore the optimal visual warning coding form when multiple targets alarm at the same time on the mine gas monitoring interface, the paper based on the mine gas monitoring system, adopted three visual coding forms of color, size and character to conducted single target and double target visual search experiments for three alarm levels of attention, warning and danger. Through the analysis of the accuracy, response time and subjective score, the results show that whether it is a single-target or dual-target visual search experiment, the search performance is optimal when the interface adopts the color-coded visual warning form. Compared with character encoding, the search time is shorter with size encoding, but the accuracy is lower. The experimental results also find that in the dual-target visual search experiment, the similarities of alarm levels have significant effect on response time. The response time of two targets with the same alarm level is shorter than that of two targets with different alarm level, and the second target is easier to be found during the search process. The results of this study are of great significance to improve the security of the mine gas monitoring interface and reduce the cognitive decision-making errors of monitoring personnel, and also have certain guiding value for the design of multiple-target visual warning forms in other monitoring interfaces.
Keywords: gas monitoring interface; multiple-target; visual search; visual encoding

Paradigm interface of MI-BCI in different visual type

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Abstract: Visual guidance of the MI-BCI paradigm interface is a prerequisite for the communication of EEG signals between the user and the BCI. In order to investigate the impact of MI-BCI paradigm interfaces guided by different visual types on the performance of MI-BCI, and to investigate the main factors influencing the visual guidance of paradigm interfaces, four types of paradigm interface prototypes were first summarised as experimental objects, and experiments were conducted using EEG equipment, using co-spatial patterns (CSP) to extract EEG signal features and classification by support vector machines (SVM). The paradigm interfaces under different visual types of guidance and their influence on the performance of MI-BCI were analyzed and compared by combining the Least Significant Difference (LSD) test and subjective evaluation. The results showed that all four types of paradigm interfaces had significant effects on MI-BCI performance, and II-paradigm had the most significant effect on MI-BCI performance, while paradigm interfaces with relatively low visual complexity had clearer visual guidance and better accuracy of EEG signal classification and MI-BCI performance. On the basis of this, it was concluded that the size and color of the cue stimuli were the main factors affecting the visual guidance of the paradigm interface in the MI-BCI paradigm interface by using the hierarchical analysis (AHP) method. The findings of the study have important reference values for the design of the MI-BCI paradigm interface and the improvement of MI-BCI efficiency.
Keywords: motor imagery; brain-computer interface; Paradigm Interface

Statistical analysis of shape of concha for mass customization of ear-related products

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Abstract: We propose a design framework for the mass customization of custom-fit hearing aids and earphones with scanned models of the concha of 310 participants which are converted into compatible non-uniform rational B-spline surfaces generated through 795 data points to perform the requisite statistical analysis. Then, the quality of the reconstructed surfaces is determined through analyses of the shape deviations, Gaussian curvature, and zebra texture. Subsequently, the shape of the concha of the participants is grouped into 29 clusters with a modified algorithm. The results are then compared with conventional approach, and it is found that the modified algorithm has the ability to better classify the participants, but still uses a small number of clusters. Furthermore, the shape deviations between the samples and clusters are performed to validate the reliability of the clustering results and the importance of classifying the shape of the concha. Finally, a wear trial and simulation test are carried out to validate the wear comfort of a designed ear piece based on the average shape of each cluster. The experimental results show that the average shape obtained as per the cluster is capable of representing the common

geometric properties of their corresponding members, and could thus be used as a reference in designing mass-customized ear-related products. The method in this study is superior to conventional methods that rely on sparse results for shape classification because it takes into account the intricate geometric shape of the concha.
Keywords: auricular concha; surface reconstruction; shape clustering; mass customization; custom-fit

Morphological and aerodynamic characteristics of respirable dust aggregates

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Abstract: Respirable dust presents as a severe health threat to workers in industries as diverse as coal mining, metal and nonmetal mining, metal fabrication, metallurgy, and construction. In China, for example, over 20,000 workers per year have been diagnosed with pneumoconiosis since 2010 due to the excessive exposure to dust. Laudable efforts have been directed towards minimising workers' inhalation of respirable dust. Driven by their small size and the humid environment, dust particles tend to stick together to form aggregates, which have been recognised as fractal objects that possess self-similar structures. Compared to individual particles, the motion of fractal aggregates is much more difficult to quantify due to their intricate structure, inherent non-uniformity in primary particle size and density, and complex interaction with fluid flow. The understanding of the aerodynamics of fractal aggregates is way incomplete. This, in turn, hinders the development and commercial deployment of conventional or emerging dust removal technologies. This study examines the morphological and aerodynamic characteristics of fractal dust aggregates. Specifically, aggregation of primary dust particles is simulated using the discrete element method (DEM). The morphological characteristics of the formed aggregates are described in terms of fractal dimension, coordination number and gyration radius. Subsequently, the dust aggregate is released in the air and let it settle and reach its steady state; the settling is solved using a fully coupled lattice Boltzmann method (LBM) and DEM. The slow aggregation process leads to a compact structure of dust aggregates. When reaching their steady settling state, aggregates tend to orientate with their maximum projection area perpendicular to the falling direction. The dependency relationship between the aerodynamics of dust aggregates and their morphological characteristics is established.
Keywords: respirable dust; dust aggregates; fractal; aerodynamics; LBM-DEM; dust removal

Study on ERP of information alarm in monitoring interface

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Abstract: Conduct research on the problems caused by the improper design of alarm modes in the digital interface of monitoring system. Based on the behavior data and physiological data obtained by the event-related potential brain electrical ex-periment, compare the influences of the two alarm modes of interface elements size change and color change on the visual cognition of users, analyze the key el-ements that cause these reasons and lay the foundation for the improvement of alarm modes of monitoring interface. In the brain electrical components of color change and size change, N100, P200 and P300 are more obvious, and they are focused on the top region, the central left top region and the central right top re-gion. As for the present of digital interface alarm information, in the present method with the same channel, participants is more sensitive to the color code change, although the activation degree of size change on human brain is higher. The data analysis and conclusion of this thesis can provide reference for the de-sign of the digital interface alarm mode in the future, so as to effectively avoid the users' misjudgment and omission on the interface information and improve the use efficiency of system in reality.
Keywords: information identification; ERP; human computer interaction

Research on energy dissipation and electromagnetic radiation response of fractured sandstone under static and dynamic loads

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Abstract: In order to study the energy dissipation and electromagnetic radiation (EMR) response law of fractured sandstone under dynamic and static loads, the impact dynamics experiment based on EMR test was carried out to analyze the sandstone energy dissipation and EMR change law during the failure process, and to deeply discuss the crack angle and impact velocity. The influence of the energy consumption of sample rupture and the generation mechanism of EMR. The results show that as the energy of the stress wave increases, the dissipated energy density and damage variables of the sample gradually increase, and the EMR energy also increases. With the increase of the crack inclination angle, the dissipated energy density of the sample first decreases and then increasing trend, while the damage variable and EMR energy show a trend of first increasing and then decreasing. In the process of impact damage, the main frequency of EMR is 0~5 kHz. As the energy of the stress wave increases, the dominant frequency band of the main frequency expands from low frequency to high frequency, and the amplitude signal gradually increases, and α=45°specimen frequency domain relatively widest, the amplitude is also relatively largest. The inclination angle of the crack changes the failure state of the sample, resulting in a significant change in the energy dissipation of the sample and the response law of electromagnetic radiation. The electromagnetic radiation signal mainly comes from the piezoelectric effect, crack propagation and friction effect.
Keywords: crack dip angle; stress waves; energy dissipation; EMR; frequency analysis; damage variable

Experimental study on diffusion radius of inorganic fire extinguishing materials in loose body

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Abstract: In order to study the flow and diffusion law of inorganic fire extinguishing materials in the coal body in the goaf of underground coal mine, to carry out the viscosity study of inorganic materials mixed with water and the analysis of fire extinguishing performance in the early stage, a grouting test platform was built in the laboratory, sand and stone were used to simulate broken coal body, and orthogonal tests were designed to carry out multiple groups of grouting tests. The influence of grouting pressure, water-cement ratio and pore ratio on grout diffusion radius is analyzed, and the variation of grout diffusion radius with the change of water-cement ratio is discussed under the action of grouting pressure. The results show that the 3d grouting test platform can satisfy the grouting test of loose sandstone under different grouting pressures. It is found that the influence of grouting pressure, water-cement ratio and pore ratio on grout diffusion is not linear relation, but multiple power function relation. The corresponding grout diffusion radius formula is constructed, and the factors affecting the grout diffusion range are analyzed. The grouting pressure and water-cement ratio have significant influence on grout diffusion. The results can provide a reliable basis for grouting design of inorganic fire extinguishing materials in goaf.
Keywords: inorganic materials; grouting device; viscosity characteristics; diffusion pattern

Research on the disaster characteristics of pool fire with circular obstruction

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Abstract: For a typical thermal runaway process of uncontrolled energy release, pool fires are typically associated with the safety of energy application in modern production and life. In order to improve fire safety in energy utilization, it is significant to investigate the disaster characteristics of pool fire incorporating mass burning flux and flame characteristic, which are fundamental parameters in hazard prediction and risk management. Although the disaster characteristics of pool fire under the free burning condition have been studied by lots of researchers, there are limited work about pool fire under the effect of obstruction. In order to explore the disaster characteristics of pool fire, 10 cm diameter n-heptane and ethanol pool fires with obstruction were performed, where the mass burning flux, flame appearance and flame radiation were measured and analysed. The experimental results show that the mass burning flux of the pool fire with obstruction decreases with the increase of obstruction height, and increases with the increase of the obstruction diameter. Based on the dimensionless theoretical analysis, a new correlation is further obtained from the experimental data of heptane and ethanol pool fires to describe the effect of obstruction. Besides, the obstruction above the fuel pool would lead to a larger peak value of the radiation heat flux. Using a physical method, prediction models for flame characteristics including flame width, flame height and maximum value of radiation heat flux were proposed. It is expected this work will help to understand the disaster characteristics of pool fires in a more realistic setting and to enhance the safety assessment for practical engineering applications.

Keywords: disaster characteristics; pool fire; circular obstruction

Extraction and utilization of heat and humidity in mine ventilation

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Abstract: Much low-level thermal energy and water vapor are stored in the hot and humid airflow of mines, which results in a poor underground working environment, proposing threats to workers' safety and health. The direct discharge of exhausted ventilation air causes a waste of resources as well as pollution problems to the surrounding environment. Therefore, the extraction and utilization of mine ventilation heat and humidity have become an important way to solve the thermal damage problems in deep mines and promote a low-carbon transformation for their development. Since the heat and humid parameters of mine airflow change with time, the real-time determination of them is critical to the thermal and moisture recovery from mine ventilation air. In this study, the distribution and variation of heat temperature and humidity for key mine joints were determined based on the real-time calculation of the heat and moisture content for the air network. The calculation model of condensation heat and humidity extraction was established. The technology of low-level heat extraction ventilation airflow was also developed. These two together formed a refrigeration, dehumidification, and resource in-situ utilization system. Furthermore, the thermal and humidity extraction and utilization methods were put forward for the centralized and the distributed sources from mine ventilation. The effects of heat extraction and water recovery were analyzed with examples. The results show that around 224 t/day of moisture and thousands of kilowatts of thermal energy were wasted with direct ventilation air emission, the recovery and utilization of which could benefit economically. The approximately linear relationship was revealed between the temperature decrease and the theoretical moisture recovery from ventilation air emission, which provides a rapid way for engineering estimation. The work of this study provides constructive ideas and a theoretical basis for the extraction and utilization of low-level thermal energy and the heat damage control in mines.
Keywords: mine ventilation; hot and humid airflow; wind network calculation; low-level thermal energy extraction; condensation waste heat utilization

Influence of disinfection on the reuse of disposable masks and N95 respirators

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Abstract: To address the shortage and corresponding reuse of disposable masks and respirators caused by the COVID-19 outbreak, this study independently built a mask/respirator simulation test system based on stringent standards. Through substituting naked virus strain with 0~200 nm NaCl aerosols, two masks and three N95 respirators commonly used during the epidemic were tested under simulated human breathing flows of 15, 50 and 85 L/min. The results show that during the 8-h testing process, the penetration value of each tested mask or respirator increases linearly and the inspiratory resistance rises slowly; after 8 h, the filtration efficiency of each N95 respirator is still over 95%, and the inspiratory resistance is below 300 Pa. Subsequently, different disinfection measures were applied, and it was found that hot-water soaking, alcohol spraying and high-pressure steaming greatly reduce the filtration efficiency, while ultraviolet irradiation and dry heating barely influence the filtration efficiency and inspiratory resistance, which can still guarantee the protection level of the respirators for reuse. This work can serve as a reference for the disinfection and reuse of disposable masks and respirators during the early stage of the epidemic outbreak.
Keywords: masks; respirators; decontamination; reuse; filtration efficiency; breathing resistance

Novel Cu-based perovskites for solid oxide cells

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Abstract: Reversible solid oxide cells can work as electricity and heat generators, but also as electrolyzers, generating hydrogen fuel when surplus electrical energy is available. Currently, Co-based perovskites are usually adopted for preparation of their oxygen electrode, but cobalt is toxic, expensive, as well as its resources are limited. In this work we show the development of high Cu content electrode compounds from the proposed $RE_{1-x}A_xTM_{1-y}Cu_yO_{3-\delta}$ (RE: selected rare-earth elements, A: selected alkaline-earth metals, TM: selected 3d metals) group, in which Co was fully replaced or its content was largely limited. The studied materials were synthesized by sol-gel and solid-state methods, the phase composition and crystal structure were confirmed by X-ray diffraction at room and high temperatures. Physicochemical properties, including thermal expansion, oxygen content, electrical conductivity and catalytical activity, were studied by dilatometry, iodometric titration, thermogravimetry, and 4-probe electrical conductivity measurements, respectively. Screen-printing method was used for the preparation of the $RE_{1-x}A_xTM_{1-y}Cu_yO_{3-\delta}$ electrode layers. The polarization resistance was evaluated in symmetrical cells. Button-type full cells were constructed using thin $La_{0.8}Sr_{0.2}Ga_{0.8}Mg_{0.2}O_{3-\delta}$ electrolyte, $RE_{1-x}A_xTM_{1-y}Cu_yO_{3-\delta}$ oxygen electrode and $Ni\text{-}Ce_{0.8}Gd_{0.2}O_2$ cermet anode. It was found that copper allows to decrease the thermal expansion, while the oxides show suitable stability at high temperatures, as well as high mixed electrical conductivity. Low electrode polarization values were obtained, below 0.1 Ω cm² at 650 °C, which enabled to achieve power density outputs exceeding 250 mW cm^{-2} at the same temperature. Good properties were also achieved in the reversed operation. The results clearly indicate that copper-based perovskites show suitable electrocatalytic activity, and Cu can be used to replace cobalt for the preparation of the effectively-working oxygen electrode materials.
Keywords: Cu-based oxide; perovskite; oxygen electrode; electrocatalytic activity; reversible SOC

Control over wettability as a route towards improved solid state sodium metal batteries

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Abstract: Energy storage belongs to the central topics in power supply chains, especially when intermittent renewables, such as wind and sun, take the lead among various energy sources. As electrochemical batteries offer short response time, high energy and power density, along with high efficiency, they became one of the most promising energy storage techniques. Currently lithium batteries are the first choice when portable electronics, electric vehicles and grid energy storage are concerned. However, due to limited reserves of raw materials various alternatives are considered. Among them solid state sodium metal batteries recently attracted vivid interest in the scientific community due to utilization of abundant raw materials, high energy density and increased safety. A key factor determining performance and safety of the sodium metal electrochemical cell are the interfaces between the solid-state electrolyte and the electrodes, as it is where charge transfer, a limiting step for operation of an electrochemical cell, occurs. In this work we aim to verify a hypothesis that wettability of a solid state electrolyte by metallic sodium is one of critical factors governing plating and striping behavior of sodium metal electrode. Four alloying additives were selected and tested as agents affecting contact angle: silicon, antimony, tin and indium, and two ceramic solid electrolytes were applied: β-Al_2O_3 and NaSICON $Na_3Zr_2Si_2PO_{12}$. Contact angle between each of the molten alloys and two of the electrolytes were measured under argon atmosphere using static sessile drop technique. Charge transfer resistance of the electrode/electrolyte interface was measured for symmetrical Na/solid electrolyte/Na cells using electrochemical impedance technique. Critical current density was measured using galvanostatic method. Correlation between contact angle and electrochemical performance is discussed in this work.
Keywords: energy storage; sodium metal batteries; ceramic solid electrolytes; wettability

Efficient conversion of low concentration coal-bed methane into power via solid oxide fuel cells integrated the activated catalyst-modified microchannels

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Abstract: Clean and efficient utilization of the abundant low concentration coal-bed methane (LC-CBM) via solid oxide fuel cells (SOFCs) is highly attractive for saving energy and mitigate the emission of greenhouse gases. However, it still remains a great challenge for SOFCs as the high concentration of oxygen in LC-CBM. In this study, the effect of the oxygen concentration in oxygen-bearing LC-CBM on performance is investigated and an integrated SOFC with anode function layer (AFL) and highly active catalysts (Ni-Y_2O_3-$Ce_{0.5}Zr_{0.5}O_2$) in vertical microchannels is proposed to improving the electrochemical performance and methane conversion efficiency. The results show that the oxygen concentration in LC-CBM has two sides: small amount of the oxygen content can boost the electrochemical process, but too much oxygen content plays a opposite effect. In order to achieve a stable, safe and efficient output performance under a relative high oxygen content, the integrated anode with AFL and active catalysts will boost the partial oxidation process of methane, resulting in the improvement of power density from 904 to 1208 mW cm^{-2} at 750°C and the increase of methane conversion efficiency from 23.59% to 43.22%. In addition, the coking tolerance can be dramatically enhanced. The proposed integrated SOFC provides a great application potential for the utilization of LC-CBM.
Keywords: low concentration coal-bed methane; solid oxide fuel cells; vertical microchannels; surface modification; infiltrating catalysts

Potassium Prussian Blue cathode for potassium-ion full-cells

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Abstract: Potassium Prussian Blue (KPB) have been investigated as promising cathode materials for potassium-ion batteries. Herein, dual stabilization strategy of structure of KPB particles and cathode/electrolyte interface is reported to enhance the capacity and electrochemical stability. The structure of KPB is stabilized through inhibiting nucleation and slowing growth by addition of ethylenediaminetetraacetic acid dipotassium salt during co-precipitation, which can enlarge the particle size. Meanwhile, stabilizing the cathode/electrolyte interface *via* changing potassium hexafluorophosphate to potassium bis (fluorosulfonyl) imide (KFSI) electrolyte can further reduce side reactions to boost the coulombic efficiency of KPB cathode. To demonstrate its practical use, KPB//graphite full-cell device is successfully constructed, exhibiting the capacity up to 102.4 mAh g^{-1} at 0.1 A g^{-1}, high-rate (40.4 mAh g^{-1} at 1.5 A g^{-1}) and superior cyclic stability (88% capacity retention from cycle 25 to 400 at 1 A g^{-1}). This work provides a synergetic engineering strategy to realize the powerful application of high-performance potassium-ion full-cell devices in energy storage.
Keywords: potassium-ion batteries; full-cell; cathode materials; Prussian blue; interface

Design of cathode materials and electrode/electrolyte interface to enhance the potassium storage performance

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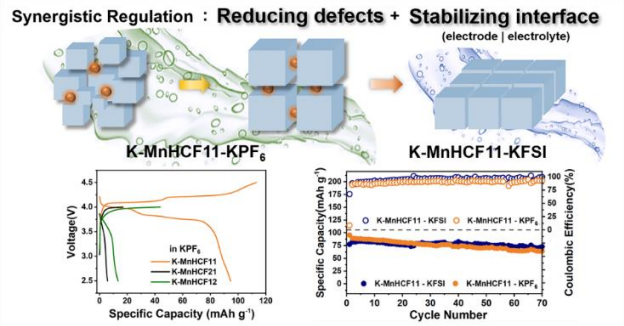
Abstract: Recent years, potassium-ion battery (PIB) is becoming a popular alternative to lithium-ion batteries due to their low-cost and abundant potassium resources. Potassium manganese hexacyanoferrate (K-MnHCF) has been considered as a promising cathode material for potassium-ion batteries on account of their high potential and capacity, but also suffers from the poor cyclic performance. Herein, a synergistic strategy combining the defects-reducing of K-MnHCF together with the electrode/electrolyte interface-stabilizing is developed to boost the electrochemical potassium-ions storage performance. By adjusting the co-precipitation process, K-MnHCF displays the regular cubic particle with the size of 100 - 150 nm, exhibiting the reversable capacity of 95 mAh g^{-1} in KPF_6 electrolyte system. Moreover, stabilizing the interface between K-MnHCF cathode material and electrolyte is further applied to enhance the cycling stability and coulombic efficiency of K-MnHCF cathode, by reducing the side reactions at the interface in high concentration KFSI electrolyte system. Here, we will discuss how to design the cathode materials and electrode/electrolyte interface to enhance the potassium storage performance. These works give some suggestions about the synergistic regulation of low-defects manganese hexacyanoferrates with stable electrode/electrolyte interface for boosting the electrochemical

performance of PIBs.

Graphic abstract



Keywords: potassium-ion battery; cathode material; potassium manganese hexacyanoferrate; low-defect; interface

Methoxy-grafted NiFe-LDH with enhanced adsorption removal of methyl orange from aqueous solution

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Abstract: The printing and dyeing industry discharges a large amount of dye wastewater, which causes serious pollution to the environment. Therefore, the removal of dyes in water is very important to the sustainable development of human society. Methyl orange (MO) is a common dye, whose removal has important representative significance. Layer double hydroxide (LDH) is an anionic layered compound with a brucite structure. Its physical and chemical properties can be precisely controlled by adjusting the ratio and type of anion and cation. LDH is often used as an adsorbent, electrocatalyst, etc. In this work, MO adsorption was studied using methoxy-modified NiFe- Layer double hydroxide (NiFe-LDH). A facile co-precipitation method was used to prepare NiFe-LDH, and a solvothermal treatment was used to modify NiFe-LDH with methoxy. The obtained methoxy-modified LDH was characterized by XRD, TEM, TG-DTG, DIS, etc. The effects of different pH values, dosages and MO concentrations on the adsorption performance of the samples before and after methoxy modification were investigated. In addition, the adsorption kinetics of the samples were also studied. Finally, it was found that the LDH modified with methoxy presented significantly improved MO adsorption performance, with a q_m of 442.47 mg/m g, much higher than the single LDH adsorbent performance that has been reported so far. The reason may be due to the enhanced anion exchange capacity with MO resulting from the enlarged interlayer spacing, and the enhanced van der Waals attraction to MO molecules by methyl oxygen replacement.
Keywords: layered double hydroxide; methoxy; modification; adsorption; methyl orange

Granules of zeolite - strontium chloride composite for a reliable ammonia-based selective catalytic reduction

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Abstract: Nitrogen oxides as one of the most harmful air pollutants have resulted in severe environmental problems. Therefore, the reduction of nitrogen oxides has been a long-time goal for achieving better air quality. Ammonia, as the most common reductant in selective catalytic reduction, faces several challenges in its storage on vehicles. Strontium chloride as a typical ammonia carrier shows slow ammonia sorption kinetics and poor structural stability. In this work, a zeolite - strontium chloride composite is designed and evaluated as ammonia carriers. The composite granules are achieved with two different approaches, chloride impregnation and freeze granulation. The zeolite - strontium chloride composite demonstrates a two-stage ammonia sorption: a rapid stage (0.24 mmol g^{-1} min^{-1}) by the physisorption and a slow stage (0.07 mmol g^{-1} min^{-1}) by the chemisorption. In addition, the mechanical performance of the granules by chloride impregnation maintains excellent after ammonia sorption cycles, offering a reliable structure of the designed composite.
Keywords: ammonia; zeolite; SCR; deNOx; strontium chloride

Controllable preparation and doping modification of two-dimensional tellurium nanosheets as bifunctional electrocatalysts

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Abstract: As an important new energy, the conversion efficiency of hydrogen is a research hotspot today. The electrocatalytic performance of the electrode for hydrogen production has a decisive effect on this efficiency. Two-dimensional tellurium (2D Te) is a newly discovered layered material, which has aroused great interest in the field of electrocatalysis, yet its production remains challenging. Herein, Te nanomaterials were synthesized by hydrothermal reaction. It was found that the morphology of Te crystals could present from nanowire to nanosheet and irregular bulk particle by changing pH value and reaction time when hydrazine as reducing agent. Moreover, their electrocatalytic performance was tested and showed that Te nanosheets had the optimal comprehensive performance. On the basis, the Te nanosheets were doped with transition metal for better performance. The results indicated that the electrocatalytic properties of the samples varied greatly after doping various transition metals. Specifically, doping Co can greatly improve the hydrogen evolution performance, and the optimal sample only needs a hydrogen evolution overpotential of 147mV to reach a current density of 10 mA·cm^{-2}. However, doping Fe can greatly improve the oxygen evolution performance and the oxygen evolution overpotential of the optimal sample is 277mV at 10 mA·cm^{-2}. It was suggested that different transition metals doped into Te nanosheets should produce different functions, resulting in different electrocatalytic performance. Practically, doping Co usually causes optimized adsorption energy to promote hydrogen formation, while doping Fe facilitates the formation of lattice oxygen which promotes oxygen evolution. This influence mechanism is worthy of in-depth exploration. This work provides a promising route to design and optimize layered two-dimensional materials as electrocatalysts.
Keywords: Te nanosheets; hydrothermal reaction; morphology control; doping modification; electrocatalytic performance

Pore structure engineering in amorphous carbon for fast potassium storage

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Abstract: Introducing pore into carbon materials can improve potassium storage capacity due to the abundance of active sites. However, unsuitable pores, especially micropores, restrict the fast storage of potassium ions. Thus, pore structure engineering in carbon is essential but challenging for the kinetics of fast potassium storage. Herein, we report a general "pore expanding" strategy by the *in-situ* pulverization-reaggregation technology of basic carbonate to achieve accurate pore width adjustment and carbon structure modulation. And this strategy also applies to many pitch/basic carbonates (e.g., pitch/basic magnesium carbonate, pitch/basic zinc carbonate, pitch/basic nickel carbonate and pitch/basic cupric carbonate), showing controlled adjustment of pore width. Taking pitch/basic magnesium carbonate as an example, the pores of carbon nanosheets (CNS) can be tuned from 5 nm to 9.3 nm by the formation and orientation aggregation of MgO nanoparticles. Benefiting from the expansion of pores and the generation of rich defects, the material achieves high capacity (417.6 mAh g^{-1} at 0.1 A g^{-1}) and high rate performance (147 mAh g^{-1} at 2A g^{-1}). This study provides a general strategy for the pore structure engineering in carbon materials and offers mechanism insights for fast potassium storage in carbon materials.
Keywords: potassium storage; carbon materials; pore structure; carbon nanosheet

Dense carbon: A high-initial-coulombic-efficiency and low-discharge-plateau K^+ storage anode for 4.0V full cells

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Abstract: Dense carbon anode materials with low potassium storage voltage, high initial coulombic efficiency (ICE), and high capacity are critical but challenging for the practice utilization of high-energy potassium-ion batteries (PIBs). Herein, a multi-densification strategy is developed to fabricate dense carbon (DC-2H) with sp^2-sp^3 hybrid structure through chemical welding with oxidized pitch as the building units, thus boosting the K^+ storage capacity bellow 1V, ICE, rate capability and cyclic stability simultaneously. The hybrid structure not only provides nanographitic domains for low-voltage potassium storage, but also ensures excellent K^+ transport kinetics in the defective networks. Thus, high reversible

capacity at <1 V (248.8 mAh g^{-1} at 0.05 A g^{-1}, 71.4% at < 1V), high ICE of 68.2%, high-rate (209.9 mAh g^{-1} at 1A g^{-1}) and excellent cyclic stability (79.7% capacity retention after 6000 cycles) are achieved simultaneously. The practice application is evaluated in potassium-ion full cell delivers with the DC-2H as the anode materials, showing a significant discharge plateau at ca. 3.5V and excellent cyclic stability (92.03% capacity retention after 200 cycles). This work provides fresh mechanism insights for high-reversible potassium storage at low-voltage in carbon anode materials, which will greatly promote the practical application of PIBs.

Keywords: low potassium storage potential; high ICE; carbon materials; full cells

LDH-derived flower-like Co-Ni fluorides as electrode material for asymmetric supercapacitors

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Abstract: Designing and exploring electrode materials with wide potential window are of crucial significance for the future large-scale development of supercapacitors. Herein, Co-Ni fluorides were prepared by a two-step method with layered double hydroxides as a template. Benefitting from the unique hierarchical structure and synergistic effects between each component, the resultant Co-Ni fluorides displayed a spectacular specific capacitance of 1890 $F{\cdot}g^{-1}$ at a current density of 1 $A{\cdot}g^{-1}$ with an outstanding rate capability of 62.3% at 10 $A{\cdot}g^{-1}$, which was highly superior to those of other Co-Ni composites. The asymmetric supercapacitor assembled with Co-Ni fluorides and activated carbon(AC)as the cathode and anode exhibited high energy density up to 37 $Wh{\cdot}kg^{-1}$ at 900 $W{\cdot}kg^{-1}$. Moreover, it had good cycle stability, maintaining 94% of its initial capacitance after 2000 cycles. These intriguing electrochemical performances indicate that Co-Ni fluorides has enormous potential application in high performance energy storage systems in the future.

Keywords: transition metal fluorides; electrochemical; supercapacitors; LDH

Multiphase engineered $Bi_{1/2}Na_{1/2}TiO_3$-based ceramics with simultaneous high polarization and superior breakdown strength for energy storage applications

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Abstract: Dielectric ceramics are crucial for high-temperature, pulse-power energy-storage applications. However, the mutual restriction between the polarization and breakdown strength has been a significant challenge. Here, multiphase engineering controlled by the two-step sintering heating rate is adopted to simultaneously obtain a high polarization and breakdown strength in $0.8(0.95Bi_{0.5}Na_{0.5}TiO_3$-$0.05SrZrO_3)$-$0.2NaNbO_3$ (BNTSZNN) ceramic systems. The co-existence of tetragonal (T) and rhombohedral (R) phases benefits the temperature stability of BNTSZNN ceramics. Increasing the heating rate during sintering reduces the diffusion of $SrZrO_3$ and $NaNbO_3$ into $Bi_{0.5}Na_{0.5}TiO_3$, which results in a high proportion of the R phase and a finer grain size. The overall polarization is enhanced by increasing the proportion of the high-polarization R phase, which is demonstrated using a first-principles method. Meanwhile, the finer grain size enhances the breakdown strength. Following this design philosophy, an ultrahigh discharge energy density of 5.55 J/cm^3 and energy efficiency above 85% is achieved in BNTSZNN ceramics as prepared with a fast heating rate of 60 ℃/min given a simultaneously high polarization of 43 $\mu C/cm^2$ and high breakdown strength of 350 kV/cm. Variations in the discharge energy density from room temperature to 160 °C are less than 10%. Additionally, such BNTSZNN ceramics exhibit an ultrafast discharge speed with the discharge time ($\tau_{0.9}$) at approximately 60 ns, which shows the great potential in pulse-power system applications.

Keywords: multiphase engineering; energy storage; high polarization; high breakdown strength; temperature stability

High-performance BNT-based ferroelectric ceramics with simultaneously enhanced polarization and breakdown strength

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Abstract: BNT($Bi_{0.5}Na_{0.5}TiO_3$)-based ferroelectric ceramics have drawn much attention in energy-storage field due to the high polarization and good temperature stability. However, the reduction of Ti^{4+} caused by the volatilization of Bi and Na elements during high-temperature sintering is a huge problem. Multivalence element (Mn) is adopted in this work to prevent the reduction of Ti^{4+}, and thus enhance the polarization and breakdown strength simultaneously. Various content of MnO_2 doped ($0.95Bi_{0.5}Na_{0.5}TiO_3$-$0.05SrZrO_3$)-$0.2NaNbO_3$ (BNTSZNN) ceramics were prepared by the Ramp-to-spike sintering method. The existence of Ti^{3+}, confirmed by the X-ray photoelectron spectroscopy (XPS), proves the reduction of Ti^{4+}. As the content of MnO_2 increases, the content of Ti^{3+} is effectively decreased, reducing the degradation of ferroelectricity and leakage conductance. As a result, an ultra-high discharge energy density (W_{rec}) of 7.05 J/cm^3 is achieved in the BNTSZNN-0.15MnO_2 ceramic at 387 kV/cm. Importantly, the BNTSZNN-0.15MnO_2 ceramic system behaves quite excellent temperature stability both in energy-storage and capacitance field. The variation in the discharge energy density (W_{rec}) is less than ±4% in the temperature range from 30 °C to 160 °C under the applied field of 120 kV/cm. Additionally, the variation in the capacitance (or dielectric permittivity) of the BNTSZNN-0.15 MnO_2 ceramic is less than ±15% over the temperature range from -55 °C to 450 °C, with a high room temperature dielectric permittivity of 1507. All the above characteristics indicate the potential of BNTSZNN-0.15MnO_2 as high-temperature and high-voltage ceramic dielectrics.
Keywords: anti-reduction; energy storage; high polarization; high breakdown strength; temperature stability

Preparation and anticancer effects of kaolinite/carbon nitride quantum dots complex

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Abstract: At present, multifunctional nanocarriers as theranostics nanoplatforms have attracted much attention. Owing to the large specific surface area, abundant hydroxyl groups, and excellent biocompatibility, kaolinite (Kaol) nanosheets can co-load chemo-drugs, photosensitizers, imaging agents for imaging-guided combined therapy. Combined with carbon nitride quantum dots (CNQDs) and anticancer drug (doxorubicin, DOX), Kaol complex (Kaol/CNQDs/DOX) are obtained to realize the improved anticancer effects. Kaol nanosheets obtained by an intercalation-stripping method are detected to be low toxic, while CNQDs of 2.2 nm are synthesized by mechanical exfoliation from bulk graphitic carbon nitride (g-C_3N_4). Kaolin/CNQDs composite (the mass volume ratio of Kaol and CNQDs is 25:20 mg/mL) which is obtained through a vacuum method not only has the best fluorescence performance of CNQDs but also promotes the generation of reactive oxygen species (ROS) due to the interfacial regulation between Kaol and CNQDs under the laser irradiation (670 nm) thus achieving photodynamic therapy. In addition, Kaolin/CNQDs composite drug-carrying system has a good drug loading capacity (loading efficiency of 41.38%, encapsulation efficiency of 75.86%) as well as a pH-trigged drug release behavior of DOX. The construction of a nanoclay-based drug delivery system provides a new platform for the realization of precise and efficient combined therapy for tumors. This work was supported by the National Natural Science Foundation of China (51974367).
Keywords: kaolinite; carbon nitride quantum dots; doxorubicin; drug delivery system; anticancer

One-step solution combustion synthesis of micro/nano-scale porous Cu/CeO_2 with enhanced photocatalytic properties

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Abstract: The Cu/CeO_2 nanoporous composite material was prepared via a one-step and energy-saving method of solution combustion synthesis (SCS) for the first time. The phase composition, surface morphology and optical characteristics of Cu/CeO_2 were studied. The results show that the SCS products are composed of cubic fluorite CeO_2 and Cu. Due to the generation and escape of gas during the synthetic reaction, the SCS CeO_2 shows porous structure, in which the mesopores (diameter 10 ~ 17 nm) nested in

the wall of large pores (diameter 80 ~ 300 nm). X-ray photoelectron spectroscopy (XPS) outcomes indicate that the oxygen vacancy concentration of CeO_2 increases (18.97%-30.93%) with the increase of Cu concentration. The decoration of Cu greatly enhances the catalytic activity of CeO_2 nanomaterials. 30wt% Cu/CeO2 composite material shows the best photocatalytic activities for the degradation of methyl orange (MO) (95.99%), which is about 4.3 times that of CeO_2 at the same time (120min). UV-vis diffuse reflectance spectroscopy (DRS) results show that the semiconductor band gap is reduced with the addition of metallic Cu, which leads to the enhancement of photocatalytic activity. The free radical trapping experiments demonstrate that·O^{2-} and h+ were the main active species in the photocatalytic degradation of MO. Based on the above results, a hypothesized mechanism for enhanced photocatalysis of Cu/CeO_2 nanomaterials was proposed: the porous structure provides more reactive sites and channels for mass transfer, and the presence of metallic Cu improves the oxygen vacancy concentration of CeO_2 and then promote charge-carrier separation, which helps enhance the photocatalytic performance of Cu/CeO_2.
Keywords: solution combustion synthesis; Cu/CeO_2; nanoporous material; photocatalyst

$Na_{3+x}V_{2-x}Fe_x(PO_4)_2O_2F$: An advanced cathode material with ultra-high stability for superior sodium storage

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Abstract: Searching a suitable electrode material is one of the key issues of Sodium-ion batteries (SIBs) for the large-scale applications. Sodium-rich $Na_3V_2(PO_4)O_2F$ (NVPOF) with a 3D tunnel structure is the promising cathode material for SIBs owning to the advantage of its high operating voltage and, stable structure, and good thermal stability. Nevertheless, the inferior reaction kinetics and unsatisfied sodium storage behavior resulting from its low electron conductivity hinder its further practical application. Here, $Na_{3+x}V_{2-x}Fe_x(PO_4)_2O_2F$ microcuboids were synthesized via iron partially replacing V atom sites of $Na_3V_2(PO_4)_2O_2F$ by a simple hydrothermal method. Benefiting from the intrinsically improved electronic conductivity and enhanced charge transfer kinetics, $Na_{3.15}V_{1.85}Fe_{0.15}(PO_4)_2O_2F$ (NVFPOF) with 15 wt% doping concentration shows an initial capacity of 137.2 mAh g^{-1} at 1 C, which is about 31% higher than that of NVPOF. In addition, a full cell based on NVFPOF cathode and hard carbon anode showed 91.3% capacity retention even after 60 cycles at 0.4 C. Moreover, iron atoms can be used as the pillar of the host structure to buffer deformation and effectively alleviate the volume change (less than 1.05%) upon cycling, showing 86.5% capacity retention at 20 C after 1000 cycles. The results provide an effective and simple way to construct advanced cathodes for SIBs.
Keywords: sodium-ion batteries; $Na_3V_2(PO_4)O_2F$; Fe^{3+}-doping; electronic conductivity; structural stability

Ruddlesden-Popper-structured $(Pr_{0.9}La_{0.1})_2(Ni_{0.8}Cu_{0.2})O_{4+\delta}$: An effective oxygen electrode material for proton-conducting solid oxide electrolysis cells

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Abstract: Proton-conducting solid oxide electrolysis cells (H-SOECs) have attracted lots of attention due to high efficiency, energy saving and environmentally friendly. The ideal H-SOEC oxygen electrode materials are triple conducting oxide with mixing proton (H^+), oxygen ion (O^{2-}) and electron (e^-) conductivity. Herein, the triple conductive oxide $Pr_2NiO_{4+\delta}$ (PNO)-based perovskite $(Pr_{0.9}La_{0.1})_2(Ni_{0.8}Cu_{0.2})O_{4+\delta}$ (PLNCu) is chosen as the oxygen electrode of H-SOEC with impressive electrochemical performance. Its crystal structure, physicochemical property and cell performance are discussed in detail. The thermal expansion coefficient of the PLNCu sample is 13.78×10^{-6} K^{-1}, and the electrical conductivity is 258 S cm^{-1} at 450 °C. Moreover, the polarization resistance of the single cell is as low as 0.056 Ω cm^2 and the current

density at 1.3 V can reach 1.61 A cm^{-2} at 750 °C, which shows the good electrochemical performance. 100 h of long-term testing also shows that the cell has good performance and structure stability. Therefore, this work highlights a novel oxygen electrode material $(Pr_{0.9}La_{0.1})_2(Ni_{0.8}Cu_{0.2})\ O_{4+\delta}$ for proton-conducting solid oxide electrolysis cells.
Keywords: proton conducting; solid oxide electrolysis cells; Ruddlesden-Popper perovskite; oxygen electrode; electrochemical performance

One-step route to Fe_2O_3 and $FeSe_2$ nanoparticles loaded on carbon-sheet for lithium storage

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Abstract: Iron-based anode materials such as Fe_2O_3 and $FeSe_2$ have attracted widespread attention for lithium-ion battery due to their high capacities and abundant reserves. However, the capacity decays seriously because of the poor conductivity and severe volume expansion, which greatly limits their practical application. Designing nanostructure and combined with carbon are effective means to improve cycling stability, because of that the incorporated carbon not only can act as a structural buffer to effectively alleviate the volume expansion, but also significantly improve the conductivity, and the nanostructure of the synthesized materials could afford space for lithium intercalation and extraction processes. In this work, ultra-small Fe_2O_3 nanoparticles loaded on carbon framework were synthesized through a one-step thermal decomposition of the commercial $C_{15}H_{21}FeO_6$ [Iron (III) acetylacetonate], which could be served as the source of Fe, O, and C. As an anode material, the Fe_2O_3@C anode delivers a specific capacity of 747.8 mAh g^{-1} after 200 cycles at 200 mA g^{-1} and 577.8 mAh g^{-1} after 365 cycles at 500 mA g^{-1}. What's more, the synthetic strategy can be simply extended to prepare other iron-based anode material, $FeSe_2$@C for instance also showing good cycling performance.
Keywords: lithium-ion battery; anode materials; Fe_2O_3@Composite; $FeSe_2$@C composite

A visual saliency-based anomaly detection algorithm for mineral materials

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Abstract: There may be scratches, dislocations, color, and texture changes in mineral materials such as wood, steel pipes, and fabrics in the mine production process, which influences the production efficiency of mine to some extent. To solve this problem, better detect anomalies and improve production efficiency, this paper proposes a detection algorithm for mineral material anomalies based on visual saliency. In our algorithm, first, we perform morphological processing and median filtering on the input image of mineral materials with anomalies, highlighting the area that has anomalies. Secondly, we divide the processed image into multiple overlapping image blocks to obtain the feature template of the image, use the template to obtain the visual saliency of each part of the image blocks, stitch the images together, form a visual saliency map, and initially locate the anomaly area. Finally, we combine the visual saliency map with superpixel segmentation to pinpoint the anomaly area further. The experiments prove that our algorithm has a high recognition accuracy and good recognition effect. The algorithm can be directly applied to the real-time monitoring of mines.
Keywords: mineral materials; anomaly detection; visual saliency; superpixel segmentation

Three-dimensional honeycomb-liked MoP@C nanocomposite with advanced sodium/potassium ion storage performance

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Abstract: MoP@C nanocomposite, combined three-dimensional (3D) honeycomb-liked carbon matrix with molybdenum phosphide, was synthesized through a simple hard template method followed by high-temperature phosphating treatment. Here, the MoP@C nanocomposite has shown excellent sodium and potassium-ion storage properties applied as anode materials for sodium-ion batteries (SIBs) and

potassium-ion batteries (PIBs), superior to those traditional composites. The MoP@C composite maintains a high reversible specific capacity of 250 mAh g-1 in SIBs after 100 cycles at 0.5 A g^{-1}. Furthermore, even at a high current density of 5 A g^{-1}, it still delivers a specific capacity of 200.5 mAh g^{-1}. Additionally, the nanocomposite holds 147.2 mAh g^{-1} under a high current density of 1 A g-1 in PIBs. The excellent electrochemical performance benefits from the synergistic effect of the hierarchical MoP@C nanostructure. For instance, the exquisite porous nano-frame with higher conductivity and larger specific surface area, provides full contact opportunities between the electrolyte and the active material, and successfully shorts the diffusion distance of electrons and ions. Moreover, the stable three-dimensional carbonaceous cavity in the heterostructure effectively inhibits the instinctive aggregation of MoP and simultaneously alleviates the volume expansion during the intercalation and deintercalation of ions in the charge and discharge process, enabling the excellent rate performance and long cycle life of MoP@C electrode. The satisfying result has laid a solid foundation for the development of MoP in the field of electrochemical energy storage.

Keywords: MoP@C nanocomposite; three-dimensional honeycomb-liked structure; sodium-ion battery; potassium-ion battery

Prussian blue analogue-derived $ZnO/ZnFe_2O_4$ core-shell nanospheres as high-performance anode materials for alkali-ion batteries

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Abstract: The transition metal oxides (TMOs) have been intensively researched for alkali-ion batteries because of the high theoretical specific capacity. However, TMOs have the problems of rapid specific capacity attenuation owing to the volume change during the cycles. For a long time, researchers have designed a variety of reasonable nanostructures to solve the volume expansion problem to improve the commercial application of TMOs. In this work, the core-shell nanostructures of $ZnO/ZnFe_2O_4$ through self-sacrifice template method with Prussian blue analogue ($Zn_3[Fe(CN)_6]_2$) as precursor were successfully synthesized by controlling the annealing temperatures and rates. The formation mechanism of the core-shell nanostructures is explored through the morphology transformation at different annealing temperatures and rates. Annealed at 450° at 5 ℃ min^{-1}, the obtained sample shows the core-double shell nanostructure. Benefiting from the unique core-double shell nanostructure and the synergistic effect of the ZnO and $ZnFe_2O_4$, the obtained $ZnO/ZnFe_2O_4$ composite material shows excellent cycling performance as LIBs (1310 mAh g^{-1} at 100 mA g^{-1} after 50 cycles) and PIBs (112 mAh g^{-1} at 100 mA g^{-1} after 100 cycles). The results prove that the strategy of designing nanostructures can significantly relieve the volume expansion of TMOs and improve the electrochemical performance of TMOs for alkali-ion batteries.

Keywords: volume expansion; Prussian blue analogue; core-shell; self-sacrifice template method; $ZnO/ZnFe_2O_4$

Structural analysis and lightweight design of mining bucket based on ANSYS workbench

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Abstract: The bucket, as an important working and load-bearing part of the excavator, is in direct contact with the material and is subject to more severe wear than the rest of the equipment. In order to investigate the force situation of the bucket under different working conditions and its structural analysis and light-weight design ideas, a 3D geometric model of the bucket is established by UG software, and the structural statics of the bucket is calculated by ANSYS Workbench software based on the finite element method, and at the same time, uses sensitivity analysis to find out the parts that have the greatest influence on the quality of the bucket, and uses them as design variables to determine the influence parameters of the optimization target were determined. The response surface optimization method was used to optimize the structural dimensions to achieve the light-weight design. The research results show that:(1) the maximum stresses of the bucket under typical working conditions are mainly distributed at the edge plate, teeth and side plate, which are consistent with the feedback results of field failure cases of this bucket; (2) Among various design variables, the results of sensitivity analysis show that the ear plate, edge plate, side plate and clamp plate have the greatest influence on the overall mass of the bucket, and the edge plate has the greatest influence on the maximum deformation; (3) among the four typical working conditions, the results of light-weight design are similar, with a mass reduction ranging from 2% to 4%, and the overall goal of light-weight design of the bucket structure is achieved, which provides a theoretical basis and reference for the subsequent structural design and optimization analysis of new bucket products.

Keywords: excavator; bucket optimization; lightweight design; finite element analysis; response surface optimization

Microstructure and high-temperature oxidation resistance of MoSi2-based coatings for Niobium substrate using spent MoSi2

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Abstract: Spent $MoSi_2$ heating elements, which worked in the industrial electrical furnace at high temperature, were crushed into powders and reused as coating raw materials. ZrO_2 was added into spent $MoSi_2$ powders to fabricate $MoSi_2$-ZrO_2 coatings on niobium by spark plasma sintering, and the microstructure and oxidation behavior of the coatings at 1500 and 1700 °C were explored. The results showed that cracks exist in $MoSi_2$ coating while ZrO_2-containing coatings are crack-free with the formation of $(Mo, Nb)_5Si_3$ diffusion layer after SPS, indicating good metallurgical bonding. After oxidation at 1500 °C for 20 h, the lowest mass gain is obtained by $MoSi_2$-30ZrO_2 coating. SiO_2 and $ZrSiO_4$ are formed on the composite coatings at elevated temperature, which improves the high-temperature oxidation resistance. After oxidation at 1700 °C for 60 min, the oxide scale of $MoSi_2$-30ZrO_2 coating is dense without any voids or cracks, demonstrating better high-temperature oxidation resistance than that of single $MoSi_2$ coating.
Keywords: spent $MoSi_2$; oxidation behaviour; Niobium substrate; spark plasma sintering.

Micro-spherical BiOI photocatalysts for environmental remediations: Efficient degradation of residual xanthate and gaseous nitric oxide

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Abstract: BiOI microspheres were synthesized using solvothermal method for the degradation of residual xanthate and gaseous nitric oxide (NO) under visible light irradiation. The as-prapared BiOI nanomaterials are then characterized using various technologies including XRD, FE-SEM, TEM, UV-vis DRS and XPS. The photodegradation results show that the removal efficiency of isobutyl sodium xanthate can reach 98.08 % at initial xanthate concentration of 120 mg/L; that of NO is as high as 96.36 % at inlet NO concentration of 11 ppm. Moreover, the effects of operational parameters such as catalyst dosage, initial xanthate concentration, and pH value of wastewater on the removal of xanthate were investigated. The results of scavenging tests and full-spectrum scanning indicate that $\cdot O_2^-$ radicals are the main active species in xanthate degradation, and peroxide xanthate is an intermediates. The reusability of BiOI was explored through cyclic experiments. Furthermore, the reaction path and mechanism of NO removal using BiOI were analyzed, and the main active species is also $\cdot O_2^-$. It is concluded that BiOI photocatalysts have high potentials for wastewater treatment and waste gas clean-up in mineral industry.
Keywords: BiOI microspheres; photocatalytic degradation; xanthate; nitric oxide

Nitrogen and sulfur co-doped graphene aerogels/SnO_2@SnS_2 heterostructure building high-performance lithium and sodium-ion batteries

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Abstract: The construction of heterostructures can enable materials to have excellent application properties in high-speed electronics, optoelectronics, and other fields, thanks to the charge transfer driving force embedded in the material, which is beneficial to the material-specific charge transfer kinetics. However, the rational design and controllable synthesis of high-rate performance nano-heterostructure anode materials remain a great challenge. In this work, we successfully used a one-step hydrothermal method to uniformly anchor SnO2@SnS2 heterostructures to Nitrogen and Sulfur co-doped Graphene. The faster electron transport kinetics than SnO2 can be achieved at heterointerfaces of SnO2@SnS2 through electrochemical tests analysis. The enhanced mobility is due to the interfacial effect of the heterostructure, which induces an electric field inside the nanocrystals, making the nanocrystals less resistant to ionic diffusion and facilitating interfacial electron transport. In addition, SnO2@SnS2 nanocrystals (3-5 nm) can greatly shorten the diffusion path of Li/Na ions, while the NSG substrate has

good electrical conductivity and structural stability is good. High reversible charge storage capacities are achieved for both LIBs (1093 mAh g^{-1}, 0.1 A g^{-1}, 209 mAh g^{-1}, 5 A g^{-1}) and SIBs (532 mAh g^{-1}, 0.1 A g^{-1}, 87 mAh g^{-1}, 5 A g^{-1}).
Keywords: graphene aerogels; SnO2@SnS2 heterostructure; lithium and sodium-ion batteries

Study on photocatalytic and antibacterial properties of Nano-ZnO composite coating prepared by plasma spraying-chemical vapor deposition

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Abstract: It has always been an important issue for researchers to explore environmentally friendly materials that can degrade organic pollutants and fight bacteria. In this paper, an efficient and environmentally friendly method for the preparation of porous Nano-ZnO composite coatings by plasma spray-chemical vapor deposition is reported. With this method, ZnO/Ag/Zn composite coatings were chemically vapor deposited on the stainless steel substrate using a self-made Zn@ (ZnO/Ag) core-shell powder as raw materials and plasma jet as heat source. The coating has a cauliflower-like microstructure with particle sizes ranging from 40 nm to 60 nm. It is found that the size of coating nanoparticles decreases with the increase of spraying power and spraying distance. The ratio of ZnO: Zn in the coating increases with increasing spraying power or decreasing spraying distance. When the spraying power was 31.5kW and spraying distance was 100 mm, the photocatalytic degradation rate was the fastest and the efficiency was the highest (87.5%). The prepared composite coating has good antibacterial performance, and the antibacterial performance with light is better than that under dark condition. Under simulated sunlight, the MIC and MBC are 50 and 50 μg/mL for S. *aureus*, and 400 and1600 μg/mL for E. *coli*, respectively.
Keywords: ZnO composite coating; plasma spraying-chemical vapor deposition (PS-CVD); photocatalytic degradation; antibacterial properties

Deepening the field-effect of homojunction by gradient doping for highly efficient perovskite solar cells with high hole transfer

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Abstract: Inverted perovskite solar cells (PSCs) have triggered enormous studies and have become a star structure on account of their negligible hysteresis effect. Despite this, the highest power conversion efficiency (PCE) has been boosted to 23.8% for inverted PSCs, which is still far from the reported champion PCEs of PSCs with conventional structure. Obviously, the energy levels mismatch between conventional hole transport layer (HTL) and the perovskite absorber layer should be mainly responsible for the above efficiency distance. Herein, a gradient-doped homojunction (GHJ) based on gradient cobalt doped NiO was fabricated and used as HTL of the inverted PSCs. This GHJ structure contains four layers multiple-homojunction, which constructed conveniently by gradient cobalt doped nickel oxide. The GHJ structure can accelerate charge separation and efficiently improve the hole transfer. Accordingly, planar inverted PSCs with GHJ structure achieve an efficiency of 20.48%, narrowing the efficiency gap of PSCs with conventional structure. Notably, the GHJ-based PSCs exhibit an excellent long-time stability with only a 6% efficiency decline for 360 h under full spectrum illumination in N2. Therefore, the GHJ configuration improves both long-time stability and efficiency of inverted PSCs, which will provide important insights into the commercialization of optoelectronic devices.
Keywords: nickel oxide; perovskite solar cells; interface; carrier transport; gradient-doped homojunction

Design of scalable dendritic copper as high specific surface area support for efficient energy storage

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Abstract: Design and fabrication of novel electrode materials with excellent specific capacitance and cycle stability is urgent for the advanced energy storage devices, which depends on the electrode materials. Recently, three factors for advanced electrode materials have revealed by experimental investigations and

reviews: (i) doping other metal cations into monometallic active material to optimize the utilization of pseudocapacitance and improve surface activity, (ii) the development of tunable support with high surface area, low ion diffusion resistivity and outstanding electron conductivity, (iii) the in situ growth of active materials on ideal supports to reduce contact resistance and the ineffective area. Herein, we report scalable leaf-shaped nanostructured copper with controllable morphology (the length of branch ranging from 2 μm to 30 μm and the diameters is between 40-80 nm), which can be adjusted by electrodeposition voltage and time. The selfstanding scalable dendritic copper offer large surface area and promote fast electron transport. Further, NiCoP nanosheets array were in situ grown on the 3D copper by a novel electrodeposition method, this 3DCu@ NiCoP electrode manifests a markedly improved electrochemical performance with a high specific capacity of ~1645 C g^{-1} at 1 A g^{-1} and an outstanding rate capability (1529 C g^{-1} at 20 A g^{-1}) due to its compositional and structural advantages. These findings may shed some lights into the rational design of transition metal compounds with tunable architectures by multiple modification methods for efficient energy storage.

Keywords: scalable copper; cations doping; electrode materials; energy storage

Layered double hydroxide: A new cathode material for high performance chloride ion batteries

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Abstract: Chloride ion batteries (CIBs) are regarded as promising energy storage systems due to their large theoretical volumetric energy density, high abundance, and low cost of chloride resources. We demonstrate for the first time, the synthesis of a CoFe LDH with Cl^- in the interlayer space (denoted as CoFe-Cl LDH) and its potential application as a cathode material for high-performance CIBs. The Cl^- ions storage mechanism was based on the unique topochemical transformation of CoFe-Cl LDH structure. First-principles calculations reveal that CoFe-Cl LDH is an excellent Cl^- ion conductor, with extremely low energy barriers ~0.25 eV for Cl^- diffusion. This work opens a new avenue for LDH materials as promising cathodes for anion-type rechargeable batteries, which are regarded as formidable competitors to traditional metal ion-shuttling batteries. In addition, the$Ni_2V_{0.9}Al_{0.1}$-Cl trimetallic LDH with Cl^- in the interlayer was synthesized and have also been demonstrated to be excellent cathode materials for CIBs. The $Ni_2V_{0.9}Al_{0.1}$-Cl LDH is capable of delivering a high initial capacity of 312.2 mAh g^{-1} at 200 mA g^{-1} and an ultralong life over 1000 cycles (with a capacity higher than 113.8 mAh g^{-1}). Such a long cycling life exceeds that of any reported CIBs. The remarkable Cl^--storage performance of the $Ni_2V_{0.9}Al_{0.1}$-Cl LDH is ascribed to the synergetic contributions from V^{m+}(high redox activity), Ni^{2+} (favourable electronic structure) and inactive Al^{3+} (enhances the structural stability), which is revealed by a comprehensive study that utilizes synchrotron Xray absorption near-edge structure experiments, kinetic investigations and theoretical calculations.

Keywords: chloride ion batteries; layered double hydroxides; cathode material; high performance; synergetic contributions

Reducing defect of perovskite solar cells by a peptide organic molecule

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Abstract: The use of molecular modulators to passivate the defect density at the surface and grain boundaries of perovskite films had been demonstrated to be an effective strategy which was used to minimize nonradiative recombination losses in perovskite solar cells. Herein, we use a polypeptide molecule (Fmoc-FKFKFKFK-NH_2) composed of multiple amino acid molecules to passivate the defects between the nickel oxide and perovskite layer. Experimental results confirmed that Pb^- cluster and Pb-I defects can be effectively passivated by amino and carbony group bonding with the Pb^{2+} on the perovskite surface, leading to a significantly suppressed non-radiative recombination. As a result, the power conversion efficiency (PCE) increased from 12.16% to 15.14%, mainly due to the passivation of defects at the interface and grain boundary, which can obtain higher short-circuit current and fill factor. Furthermore, the Fmoc-FKFKFKFK-NH_2 treated perovskite device shows better long-term environmental stability. Our work reveals an effective method to use rationally designed peptide molecules to simultaneously enhance device performance and stability.

Keywords: perovskite solar cells; interface modification; charge extraction; peptide organic molecules

Tunable covalent triazine-based frameworks (CTF-0) for visible-light-driven hydrogen and oxygen generation from water splitting

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Abstract: Covalent triazine-based frameworks (CTFs), a group of semiconductive polymers, have been identified for photocatalytic water splitting recently. Their adjustable band gap and facile processing offer great potential for discovery and development. Here, we present a series of CTF-0 materials fabricated by two different approaches, a microwave-assisted synthesis and an ionothermal method, for water splitting driven by visible-light irradiation. The material (CTF-0-M_2) synthesized by microwave technology shows a high photocatalytic activity for hydrogen evolution (up to 7010 μmol h^{-1} g^{-1}), which is 7 times higher than another (CTF-0-I) prepared by conventional ionothermal trimerization under identical photocatalytic conditions. This leads to a high turnover number (TON) of 726 with respect to the platinum cocatalyst after seven cycles under visible light. We attribute this to the narrowed band gap, the most negative conduction band, and the rapid photogenerated charge separation and transfer. On the other hand, the material prepared by the ionothermal method is the most efficient one for oxygen evolution. CTF-0-I initially produces ca. 6 times greater volumes of oxygen gas than CTF-0-M_2 under identical experimental conditions. CTF-0-I presents an apparent quantum efficiency (AQY) of 5.2% at 420 nm for oxygen production without any cocatalyst. The activity for water oxidation exceeds that of most reported CTFs due to a large driving force for oxidation and a large number of active sites. Our findings indicate that the band positions and the interlayer stacking structures of CTF-0 were modulated by varying synthesis conditions. These modulations impact the optical and redox properties, resulting in an enhanced performance for photocatalytic hydrogen and oxygen evolution; confirmed by first-principles calculations.
Keywords: covalent triazine framework; photocatalysis; hydrogen generation; oxygen generation

Co-doped conductive polyaniline hydrogel for flexible supercapacitor and wearable strain sensor

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Abstract: In the present work, a self-standing conductive polyaniline/polyvinyl alcohol (PANI/PVA) hydrogel ($CPH_{PA/SA}$) co-doped with phytic acid (PA) and sulfuric acid (SA) has been synthesized by chemical oxidation polymerization. The anisotropic tubular structure imparted by SA and the three-dimensional microporous structure imparted by PA enable $CPH_{PA/SA}$ electrodes to exhibit excellent mechanical and electrochemical performances. The $CPH_{PA/SA}$ electrodes showed high areal specific capacitance of 1697 mF/cm^2 at current density of 1 mA/cm^2 and outstanding cycling stability of 83% capacitance retention after 10000 charge/discharge cycles at current density of 3 mA/cm^2, which was superior than that of single-doping hydrogel electrode. In order to further explore the potential application prospects of the synthesized hydrogel electrodes in flexible devices, an all-hydrogel flexible supercapacitor device was fabricated by $CPH_{PA/SA}$ hydrogel electrodes and PVA/H_2SO_4 hydrogel electrolyte. The assembled supercapacitor exhibited high energy density of 52.2 μWh/cm^2 at the power density of 250 μWh/cm^2. The sensor was designed based on the $CPH_{PA/SA}$ hydrogel, which can detect the tiny signals related to human body with low distortion. This study provides a new direction for the preparation of novel energy storage and wearable smart sensors and human health monitoring devices with flexible hydrogel electrode materials.
Keywords: polyaniline; co-doping; supercapacitors; electrochemical properties; sensor

High energy density nanocomposite materials based on ultrafine ferroelectric nanoparticles

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Abstract: High energy density nanocomposite materials are highly required in pulsed-power electronic devices. We fabricated flexible nanocomposite materials based on ultrafine ferroelectric nanoparticles. Barium titanate nanoparticles with an average particle size below 10 nm were obtained by a “TEG-sol” method. As the nanoparticles have a high dispersibility and very large specific surface area, the filling

fraction can be very high in the nanocomposite. Moreover, the modified nanocomposite still has high mechanical properties as well as excellent dielectric properties. And the energy density of the nanocomposite can be significantly improved. This method provides an ideal filler material for functional nanocomposite materials.
Keywords: barium titanate; ferroelectric; nanocomposite; nanoparticles; energy density

Exploring the mechanism on cyclic stability in carbon anode materials for ion batteries

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Abstract: Carbon materials have attracted extensive attention for ion battery anode because of the merits of their low cost, high electric conductivity, and thermal and chemical stability, *etc*. By tuning the particle size, morphology, surface area and porosity, some carbon anodes exhibit capacities above the theoretical value predicted based on hybrid ion storage mechanisms of insertion and adsorption. However, in most cases, it is hard to simultaneously maintain the high specific reversible capacity and cyclic stability. In addition, in contrast to conventional observations of loss upon cycling, capacity increases are sometimes observed, especially when porous carbons are used as lithium-ion battery anode. Here, we will introduce our current understanding of the mechanism on cyclic stability in carbon-based anodes for ion batteries. We will also discuss how the changes in the carbon structure can induce capacity enhancement upon cycling. These works give some insights into the mechanism of reversible ion storage of carbon-based anodes. The mechanism on cyclic stability in carbon anode materials for ion batteries is studied. The capacity fading can be results from the irreversible decomposition of electrolyte and the irreversible trapping of ions within active sites with high adsorption energy. The capacity increase can be ascribed to the stepwise diffusion of ions inside the defect structure. Both capacity fading and capacity increase will harm the cyclic stability of carbon anode. Especially when the carbon anodes are applied in full-cells, the instable performance will result in serious capacity deterioration.
Keywords: carbon; battery; anode

Study on the preparation and Cd^{2+} adsorption properties of polyacrylic acid / bentonite composite

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Abstract: Polyacrylic acid/Bentonite multifunctional composite with three- dimentional network was prepared through aqueous solution polymerization. The properties of the composites were characterized by Fourier transform infrared spectroscopy (FT-IR), scanning electron microscopy (SEM) and X-ray diffraction (XRD). The resulted composite material was applied to remove Cd^{2+} ions in wastewater as adsorbent. The effect of time, the initial pH value and initial concentration of Cd^{2+} solution was examined. The adsorption isotherm as well as the reusability of the composite is evaluated. The results indicated that the saturated adsorption capacities of the composite for Cd^{2+} was found to be 843 $mg \cdot g^{-1}$ under the following condition: contact time 24 h, pH=6, initial Cd^{2+} concentration 450 mg. L^{-1} and amount of adsorbent 100 mg. The adsorption process for Cd^{2+} is in line with Langmuir isotherm model. Compared with other adsorption materials, the composites exhibited good adsorption of Cd^{2+} ions in water and retained 74% of their initial adsorption capacity after six adsorption-desorption cycles. Compared to some reported adsorbents such as activated carbon, the synthesised polyacrylic acid/bentonite adsorbent has a high adsorption capacity for Cd^{2+} and is expected to be a new type of adsorbent material for heavy metal ions in wastewater.
Keywords: acrylic acid; bentonite; characterization; adsorption; cadmium ion

Redox processes on carbon nanomaterial surface proceeding in supercapacitors and Li batteries when potential is applied

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Abstract: Carbon nanomaterials are potential materials for electrodes of supercapacitors and Li-ion batteries due to their unique chemical and physical properties. The main advantages of these materials are mechanical stability, high specific surface area, good electrical conductivity, high thermal stability, chemical inertness, controlled hydrophilicity/hydrophobicity, wide possibility of surface fictionalization,

etc. The basic principle of functioning of carbon nanomaterials in supercapacitors is the formation of a double electric layer on the electrode-electrolyte interface. Also, the surface of the carbon nanostructures can be functionalized or doped with heteroatoms which provide additional redox activity and enhancing the energy storage capability of the material. Reduced graphite oxide is a material with high surface area and aromatic or semi-aromatic network and can be decorated with oxygen-containing functional groups such as hydroxyl (carbinol) (–OH), epoxyl (–C –O –C –), carbonyl (C=O) and carboxyl (–COOH) which demonstrates high activity in electrochemical processes. Also, the quantity of oxygen-containing functional groups provides variation of important material characteristics as conductivity, wettability, and specific surface area. In this work we investigate the influence of thermal and chemical treatment of reduced graphite oxide on its functional composition and electrochemical performance. It is found that carboxyl, carbonyl, hydroxyl and epoxy groups present on the reduced graphite oxide surface, can be controllably modified. Electrochemical measurements over a wide range of pH values of the water buffer electrolytes for supercapacitors or organic electrolyte for Li-ion batteries allow to correlate the peaks in the cyclic voltammogram curves with the redox reactions of oxygen-containing functional groups as a function of applied potential. Also, contribution to capacity and stability parameters of investigated carbon nanomaterials is correlated with its functional composition.
Keywords: Li batteries; supercapacitors; carbon nanomaterials; redox processes; oxygen-containing functional groups

Topic 8: Public Security and Emergency Management

Governance capacity and governance legitimacy - challenges in crisis management

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Abstract: The presentation will first focus on the concepts of governance capacity - the effective organization and use of resources - and governance legitimacy - the trust and support of the executives from the citizens, which is crucial in any policy area. The dynamics between the two factors will be elaborated. Further, the relevance and challenges of these concepts for crisis management will be discussed and examples given from the handling of COVID-19 in China and other countries.
Keywords: governance capacity; governance legitimacy; crisis management; COVID-19; China

New security perspective in a time of global turbulence, fast technological change, and green development imperative

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Abstract: The paper discusses safety and security issues in today's turbulent and fast changing world. The author maintains that while awareness for safety and importance of emergency/crisis management is high, the understanding and preparedness for emergency/crisis management is actually low and inadequate. Using coal mine safety and other examples, the author shows that in today's high tech and turbulent world, the crisis situations caused by humans could be more hazardous than the natural crisis. We actually face bigger problems than we thought. New perspectives and broader-based crisis awareness and management practices need to be in place to help us prevent and properly respond to crisis situations to ensure safety and sustainable development.
Keywords: crisis management; coal mine; public management; sustainable development; carbon emission

Paradox theory and crisis management: The case of COVID-19 pandemic control in China

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Abstract: Paradox theory deals with paradoxical situations in which two or more mutually contradicting problems are handled simultaneously. In this study, we use the theory or paradox to explore crisis management. Specifically, we use the case of COVID-19 pandemic control in China to explore the implications of paradox theory for crisis management. Our study suggests that it is of importance to treat crises as paradox and develop doable approaches to simultaneously purpose seemly conflicting goals.
Keywords: paradox theory; crisis management; COVID-19; pandemic control; China

Accident cause mechanism and dual prevention theory based on hazard and hidden danger

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Abstract: In order to effectively implement the construction of dual prevention system of risk and hidden danger, aiming at the problems of unclear concepts and management interface among hazard, risk, and hidden danger in the process of system construction, this paper discusses the relationship among hazard, risk, and hidden danger in safety production, puts forward the accident-causing mechanism model based on hazard and hidden danger, and then constructs the theoretical model of double prevention of risk and hidden danger which includes the risk classification control and hidden danger screening and elimination, and clarify the control content of each node of the model. The results show that the accident-causing mechanism model based on hazard and hidden danger reveals the causal chain from hazard to hidden danger to accidents, the theoretical model of dual prevention mechanism of risk and hidden danger constructed around the nodes of the causal chain conforms to China's situation and defines the positions of the two gateways (managing risk and treating hidden danger) in the dual prevention mechanism, which provides theoretical support for the launch of dual prevention system of risk and hidden danger.
Keywords: safety production; hazard; dual prevention; risk control; hidden danger

Identification of critical factors of urban resilience under public health events based on the ism model and a complex network: A case study of Jiangsu Province in China

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Abstract: Public health events have a massive impact on the safety of people's lives and the sustainable development of cities. It is helpful for planning and constructing resilient cities to clarify the action paths among the influencing elements of urban resilience and identify the critical factors. To address this gap, the primary goal of this research is to take Jiangsu Province as an example, based on the ISM model and a complex network, to identify the critical factors of urban resilience under public health events. Initially, a meta-analysis of the relevant literature was conducted to separate 23 influencing elements of urban resilience under public health events into six categories. Furthermore, the urban panel data of Jiangsu Province from 2000 to 2019 were selected as the original data. A complex network model was developed with the help of the mutual influence relationships among the influencing elements, and an explanatory structure model was applied to draw the hierarchical directed graph of the network. Thus, three action paths with direct, indirect, and fundamental effects on urban resilience and the hierarchy importance identification division were obtained. Finally, this paper identified the critical factors of urban resilience from two aspects of node-local and network global, including economic resilience, emergency communication capabilities, and government investment in disaster response. These critical factors can provide strategic support for cities to respond to public health events and effectively enhance urban resilience.
Keywords: urban resilience; critical factors; meta-analysis; ISM model; complex network

Risk identification and dynamic control of municipal artificial ground freezing construction

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Abstract: The artificial ground freezing (AGF) method is an advanced construction technology in line with green building and sustainable development. It has been more and more widely used in municipal engineering with the rapid development of urban construction in China. However, with the increase in the scale and quantity of AGF projects, engineering accidents have also shown an increasing trend in recent years. The research which based on the case investigation of accidents in recent decades and the latest modern risk management and control theory in China systematic identification of risk sources in AGF projects from the five aspects of worker, equipment, method, environment, and management. Finally, it established a dynamic risk assessment method that considers the freezing pipe quality, the seepage velocity, and the freezing effect before excavation. In the end, based on the new method, the risk source identification and dynamic risk assessment about the cross-passage freezing project in Beijing were carried out, and the evaluation results could better reflect the actual situation.
Keywords: artificial ground freezing; dynamic risk assessment; risk identification; cross-passage

Mechanisms to promote farmers' participation in land rental activities: Evidence from tangible versus invisible markets

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Abstract: The development of land rental markets is vital in optimizing the allocation of rural land resources and improving agricultural production and farmers' income. How to improve the government's ability of land transfer management is of great significance to the reform of public management and the utilization and protection of cultivated land. China has an imperfect land rental market with high transaction costs. This study focuses on the impact of invisible and tangible markets such as price, supply, and demand, and intermediary organizations on rural households' decisions to rent in or rent out land and compares which market mechanisms are more important in the current development of the land rental market. Adopting nationally representative farm and village survey datasets and the Box-Cox double-hurdle model, we find that tangible markets represented by intermediary organizations established at the grassroots level play a greater role than invisible markets in improving the probability that farm households will rent in or rent out land and in increasing the amount of land rented. The intermediary organizations have increased the ratio of land area transferred to total area at the village level. The supply side of the land rental market represented by the village-level land transfer rate has affected significantly the probability of a decision to rent in land and the amount of land rented out. However, the price mechanism represented by a village's average land rent failed to guide the flow of land resources. We put forward policy implications for how government and market intermediaries can promote China's land rental markets and for how to better perform price mechanisms.
Keywords: land rental market; land renting participation; market mechanism

Exploring 'ritualized institutions': Public health emergency plans in China's rural communities

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Abstract: Public health emergency plans reflect the strong determination of the Chinese government to prevent, control, and eliminate the hazards of public health emergencies, to protect and promote public health, and to lay a solid foundation for effective epidemic prevention and control. Based on Smith's policy implementation process theory, we have conducted a field study in 44 townships from 22 provinces across China. We find that rural communities, as the main battlefields for epidemic prevention and control, face the problem of ritualization of public health emergency plans, resulting in a state of 'substantial system ritualization', which, to some extent, only has symbolic or ornamental value. Substantial system ritualization is embodied in functional-failure ritualization, functional-delay ritualization, functional-vacancy ritualization, and functional-devaluation ritualization. In this article, we explore these four forms of ritualization and the reasoning underlying them, contributing new insights and theoretical innovations.
Keywords: rural community; public health emergency; emergency plan; ritualization

The influence of micron-sized soil particles on the settlement-consolidation evolution process of tailings under confined conditions

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Abstract: Fine-grain tailings have a unique soil structure, which leads to a long consolidation time and has an important influence on dam-building technology. However, the formation process of its structure is not clear. Based on micron-scale observation techniques and digital image processing technology, settlement-consolidation macro correlation test of fine-grain tailings is carried out. The effect of micron-sized soil particles on the settlement-consolidation of tailings is studied. The results show that the mineral constituent and content of micron-sized soil particles have influence on the settlement characteristics of tailings slurry. There is a critical fine-grained content for the impact on settlement characteristics. The flocculated structure of fine-grain tailings will constantly change during settlement-consolidation process. This is an important factor affecting the settlement-consolidation properties of fine-grain tailings. A macro-correlation model of settlement-consolidation is proposed. The model is able to describe settling-consolidation evolution of fine-grain tailings from microstructure scale. The research results can lay the foundation for solving the problem of tailings ponds strata formation conditions.
Keywords: fine-grain tailings; sedimentary characteristics; secondary consolidation; particle science; macro-micro correlation

How to measure the safety cognition capability of urban residents-An assessment framework based on cognitive progression theory

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Abstract: The salience of social risks and the incidence of various crises in China have induced widespread concerns among urban residents. Encountering frequent risks places higher demands on the cognition of urban residents. The concept of safety cognition capability is defined within the context of urban residents' daily life, and measurement instruments are developed and tested to lay the foundation for grasping the current safety cognition capability of urban residents and conducting further research. In this paper, the five-dimensional structure of urban residents' safety cognition capability (URSCC) was proposed by using the grounded theory method to sort out the interview transcript of interviews with 30 urban residents, and a total of 38-item URSCC scales in four domains - public health, natural disasters, accidents, and social security - were designed and used for surveys conducted in China. The results show that the scale can be used as a valid tool to measure the URSCC, and it can help city managers to better understand the safety needs of residents, as well as monitor the effectiveness of policy implementation.
Keywords: urban residents; safety cognition capability; conceptual structure; scale development; qualitative analysis

Research on data-driven smart city risk identification mechanism in Jiangsu Province

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Abstract: Jiangsu Province, as a major province with various resources in China, faces a lot of risks while developing its economy and society. Therefore, establishing a timely, effective and accurate risk identification mechanism has become a key issue in preventing urban risks and maintaining urban order. This subject builds an index system on the basis of literature research and Delphi expert consultation method, and based on entropy weight method, evaluates the ability of emergency risk identification in Jiangsu Province from four aspects: planning and preparation, risk identification development, supervision and communication, and improvement. According to the evaluation results, it is concluded that in the risk identification of emergencies in Jiangsu Province, there are problems such as weak awareness of risk identification, poor timeliness and delay, lag in platform construction, in-depth development, and barriers to information sharing. Then, by drawing on the experience of domestic and foreign emergency risk identification capacity building models, the countermeasures and suggestions for building a risk identification mechanism for smart cities in Jiangsu Province are put forward: strengthen the construction of digital government, and promote the development of risk identification; break information barriers and achieve accurate risk identification; strengthen Algorithm correlation, promote the coordination of risk identification; straighten out the algorithm power relationship, promote the technicalization of risk identification operation; build a digital order, strengthen algorithm ethics and algorithm responsibility.
Keywords: smart city; emergencies; risk identification

Perceptional differences in the factors of local acceptance of waste incineration plant

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Abstract: Existing research has documented those public attitudes towards waste incineration plants are determined by various factors, such as risk perception, perceived benefits, and social trust. However, the diversity in perceptions within and among communities hosting waste incineration plants has not been adequately explored. To fill this re-search gap, the present paper employed Q methodology to examine the perceptions of local residents on a waste incineration plant in Xuzhou City in the Jiangsu Province of China. The results revealed four perspectives on waste incineration plants: I do not trust them and I feel besieged by risks; I trust local governments but I am unfairly treated; I am unfairly treated. I attach this place a lot; I possess knowledge of waste incineration and I feel besieged by risks. These perspectives suggest there is space and possible venues to shape local residents' attitudes toward waste incineration plants.
Keywords: locally unwanted land use; local acceptance; waste Incineration plant; Q-methodology; China

Research on undergraduate talent training path of emergency management in colleges and universities based on post competency

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Abstract: Major emergencies pose new challenges to the national governance system and governance capacity. In order to promote the construction of emergency management capacity in China, it is necessary to train emergency management talents. Through literature analysis and case analysis, this study systematically combs the talent training of five colleges and universities that currently offer undergraduate majors in emergency management in China. It is found that there are deficiencies in the training objectives, curriculum and teaching methods of emergency management talents in colleges and universities. Therefore, based on the competency of emergency management posts, It is proposed to formulate talent training objectives that meet the development needs of emergency management, build a curriculum system combining knowledge and practice, and adopt information-based and flexible teaching methods, so as to improve the quality of undergraduate talent training of emergency management in Colleges and universities and promote the high-quality development of emergency management talent team in China, Promote the improvement of China's emergency management level and ability.
Keywords: post competency; emergency management; personnel training; tesching methods; curriculum; training objectives

Explicit implicit governance: The logic and optimization countermeasures of the government's "security creation" behavior

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Abstract: There are more and more evaluations and commendations in government governance. Urban security governance is the central field of national governance. The level of urban security directly affects the well-being of urban residents. The safety committee issued the measures for the evaluation and management of national demonstration cities for safe development, which was introduced into the establishment of demonstration cities for safe development. In order to explain this phenomenon, the paper uses the methods of case study, case analysis and interview to deeply explore the problems. Starting from the five dimensions of government governance space, governance resources, governance structure, governance concept and governance cost, the paper constructs the analysis framework of "implicit governance dominance" as the logic of local government behavior, Explore the gap between the actual implementation of safety governance policies and the expectation of ideal evaluation indicators, find out the reasons for the gap, promote three explicit performance modes: explicit political attention, explicit government performance and explicit financial expenditure, and try to put forward relevant favorable suggestions to promote the steady progress of the establishment of safe development demonstration cities.
Keywords: government governance; safe city creation; government logic

Spatial and temporal intensity of improvement and degradation effects of vegetation cover in the coal mining area of Ordos City

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Abstract: In recent years, vegetation in the arid region of Northwest China has maintained a growing trend. However, the impact of high-intensity mining activities on vegetation changes in this region has received extensive attention. The existing research has rarely revealed the impact of coal mining on the intensity of vegetation changes in mining areas. Therefore, this paper uses Sen+Mann-Kendall trend analysis and piecewise linear regression model to research the spatiotemporal intensity of improvement and degradation effect of vegetation cover in the coal mining area of Ordos City. The results show that: (1) From 1998 to 2019, the mean value of NDVI in the study area generally increased with a rate of 0.0053a, and the overall vegetation coverage improved, accounting for 84.38% of the total area of the study area. The vegetation improvement and degradation phenomenon in the open-pit mining area were obvious, while the vegetation improvement in the underground mining area was obvious, and the degradation phenomenon decreased. (2) The vegetation abrupt change in the study area is dominated by improvement mutation, and the mutation years are mainly 2009, 2010 and 2014. The proportion of the abrupt change in the open-pit mining area and the underground mining area is much larger than that in the non-mining area, and the vegetation-improving abrupt change in the open-pit mining area is the most obvious. (3) After the vegetation-improving abrupt change occurred, the average annual vegetation change rate was better than that of the non-mining area in both underground and open-pit mining, indicating that the vegetation construction in the mining area enhanced the vegetation improvement intensity and weakened the vegetation degradation intensity. (4) The proportion of vegetation-improving abrupt change area in the eastern Ordos coalfield is larger, especially the vegetation-improving abrupt change area of the Jungar coalfield accounts for 46.87% of the total area of the Junger coalfield. (5) During the 20 years from 1998 to 2019 in Ordos, although the overall mining area caused vegetation degradation due to production and construction activities, targeted ecological restoration measures were implemented in different periods, and the effect of vegetation coverage improvement in the open-pit mining area was the strongest, achieved remarkable results. The research results can provide scientific and technological support for the ecological protection and restoration of the territorial space of the Ordos section of the Yellow River in China.
Keywords: vegetation cover; intensity of spatial-temporal change; coal mining area; Sen + Mann-Kendall trend analysis; Piecewise Linear Regression; ecological restoration

Changes and new trends of emergency management policy paradigm-Based on the analysis of policy texts at the central level

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Abstract: Emergency management is an important part of the modernization of the national governance system and governance capacity, and it is also the top priority of dealing with various major risks. Based on the theoretical framework of the policy paradigm, the content analysis method is used to analyze the emergency management policy texts issued by the central level since 1949, and to sort out the discourse system and paradigm change process of emergency management since the founding of New China. It can be seen that emergency management in my country has gone through three stages from passive management to preventive management to standardized management. In these three different stages, policy issues, policy objectives and policy tools also show different characteristics of the times. In the context of a risk society characterized by high uncertainty and complexity, resilience governance has become a new trend in emergency management policies and an objective requirement to consolidate the national emergency management system.
Keywords: emergency management; policy paradigm; resilience governance

Analysis of conflicts in county-level territorial spatial planning: Conflict issues and relationships

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Abstract: County-level spatial planning not only needs to refine and implement the strategic deployment of the upper-level territorial spatial planning, but also clarify the specific arrangements for the development, utilization, protection and restoration of the territorial space at its own level, which leads to conflicts prone to occur. A comprehensive understanding of various conflicts in county-level territorial spatial planning is the key to solving the current difficulties in county-level overall planning. To this end, firstly, a conflict analysis framework for county-level spatial planning is constructed to identify conflict processes, to divide conflict types, and to analyze conflict characteristics from dimensions of stakeholders, planning goals, conflict issues and relationships. Then a case study from two typical counties is carried out and some relevant suggestions are put forward. It is found that county-level spatial planning involves multiple stakeholders and objectives. Conflict issues are mainly on allocation and transfer of spatial development rights and cultivated land protection tasks, which results in the difficult trade-off of food security and regional development for both the city- and county-level governments, as well as the dilemma for city-level government to coordinate the development rights and protection tasks of developing and developed counties. In addition, enterprises and farmers are unable to reach a consensus with the county-level government on the evacuation of inefficient land and the improvement of rural settlements, respectively. The results indicate that counties with different-level development face different conflicts and the coordination mechanism in county-level spatial planning is also imperfect. It is suggested to attach importance to the reasonable expression of all parties' interests, to pay attention to the feasible alternatives to conflict goals, to seek the active compromise of stakeholders, and to emphasize the effective intervention of higher-level third parties.
Keywords: county-level territorial spatial planning; conflict types; conflict issues; stakeholders; planning goals

Research on collaborative governance of online public opinion risk in public health emergencies

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Abstract: As a relatively open and complex dynamic system, the network public opinion risk management system for public health emergencies have presented some signs, such as the inherent limitations of governance subjects and the "anti-functions" they induce, the path dependence of some governance subjects on mandatory tools, and the poor process of risk governance, all of them would increase the possibility of related risks. It was found that the causes lies not only in the energy imbalance of the governance system and the risk of path dependence of governance tools, but also in the fragmentation of the governance process. On the basis of a comprehensive review of risk-inducing systems which includes subject collaboration, tool collaboration, and process collaboration from the perspective of collaborative governance, this study believes that reasonable actions should be taken to improve the level of good governance of modern governance in this field. First of all, the rights and responsibilities fixing of governance entities should be strengthened and the self-organization level of the governance system should be enhanced; Then, the intelligence of the technical tool system should be improved and the collaborative efficiency of the governance system should be toughened up; Next, a collaborative governance network structure model that fits different risk contexts should be chosen; Last but not the least, a three-dimensional mechanism which can safeguard its sound operation should be adopted.
Keywords: online public opinion; public health emergencies; collaborative governance

From survival security to growth security: Rethinking urban security and trends from humanism

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Abstract: Security is the foundation and guarantee of urban development, and a correct understanding of the connotation and status quo is the premise of urban security work. In this paper we will discuss what concerns the security of city, including connotation, the status quo and future priorities that's why we have to embed the theory of Humanism in psychology into the analysis of urban security, it will be useful to help construct a hierarchical model of urban security. The hierarchical model of urban security shows the content of urban security needs to break through the outdated and solidified cognition, including not only the Survival Security of protecting people's life and property in the traditional sense, but also Belonging Security and Growth Security. In the process of smart cities, Survival Security is strengthened, while Belonging Security is violated, and the city is in a state of transition from danger to safety and then into danger. Therefore, the focus of future urban security work is mainly in two aspects. On the one hand, it is necessary to break through the dilemma caused by technical governance and ensure the Belonging

Security; on the other hand, it provides the convenience for Growth Security and promotes the transformation of the public from passive recipients of safety to active providers.
Keywords: urban security; survival security; belonging security; growth security; humanism.

The effects of government effectiveness on citizen satisfaction in public health: Moderating role of government credibility

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Abstract: Much attention has been paid to the effects of government performance, satisfaction, and other determinants on trust in government, a key component of government credibility. Despite their importance in explanations of trust in government in public service, relatively little is known regarding mechanisms through which trust in government influences perception of government effectiveness, a concept used to evaluate the extent to which government performance is effective, and citizen satisfaction in public health, an important part of public service. With the advent of the era of critical citizens, it is important to explore how their development can be fostered, and especially whether their development can be boosted by government credibility. Based on the evolvement of public management theory and practice and examination of the practice of how government effectiveness, citizen satisfaction, and government credibility interact, a people-centered way previous studies rarely adopted is used to measure the key variables. Expanding the measurement of Government effectiveness from macro to micro and analyzing original survey data collected from 31 provincial capital cities in mainland China, this paper examines to what extent, if any, government effectiveness and government credibility matters for citizen satisfaction. The results demonstrate that government effectiveness exerts positive and significant effects on citizen satisfaction and government credibility plays a moderate role in the relationship in public health.
Keywords: government effectiveness; citizen satisfaction; government credibility; public health; structural equation modeling

Land trust credit system study

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Abstract: As an agricultural management method and a new type of social service, land trust meets the current requirements of rural development and is conducive to promoting the realisation of large-scale agricultural operations, promoting agricultural modernisation and solving the real problem of the difficulty of farming in rural areas. However, land trusts also face many problems in their development, and the construction of a land trust credit system affects the development of land trusts. As a social mechanism, a land trust credit system reveals the credit status of participants and is conducive to providing a good environment for land trust market transactions. The aim of this paper is to analyse the problems in the construction of the land trust credit system, analyse its causes, and make suggestions in terms of the various participants in land trust, the improvement of relevant systems, and the informatization of land management, in order to reduce development risks, promote a culture of integrity, and facilitate the development of land trusts.
Keywords: land trusts; credit systems; information technology

Research on the application of big data in real estate registration under the background of inter-provincial general administration

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Abstract: In order to further deepen the reform of “discharge service” and promote the “cross provincial management” of government services, in order to further optimize government services and promote the construction of “Internet plus real estate registration”, this article takes the practice of real estate registration informatization in Peixian, Xuzhou as an example, and interviews relevant personnel. Deeply understand Pei county’s use of big data to fully break through regional barriers, and establish a service cloud platform of “inter provincial office” for real estate registration through information sharing. Provide more efficient, high-quality and convenient real estate registration services for enterprises and the public, and solve the problems of “multi location” and “turn back” of real estate registration. The real estate registration information platform applies for real estate registration in different places (where the applicant is located), online circulation, territorial (where the real estate is located), online payment,

electronic license application, EMS mail service, etc, Realize the "inter provincial office" of real estate registration, comprehensively improve the facilitation level of real estate registration, promote the coordinated development of economic zones and improve the vitality of regional economy.
Keywords: inter provincial communication office; big data; real estate registration; cloud platform

Should nonprofits prioritize self-capacity enhancement or collaboration with public institutions? -Different mediating roles of legitimacy in charitable donation acquisition

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Abstract: During the COVID-19 epidemic, the methods charitable organizations employ in mobilizing resources and address emergent natural and social disasters have become a global issue. We review previous studies that focus on nonprofit resource acquisition, exploring different mediating roles of legitimacy in the acquisition of charitable donations to differentiate the effects and underlying mechanisms of two commonly intertwined nonprofit strategies (i.e. building self-capacity and collaborating with public institutions). A total of 1131 national-sampled individual questionnaire was collected from respondents during the early COVID-19 outbreak, in which results showed that enhancing organizational self-capacity was more effective in attracting donations compared with collaborating with public institutions. The results of mediation analysis provided empirical evidence, showing that regulatory and cognitive legitimacy played positive mediating roles in the relationship between organizational capacity and donation propensity.
Keywords: legitimacy; charitable donation; self-capacity; organizational collaboration

UAV multispectral image for monitoring vegetation community diversity in semi-arid mining area

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Abstract: The long-term persistence of biodiversity is the key to mine ecological restoration. Unmanned Aerial Vehicles (UAVs) offer new opportunities for accurate vegetation assessments, which are needed to adaptively manage the restored mine ecosystem. However, studies on the relationship between UAVs data and biodiversity are limited. We selected the vegetation community in the Manlailiang mining area of Ordos City, Inner Mongolia, in northwestern China, for our study. Here, we used UAVs multispectral images to identify plant types among maximum likelihood, artificial neural network, and support vector machines and compared the data accuracy. And then, we quantified species-level biodiversity by calculating α-diversity indices at the 10m*10m and 30m*30m scales, which consisted of three dimensions: richness, diversity evenness. The results showed that the support vector machine has the highest species classification accuracy among the three classification methods, with overall accuracy and kappa coefficient of 89.38 and 0.87, respectively. The α-diversity indexes were basically consistent with those by the field survey. And 10m*10m-scale data was more accurate than 30m*30m-scale for predicting plant community diversity. Moreover, shrub-dominated planted areas have a low species diversity, and we recommend considering vegetation configuration in restoration projects. Our results demonstrate that a combined approach of UAVs multispectral sensors and ground surveys is an effective method to study plant species and predict the alpha-diversity index in semi-arid mining areas on a fine scale, which can provide guidance for monitoring ecological restoration of mines.
Keywords: unmanned aerial vehicle; multispectral imagery; vegetation identification; biodiversity; Manlailiang mine

Public opinion-based governance: A new perspective on understanding the corrective approach of China's epidemic prevention policy

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Abstract: On the eve of the Spring Festival, the local government's "cascading" epidemic prevention policies have made people "sad for the New Year". In order to avoid the implementation deviations caused

by the flexible implementation of epidemic prevention policies, China has adopted a new and effective approach which is different from the previous hierarchical governance-public opinion-based governance, i.e., changing from institutionalism with hierarchical procedural textual communication to public opinionism with open-ended media textual interaction, and building a communication channel between the central government, local communities and people in their hometowns that can be used in the double-layered space of reality and fiction to force policy implementers to take the initiative to correct deviations. The study finds that the implementation of epidemic prevention policies is marked by elite domination, pressure accumulation, imbalanced feedback, and generalized accountability, and the government's governance capacity is diminished. Based on the real situation, this paper adopts a case study approach to comprehensively explore and propose a “public opinion-based policy correction process model”, and gives feasible suggestions to strengthen the construction of a networked administrative culture of local governments, implement effective feedback of public opinion, and establish a flexible accountability mechanism in light of the deviations in real policy practice so as to improve the epidemic prevention policy. This will provide a possible reference for improving the setting and implementation of epidemic prevention policies.
Keywords: policy implementation deviations; opinion-based governance; cascading

Assessment study on the ecological restoration effect of large coal power bases in the eastern grassland area

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Abstract: Against the backdrop of significant coal resources being identified, the strategic layout of the coal power industry moving north and west has broken the original industrial structure of the eastern grassland region. The construction and operation of large coal power bases has provided reliable energy security for the eastern region, but it has also caused varying degrees of damage to the regional ecological environment, leading to a disruption of the regional carbon stability state. For this reason, effective measures should be taken to develop the coal power industry at the same time. It is particularly important to carry out ecological restoration and protection in parallel with the development of the coal power industry. Based on the system theory, this paper treats the ecology of the coal power base as a unified system, analyzes the interplay of ecological elements, proposes a system restoration framework to improve the ecological restoration effect through an integrated ecological restoration technology system according to the ecological environment characteristics of the coal power base in the eastern grassland region and the requirements of regional carbon emission reduction. Based on the system theory, this paper treats the ecology of coal power bases as a unified system, analyses the interactions of ecological elements, proposes a system restoration framework to improve the ecological restoration effect by integrating ecological restoration technology system according to the ecological environment characteristics of coal power bases in the eastern grassland region and the requirements of regional carbon emission reduction; constructs an evaluation index system for the ecological restoration effect of large coal power bases, and uses modern spatial information technology as a means to objectively evaluate the ecological restoration results of coal power bases by applying the fuzzy comprehensive evaluation method, so as to provide a reliable basis for reasonably delineating the spatial and temporal areas of ecological restoration and management of coal power bases, optimizing the ecological restoration mode and strengthening the control of the ecological restoration process. It promotes the collaborative development of large coal power bases in the eastern grassland region and enhances the ability to guarantee regional energy security.
Keywords: double-carbon; system; ecological restoration; evaluation

Study on the life cycle law of coal mining areas

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Abstract: Due to the objective influence of energy resources endowment, coal has always played a major role in the production and consumption of fossil energy in China. With the large-scale development of coal resources, the resulting socio-economic, ecological and environmental problems are also emerging. In order to maximize the advantages of coal energy resources and solve the problems caused by the development of coal resources in a timely manner, and considering the non-renewable and limited nature of coal resources, this paper uses “3S” technology and scenario analysis methods based on property rights theory and life cycle theory to analyze the whole process of coal resources development and the life cycle stages of coal mining areas. The paper analyzes the life-cycle stages of coal mining areas, and the laws of resources, environment and economic characteristics of coal mining areas in different life-cycle stages, analyzes the mechanism of the evolution of resource property rights in coal mining areas in different life-

cycle stages, and reveals the impact of the evolution of resource property rights on the ecological environment and social economy of mining areas. It also proposes policy recommendations for the synergistic development of resources, environment and economy in different stages of the life cycle of coal mining areas to promote high-quality regional socio-economic development.
Keywords: coal mining area; property rights; life cycle; synergistic development

Impact of urban maintenance and construction investment on the security sense of urban residents' public facilities-Based on the mediating role of residents' trust in government

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Abstract: Urban infrastructure is the "core" of urban development and the hardware support to stimulate the gathering of talents. Whether a city has good infrastructure may affect talents' rational choice of the city under the drive of utility maximization, and the optimization of urban infrastructure has become talents' high-level demands for life, work and social interaction. Therefore, residents' sense of security towards urban public infrastructure and its influencing factors are one of the important indicators of urban governance. Based on "public security database" and "yearbook of Chinese cities" as data sources, this study analyzed the l the government urban maintenance and construction investment and the relationship between urban infrastructure security, the result shows: the urban maintenance and construction inputs significantly positive influence on urban infrastructure, security, and residents of trust to the government has partial mediating role between the two. Based on this conclusion, this paper puts forward some suggestions for optimizing China's urban infrastructure construction and urban governance against the background of China's new cities, such as improving the emergency response mechanism in public places and enhancing government credibility. To renew the management concept of urban public facilities and realize multi-governance; Innovation of public facilities safety education model, improve residents' public safety ability.
Keywords: urban infrastructure; a sense of security; investment in urban maintenance and construction; residents' trust in government; intermediary role

Research on ecological protection and high-quality development of coal mining area in Yellow River basin based on new development concept

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Abstract: Promoting high-quality development of resource-based areas is an important guarantee for safeguarding national resources and energy security. The Yellow River Basin is the main coal resource rich area and the main coal production area in China, as well as an important ecological barrier and economic zone, and plays an important role in the national ecological environment protection and high-quality development. Firstly, based on the background of high-quality development, and aiming at the requirements of ecological protection and high-quality development strategy of the Yellow River Basin, based on five development concepts, this paper systematically puts forward the theoretical analysis framework of "economy society-resource-environment" for ecological protection and high-quality development of the Yellow River basin coal mine area. Then it systematically identifies the economic and social, resource and environmental constraints of ecological protection and high-quality development in the coal mining areas of the Yellow River Basin. Finally, the countermeasures and suggestions for ecological protection and high-quality development of coal mining areas in the Yellow River Basin are put forward from three aspects of economy society, resources and environment.
Keywords: Yellow River Basin; ecological protection; high-quality development

A study on influencing factors of county-level emergency management performance: An analysis based on structural equation

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Abstract: In China's governance structure, county-level administrative units are at the key link linking

urban and rural areas. This special location shapes the unique emergency management mode of the county and determines the generation mechanism of the emergency management performance of the county. Combined with Riggs's administrative ecology theory, this study summarizes the influencing factors of county emergency management performance into normative constraints, human political factors, cooperation political factors and charm political factors. On this basis, this study exploratively combines these four influencing factors with the structural equation model. The results show that the path coefficients between normative constraints, favour politics, cooperation politics, charm politics and emergency management performance are 0.409, 0.087, 0.246, and 0.253, respectively. Normative constraints under modernity have a strong influence on improving county emergency management performance. The traditional favour politics, cooperation politics and charm politics can also coexist with modern factors, and have a positive effect on the county emergency management performance. The discussion held that the county emergency management model is a prismatic model, which is a specific form of emergency management organization operation and power distribution in the current process of accelerated social transformation in China. This model provides a "county sample" for the "governance of China" in the new era in the modernization of emergency management systems and capabilities.
Keywords: county-level emergency management; emergency management performance; prismatic emergency management

Research on the risk of urban integration of migrant workers from the perspective of resilient communities

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Abstract: Building resilient urban integration of migrant workers is an important channel to overcome the vulnerability of the floating population, and resilient communities are beneficial for migrant workers to avoid migration risks. **Objective:** To explore the impact of resilient community construction on the risk of urban integration of migrant workers in a risk society is of great value for promoting new urbanization. **Methods:** Based on the perspective of resilient communities, structural equation modeling was used to analyze how resilient communities affect migrant workers' urban integration risk. **The research results show that:** community physical resilience, community social resilience, community economic resilience, and community political resilience all have a significant impact on the risk of urban integration of migrant workers; community physical resilience can promote the construction of migrant workers' social network, accumulate social capital, and gradually enrich social interactions. Bringing migrant workers' psychological identity to the community and the city; considerable economic level in the community helps lay the economic foundation for migrant workers to become citizens; building an inclusive system can provide conditions for migrant workers to obtain community public services and promote their political level of participation. **Conclusion:** The construction of resilient community is based on the community, with migrant workers as the main body, and builds a resilient urban integration system for migrant workers from physical, social, economic and political aspects, and increases the resilience and risk resistance of migrant workers.
Keywords: resilient communities; migrant workers; city integration risk

Research on resilient governance of grass-roots communities under sudden public events

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Abstract: COVID-19 not only seriously affects the economic and social order of China and even the world, but also seriously threatens people's lives and property. China is facing the problem of insufficient elasticity in the fight against New Coronavirus disease. Based on the contingency theory of 5*1 system, this paper discusses the current situation and problems of resilience governance in communities, and conducts in-depth surveys and interviews with three major regions in North China, central China and East China through questionnaires. The resilience of grass-roots communities was further evaluated by Likert scale and entropy weight method. It is found that there are some problems in the physical, organizational, institutional, technical and psychological aspects of resilience governance of grass-roots communities. For this, this study constructs countermeasures and suggestions to improve the resilience of grass-roots communities based on the "5*1" system contingency theory.
Keywords: "5*1" system contingency theory; community resilience; public health crisis

The triple risks of sudden network public opinion responsive governance and the smart governance strategies-Based on the perspective of communication political economy

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Abstract: There have been three risk patterns of the responsive governance of sudden network public opinions, which are the lag, randomness and the risk of failure to guide the diverse values of society of response management of sudden network public opinions, the "anti-function" risk of the responsive governance system, and the risk of excessive responsiveness. From the perspective of communication political economy, it is found that the above problems is caused by poor communication, value preference, partial failure of the response subject and response behavior system, and the "internalization" and formalized packaging of response governance. In view of the present situation, it is necessary to adopt relevant smart governance strategies such as selecting institutional innovation models that fit different risk contexts, improving the elastic governance efficiency of different risks, building a network structure model that meets the needs of modern online public opinion risk governance, strengthening the basic trust efficiency and cooperation consensus among multiple subjects, reasonably defining the response boundary of normal state and avoiding over-response risks in a pre-technology mode, which will help to continuously improve the modern governance path of risks in this field and explore the way of good governance in line with national conditions for the process of cyber power.
Keywords: responsive governance of sudden network public opinions; "anti-function" risk; the risk of excessive responsiveness; self-organizing; "internalization" of response governance; institution and technology embedded; cooperative governance; smart governance strategies

Examining the interactive coupling relationship between land space development and eco-environment from the perspective of symbiosis: Case study of Henan, China

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Abstract: As a key issue in China's sustainable development, Land space development (LSD) creates increasing pressure on the environment. Thus, a better understanding of the relationship between LSD and the eco-environment is necessary for Chinese policymakers to realize sustainable high-quality development. LSD and eco-environment is closely related and mutually dependent, and the coupling coordination pattern between LSD and eco-environment has a great significance to promote high-quality development and ecological civilization construction in the region. This study highlights the equilibrium between LSD and ecological protection and introduces symbiosis theory to measure the degree of coordinated and symbiotic development in Henan, using data from 2000-2018. The coupling coordination degree model was used to evaluate the coupling coordination relationship of spatial-temporal pattern and development type characteristics. Evaluate results show that there are regional gradient differences in the level of LSD and eco-environment, and the coupling coordination degree of LSD and eco-environment in Henan province was in the bare coordination and verge of imbalance at present. In addition, the symbiosis mechanism between LSD and the eco-environment was discussed. It is proposed that the symmetrical mutualism symbiosis mode is the harmonious state for the development of land space. Moreover, this study was suggested to implement a scientific and high-quality development path of land space, reasonably coordinate the social, economic, and eco-environment of Henan province, then promote regional sustainable development.
Keywords: land space development (LSD); eco-environment; coupling coordination degree; spatiotemporal pattern; symbiosis theory

How to resolve the conflicts of urban functional space: A perspective of urban moderate boundary

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Abstract: Under the background of urban expansion, due to the multi-functional and limited land resources, there are layout conflicts among three types of urban functional space: urban construction space (SUC), grain production space (SGP) and ecological protection space (SEP). Taking Xuzhou City as an example, this paper identifies the characteristics of space conflicts, extracts the urban moderate boundary (UMB) based on the principle of value equilibrium, and uses it as the space boundary to solve the conflicts. The results show that: (1) The space conflicts can be divided into three types: construction-production conflicts, construction-ecological conflicts and production-ecological conflicts, with an area of 17.31, 14.13 and 3.24 km² of each conflicting area respectively. (2) The cultivated land value (also the construction land price) corresponding to the UMB is 941.90 yuan/km². The construction-production conflicts and construction-ecological conflicts within the UMB should be reserved as SUC, those outer part of the boundary should be reserved as SGP and SEP. The production-ecological conflicts should be reserved as SEP according to the principle of ecological priority. (3) After solving the conflicts, the scale of SUC, SGP and SEP are 240.18, 42.56 and 55.35 km² respectively. The new perspective and method proposed in this paper can provide reference for urban planning and urban functional space layout optimization.
Keywords: urban functional space; characteristics of space conflicts; value equilibrium; urban moderate boundary; conflict resolution; Xuzhou city

How does the production-living-ecological functions of land use evolve with rapid urbanization? Evidence from Jiangsu Province, China

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Abstract: The process of urbanization is a reshape of land use functions. Exploring the interaction mechanism between urbanization and production-living-ecological functions of land use (PLEFLU) is particularly important for promoting the synergy of human-land relationship with rapid urbanization. On the premise of constructing theoretical framework, entropy method, mechanical equilibrium model and curve estimation model are specifically considered. The results indicated that: (1) The comprehensive urbanization clearly showed characteristics of “Southern Jiangsu (SJ) > Central Jiangsu (CJ) > Northern Jiangsu (NJ)” from 1997 to 2018, and the dominant type of urbanization has gradually shifted from population urbanization to economic urbanization. (2) The deviation index of PLEFLU was between 0.0055 and 0.2101, and gradually showed the difference characteristics of “SJ >NJ”. The dominant functions in SJ and NJ have changed from living function (LF) and ecological function (EF) to production function (PF) respectively. (3) There was an obvious positive correlation between urbanization and PLEFLU from multiple dimensions, and when the urbanization development levels in SJ and NJ reach 0.5038 and 0.2791 respectively, the PF becomes dominant. This research can provide a quantitative reference and policy decision basis for rationally regulating PLEFLU at different stages of urbanization.
Keywords: urbanization; land use functions; mechanical equilibrium model; interaction mechanism; Jiangsu Province

Coupling coordination measurement and driving mechanism of the Water-Energy-Food in the Yellow River Basin, China

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Abstract: Water, Energy and Food are essential resources for human survival and development. Integrated Water-Energy-Food (W-E-F) coupling coordination measurement is the foundation for effective sustainable management. Taking the Yellow River Basin (YRB) as an example, this study analyzed spatio-temporal characteristics and driving mechanism of W-E-F coupling coordination. Improved coupling coordination degree model, exploratory spatial analysis and multi-scale geo-weighted regression were adopted in this research. The results showed that: i) The evaluation indices of the water, energy and food subsystem showed varying degrees of variability from 2003-2018, with significant spatial

imbalances in each subsystem. ii) The mean value of the CCD for the W-E-F in the YRB from 2003 to 2018 varied less and remained at moderate coordination overall. High and moderate coordination areas have increased, while basic and low areas have decreased and concentrated towards the midstream and upstream. In addition, the spatial clustering phenomenon was significant. And, the hot spots in the basin showed obvious characteristics of two-stage differentiation. iii) The CCD was driven by a combination of natural and socio-economic factors, with large differences in the scales of action for different variables. GPC, AYP, PD and intercept showed significant positive correlations with the CCD, while the PSE and UR presented significant negative correlations. Of particular importance was the GPC, which contributed most to the coupled and coordinated regional development. These findings could provide a reference and basis for promoting high-quality economic development of the basin and enhance the sustainability of the W-E-F system.
Keywords: Water-Energy-Food(W-E-F); spatio-temporal differentiation; coupling coordination degree; driving mechanism; Yellow River Basin

Topic 9: Clean Processing and Conversion of Energy Resources

Development and application of CFD model for multiphase complex flow systems in mineral processing industry

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Abstract: Most of the mineral processing system are very complex, in which gas, liquid and solid co-exist with strong interphase interactions. The systems are intrinsically multi-scale - that is, there are widely separated characteristic length and time scales that are of importance to the behaviour of the system as a whole. With advances in computing speed and parallelization technology, improved software and multiphase algorithms, computational fluid dynamics (CFD) modelling is playing an increasingly important role in design, control and optimization of many industrial processes nowadays. The ability to feasibly model all important scales simultaneously is a technical challenge that increased computing resources alone will not solve. Average approaches are not sufficient for characterizing these structures and related behaviors, while discrete approaches based on very detailed mechanisms are limited to capability and cost of computation. This presentation will discuss the numerical modelling work developed in CSIRO to meet the needs of both fundamental understanding and industrial applications and will be exemplified by several process units including grinding mill, flotation, jigging, hydron-cyclone, coal beneficiation fluidized bed, gas stirred leaching tank, etc.
Keywords: mineral processing; multi-phase flow; computational fluid dynamic

Emission of N and S species during pyrolysis and gasification of low-rank coal in an entrained flow reactor

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Abstract: The information on the trace gases including nitrogen and sulphur species is essential for environmental concerns and downstream utilization of coal-derived syngas. The emission of nitrogen and sulphur species from two low rank coals (Maddingley and Yallourn coal using an entrained flow reactor were investigated under two different atmospheres: pyrolysis and CO_2 gasification. The gaseous nitrogen compounds (HCN and NH_3) and sulphur pollutants (H_2S and COS) during pyrolysis and gasification were measured. The effects of temperature (1000-1400°C), CO_2 concentration (10-40%), and gasification processes (direct and two-step gasification) were assessed under pyrolysis and gasification conditions. It was found that no NH_3 and COS were detected during pyrolysis and gasification of coal. High temperature improved H_2S and HCN emission during coal pyrolysis. High temperature promoted the HCN release during entrained flow gasification, whereas high CO_2 concentration inhibited H_2S and HCN emission. The majority of H_2S and HCN emissions came from the pyrolysis part during two-step gasification. Compared to two-step coal gasification, direct coal gasification released less H_2S and HCN. The results provide important information for the gas cleaning process downstream of entrained flow gasifiers.

Keywords: nitrogen and sulphur species; low-rank coal; entrained flow; pyrolysis; gasification

Social awareness and public acceptance of carbon capture and storage (CCS): Research in Poland

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Abstract: The research is a part of the AGaStor project realized in AGH-UST and University of Stavanger. The aim of the paper is to present social aspects of the developing the CCS technology in Poland described as social awareness (SA) and public acceptance (PA). The main research questions of the CCS PA concentrates on knowledge, acceptance of the technology, risks and benefits, the existence of NIMBY movements (Tcvetkov et al. 2019). The qualitative method of analysis of CCS PA is a survey method. In Poland were realized only local qualitative research (cf.: Brunsting et al. 2013; Kaiser et al. 2014). The study of the small population generally fails to capture significant variables that define attitudes towards CCS. Such variables as territorial distribution of worldviews or the size of localities - in small scale tend to be little differentiated. It produces the gap between the macrolevel analysis of social discourses and focuses oriented very locally. The AGaStor research fills that gap and describes the mezzo-social level of the CCS public acceptance. The randomized sample (N= 695) were made in Zachodniopomorskie region (West-North Poland) in 2021. The main variables which influence CCS PA are: place of living, education, economic situations and general worldview of the respondents. The results shows the correlation between place of living and CCS PA (higher PA in big cities); education with CCS SA (higher declarations of knowledge and SA by well educated people); NIMBY potential in villages and small towns, and the ecological worldview with the CCS PA.
Keywords: carbon capture and storage (CCS); social awareness of CCS; public acceptance of CCS; social research of the public acceptance of new technologies

Experimental on the stability of bubble swarm generated from a jet

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Abstract: Owing to high-turbulent and shear flow, co-current air-water jets can serve as bubble generators to produce fine bubbles efficiently. In the process of bubble generation, the concentration of bubble swarm is detected by the imaging grayscale obtained by a high-speed camera. We report a detailed experimental characterization of the instability of the concentration of bubble swarm at a jet outlet. To suppress this instability, a novel bubble generator, which consist of two or three serial jets with the same geometrical dimension, was investigated. Current study shows that for a certain of liquid Reynolds number, serial jets increase the stability and improve the mono dispersion of bubble size.
Keywords: bubble generation; unsteady flow pattern; ejector design; gas-liquid flow

Developments and applications of sensor-based sorting in mining industry: REE in case

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Abstract: With the rapid development of COLOR, XRF, XRT, laser induction, microwave and other sensor detection technologies, ore sorting technology based on advanced sensors has attracted great attention from well-known mining companies around the world. It is of great and positive significance to protect and reduce carbon in response to climate change. In this paper, by investigating more than a dozen international companies such as Tomra in Norway, Steinert in Germany, IMA Engineering in Finland, as well as Chinese companies such as Good Friends, Meiteng and Honest, it is found that although the current ore pre-concentration is still developing rapidly, it has basically formed a mature industrial chain with principles, methods, technologies, equipment, mine applications and effect evaluation. For some historical and market reasons, the United States and Japan don't have any advantage in the field of ore separation. Meanwhile the Europe and Australia are relatively advanced in technology R&D as well as mining applications. Although Chinese companies started late, they have also developed rapidly. The recent emergence of sensor-based sorting technology for ore enrichment has proved itself effective in rare earth elements (REE) beneficiation. As for REEs, the application and quantitative evaluation of sensor-

based sorting, particularly DEXRT are currently studied in Germany, Vietnam, Brazil, Canada and China. Thanks to the rapid development of artificial intelligence, sensor technology and big data, ore concentration technology based on advanced sensors is bound to usher in rapid development and large applications.
Keywords: sensor-based sorting; mining industry; rare earth elements; XRT; DEXRT

Production of kerosene range Fischer-Tropsch products using multi-component catalysts supported on activated carbon

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Abstract: The effects of different promoters such as Mo, Fe, Cu, and K on iron catalysts supported on activated carbon were investigated. The base case catalyst studied consists of 6 wt% Mo, 16 wt% Fe, 0.8 wt% Cu and 0.9 wt% K. Molybdenum loadings of 0, 3, 6, and 12 wt% were studied along with iron loadings of 0, 8, 16, and 32%, copper loadings of 0, 0.4, 0.8, and 1.6 wt%, and potassium loadings of 0, 0.45, 0.9, and 1.8 wt%. The reactor was operated at 300°C, 300 psig, and 6 Nl/gcat/h. The syngas ratio (H2/CO) of 1.0 is used. All reactions were carried out over a period of 72 hours. The gaseous products data were analyzed using in-line gas chromatography and liquid phases were analyzed using offline gas chromatography. Catalyst activity was measured using BET, XRD and TPR. The addition of Mo increases catalyst stability but lowers CO conversion. The oxygenate production is lowest for 3% and 12% Mo. A decrease in oil production is observed with increase in Mo loading. An increase in Fe loading increase CO conversion and oil production. Changes in the Fe loading do not significantly affect aqueous production. Changes in Cu loading have little effect on all parameters. The absence of K in the catalyst causes a very low conversion while all other K catalysts have comparable CO conversions. Increasing the K loading causes an increase in oil production.
Keywords: Fischer-Tropsch; metal promoters; activated carbon; water gas shift reaction; kerosene; iron

Precise characterization of three-dimensional structure and permeability of coal-based porous media

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Abstract: The porous carbon was prepared by using coal char particles and coal pitch as raw materials, and the porous carbon sample was scanned and tested by using a three-dimensional(3d) X-ray microscopic imaging system to obtain a large number of high-precision two-dimensional (2d) images. The iterative method is used to segment the threshold and realize the 2d pore structure characterization of the porous medium and the 3d reconstruction of the porous medium based on the gray value. The finite element model of the coal-based porous carbon is obtained by repairing and meshing the 3d structure and simulations of water and carbon dioxide infiltration are performed. The results showed that the maximum, minimum and average area porosity of the 2d images of sample1#is 38.15%, 22.37%and 27.96%, respectively. The maximum, minimum and average area porosity of the 2d images of sample 2# is 29.25%, 21.36% and 23.31%, respectively. The volume porosity of sample 1# is 26.02% with 15030 pores, and the minimum, the maximum and the average value equivalent diameter are 9.82μm, 395.61μm and 25.1μm, respectively. Correspondingly, the volume porosity of sample 2# is 23.45% with 27280 pores, and the minimum, the maximum and the average value equivalent diameter are 12.19μm, 414.17μm and 24.44μm, respectively. Through 3D reconstruction from the CT images, the finite element model of sample 1# contains 1169601 tetrahedral meshes, 300263 inner surface triangular meshes, and that of sample 2# contains 2215418 tetrahedral meshes, 630173 inner surface triangles grid, respectively. Consequently, the finite element model which can be directly imported into CFD software and close to the pore structure of real porous carbon is obtained, which avoids the simplification and correction of the heterogeneous porous medium structure in CFD calculation, and helps to obtain more realistic simulation results. The percolation patterns of different media in coal-based porous carbon are generally similar, with local differences. Under the same conditions, the starting pressures of water and carbon dioxide are 3 MPa and 0.5 MPa; the stabilization pressures are 9 MPa and 6 MPa. Gases are more permeable than liquids, and the corresponding starting and stabilization pressures are lower.
Keywords: porous media; 3d reconstruction; finite element model; infiltration simulation

Electrochemical leaching of NdFeB magnets

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Abstract: Methanesulfonic acid (MSA) is a green acid with a remarkably high solubility for metals, making it an interesting leaching agent. Nowadays efficient technology for recovery of critical rare-earth elements (REEs) from permanent magnets scrap is one of the important technological challenges. In this study, chemical and electrochemical leaching of NdFeB magnets was investigated in 0.1–1 mol/L MSA and identified using inductively coupled plasma mass spectroscopy (ICP-MS). NdFeB magnet was extensively characterized before and after leaching using electron (scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDX)) as well as chemical analyses. The influence of MSA concentration on leaching efficiency and morphological properties of the NdFeB magnets surface was discussed. Some incorporation of rare-earth element in the cathodic sediment was also observed. Efficient green hydrometallurgical route of separation of NdFeB magnet including electrochemical leaching with MSA, precipitation of REEs with oxalic acid and recovery of iron as a cathode deposit was proposed. This study provides a new insight on recycling of electronic waste by implementing principles of electrochemical leaching.
Keywords: NdFeB magnets; recycling; leaching; methanesulfonic acid; electrochemistry

Research of collision mechanics model and time-frequency characteristics during multi-stage variable-inclination screening process for clean coal

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Abstract: Equal-thickness screening is a critical part of the mineral processing, recently, multi-stage variable inclination equal-thickness screen (MSVIETS) has been utilized in the mining industry across the world. In this work, model of the collision mechanics between particles and multi-stage variable inclination screen surface was established. The maximum collision force (F_{max}) was found to be closely related to amplitude, frequency, screen surface inclination, and number of stages. The time-frequency response characteristics of multi-stage (3, 4, and 5-STAGE) screen surfaces were studied by the vibration test analysis system. The permeation screen distribution law of grain groups on the screen surface was revealed. The obtained results show the best screening performance can be obtained from the 5-STAGE scheme with a screening efficiency of higher than 95% and total mismatch content of less than 2%. The synergistic mechanism between two of the parameters was revealed by the Box-Behnken response surface methodology (BBRSM). Then the correlation between the screening evaluation index and the multiple parameters was obtained, and the significant order of the parameters influencing the screening evaluation index was: $F_t > f > n$.
Keywords: multi-stage variable inclination; collision mechanics model; time-frequency characteristics; Box-Behnken response surface methodology (BBRSM); parameter co-optimization

Graphite flotation by β-cyclodextrin/kerosene pickering emulsion as a novel collector

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Abstract: Pickering emulsion by using nanoparticles would reduce the amount of emulsifier, and generate environmentally friendly reagents, which can be employed on different processes. However,

there is no published report on the application of Pickering emulsions in mineral beneficiation by flotation separation. Collector emulsification is an effective way to improve flotation performance. β-cyclodextrin is a granular emulsifier that has been widely considered in various investigation. As a comparative investigation, this study explored the application of the β-cyclodextrin/kerosene Pickering emulsion as a collector for the flotation beneficiation of a low grade graphite ore. The response surface design was applied to investigate the influence of the water phase ratio, β-cyclodextrin weight, stirring time, stirring intensity, and the interaction of these factors on the emulsion droplet size and emulsion stability. The β-cyclodextrin weight optimization test showed that the Pickering emulsion reached its optimum flotation performance when the weight of β-cyclodextrin was 0.10 g. Surface analyses (zeta potential and contact angle measurements) indicated that the emulsion is stabilized by vesicles, which are self-assembled by inclusion compounds formed by kerosene and β-cyclodextrin. The developed Pickering emulsion could improve the graphite recovery by 6%.
Keywords: pickering emulsion; kerosene; β-cyclodextrin; graphite; flotation

Properties of bulk micro-nanobubbles prepared by hydrodynamic cavitation: Effects of the preparation time and aeration rate

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Abstract: Bulk micro-nanobubbles (BMNB) have potential advantages in various fields. However, systematic investigation under various parameters remains lacking. In this work, not only the properties of microbubbles were analyzed, but also the characters of nanobubbles. First, the dissolved oxygen concentration of water was determined for various parameters while micro-nanobubbles were being prepared. Then the size and number/concentration of microbubbles and nanobubbles were detected by focused bean reflectance measurement and nanoparticle tracer analysis respectively. Finally, the zeta potential of bulk nanobubbles and surface tension of aqueous solutions containing bulk nanobubbles were determined under a variety of operating settings. The results indicated that the characters of microbubbles (number, particle size) and nanobubbles (concentration, particle size and zeta potential) will be affected by the aeration rates and preparation time. The behavior of two distinct scale bubbles to operational conditions, on the other hand, is quite diverse. Additionally, the surface tension of an aqueous solution containing bulk nanobubbles was lower than that of pure water.
Keywords: Bulk nanobubbles (BNBs); Bulk microbubbles (BMBs); Preparation time; Aeration rate; Dissolved oxygen (DO) content; Bubble concentration and size.

Electrochemical leaching of NdFeB magnets

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Abstract: The unburned carbon (UC) content of fly ash is a vital parameter that governs its use in mortar and concrete. Flotation is an effective methodology for removing the UC contained in fly ash. However, the specific physicochemical properties of the surface of UC make it hydrophilic. In this study, we use a coal tar-based (CTB) collector to remove the UC contained in fly ash by flotation. The adsorption mechanism of CTB collector and diesel on the surface of UC was characterized with Fourier-transform infrared spectroscopy (FTIR), X-ray photoelectron spectroscopy (XPS), scanning electron microscopy-energy dispersive spectrometry (SEM-EDS), induction time tests, and molecular dynamics (MD) simulations. The levels of oxygen-containing functional groups and aromatic ring compounds present in the CTB collector were considerably higher than those in diesel. The intensity of the absorption peaks of the hydrophobic functional groups (-CH_3, -CH_2) on UC surface increased significantly after CTB collector treatment. The XPS results demonstrated that the surface oxygen-containing functional group contents on the untreated UC, diesel-treated UC, and CTB collector-treated UC decreased in that order. The CTB collector significantly enhanced the floatability of the UC particles. The MD indicated that the aromatic compounds (dibenzofuran and naphthalene, etc.) in the CTB collector interacted strongly and adsorbed at deep locations with the UC surface compared to the alkanes (dodecane, etc.). The alkanes are indispensable as the collector in the fly ash flotation process and synergize with aromatic compounds to improve the mobility of water molecules on the UC surface.
Keywords: NdFeB magnets; recycling; leaching; methanesulfonic acid; electrochemistry

Research progress of 1 mm/0.8 mm dry deep flip-flow screening technology

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Abstract: Screening is an important part of mineral processing. A large-scale dry screening method (the 1/0.8 mm classification of linear vibrating flip-flow screen) is proposed, which break through the lower limit of traditional large-scale dry deep screening. When the treatment capacity reached 4.47 t/(h·m²), the screening efficiency reached 70.56%, and the total mismatched material content of the screening machine was 8.55%. Based on this, a combined process of dry-wet two-stage desliming, gravity separation, and flotation for spodumene raw ore is proposed. About theoretical research, the screening probability model of flip-flow screening was established. The screening probability of particles was mainly determined by the average contact-mesh probability and screen-penetrating probability. The particle-size effect of flip-flow screen was clarified. As the lower limit of classification decreases during the screening process, the dominant particle-size fraction becomes more significant. When the composition of the particle-size obeyed a normal distribution and with the increasing dispersion degree, the average particle-size fraction was at a distance from the near-screen particle-size, and the comprehensive separation index was higher.
Keywords: dry deep screening; flip-flow screen; mineral processing technology; screening probability model; particle-size effect; screening effect.

Key technology for efficient screening of moist mine solid waste

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Abstract: For the complex components of moist mine solid waste, the traditional screening method is easy to cause material adhesion and accumulation, uneven loading on the screen surface, resulting in poor overall screening efficiency, which restricts the large-scale comprehensive disposal and utilization of mine solid waste resources. To solve above problems, the following research has been carried out, the segregation and stratification behaviour of the complex granules were elucidated, and the dynamic coupling mechanism of screen body - particles was revealed, then the nonlinear screening probability model of particles was established. A large span non-equilibrium excitation screening method, which increased the transport speed of particles on the screen surface by 5%, was developed. And a rigid-flexible coupling elastic screening method was proposed, where the “hardness-aperture-opening rate” of the screen surface along the material flow direction showed an increasing arrangement, and increasing the service life of the screen surface by 50%, and the screening efficiency is increased by 5%. In addition, the classification-magnetic separation process of gold tailings was proposed to produce tailings sand, dry-mixed mortar and building ceramics. The high-efficiency screening was applied to the classification and dewatering for tailings, which realized the resource utilization of full grain tailings.
Keywords: moist; mine solid waste; comprehensive utilization; large span non-equilibrium excitation screening; rigid-flexible coupling elastic screening

Enhanced fluidization of solid particles in an oscillating acoustic field

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Abstract: The fluidization quality of fine particles can be substantially improved by vibration caused by proper acoustic fields compared with an ordinary fluidized bed. To investigate the effect of acoustic field on hydrodynamic behaviour of solid particles is essential to understand the segregation behavior of fine coal particles (-6mm) with the aid of acoustic field. The effect of sound on the fluidization behaviour, including the variation of the bed pressure drop, the minimum fluidization gas velocity, the motion of bubbles and the bed collapse tests has been investigated under the application of acoustic fields of different intensities (110-130 dB) and frequencies (50-500 Hz). The results obtained show that the pressure drop after full fluidization is reduced due to the change of the particle arrangement structure induced by acoustic field. The fluidization quality of the bed can be enhanced by increasing sound pressure level. Unlike the effect of sound pressure level on fluidization quality, the sound frequency have more complicated influence that is not monotone changing relation, due to an oscillatory motion of both gas molecules and solid particle. The application of an acoustic wave, ensuring the stability of the bed density, can improve the separation performance of a gas-solid separation fluidized bed.
Keywords: acoustic field, fluidization characteristics; frequency; sound pressure level; separation performance.

CFD intensification of coal beneficiation process in gas-solid fluidized beds

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Abstract: Coal beneficiation technology using gas-solid fluidized bed is a hot topic in recent decades, however its proper design and scale-up remains a great challenge due to the very complex gas-solid flow involved. To this end, an Eulerian-Lagrangian-Lagrangian (ELL) model (Zhang et al., Renewable Energy, 2019, 136:193-201) was used to intensify the coal beneficiation process, by systematically studying the effects of particle properties, operation gas velocity, initial bed height, design of gas distributor and the size of fluidized beds. It was found that (i) coal beneficiation process can be improved significantly by using coarser beneficiated coal particles, adopting smaller initial bed height (or shallow fluidized bed) and/or operating at a properly selected gas velocity, all findings indicate that the process intensification can be realized via proper selection of operating conditions; (ii) the design of gas distributor was critical for process intensification and it should be designed properly to achieve as uniformly as possible gas flow; and (iii) there will be no scale-up effect, if uniform gas flow at the inlet can be achieved. Present study demonstrates computational fluid dynamics is a cost-effective tool for process intensification of gas-solid fluidized beds.
Keywords: coal beneficiation; CFD simulation; particles dynamics; scale-up of bed

Machine learning prediction of calorific value for coal based on the hybrid analysis

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Abstract: As one of the most important indicators of coal, calorific value (CV) not only determines the value of coal product, but also has a significant impact on the further processing and utilisation of coal. Traditional methods of obtaining prediction data suffer from a range of problems such as too many input variables, low prediction accuracy of a single analysis method and lack of sensitivity analysis of input variables. In this paper, a novel hybrid analysis was presented to predict the CV of coal. Pearson correlation coefficient (PCC) was used to remove correlations between variables in order to provide a suitable combination of input variables for ML models. The results showed that based on the optimal combination of input variables (ash, Fe, Mg and Na), RF model provided a better regression, better fit and better robustness on the testing set than the other three models when the performance indicators and the number of input variables were considered. In addition, sensitivity analyses of input variables showed the relative importance of individual variables and the way in which each variable affects the output variables. The present work provided novel insights and ideas for understanding the prediction of the CV of coal.
Keywords: machine learning; calorific value; hybrid analysis; Pearson correlation coefficient; sensitivity analysis

Segregation dynamics of particles in granular bed

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Abstract: In this work, the discrete element method was used to study the effects of vibrations and intruder shape on the dimensionless ascending velocity (v_a) of the intruder. The intruder was in prolate shape with aspect ratio varied but its equivalent diameter fixed. It was found that v_a increases and then decreases with the rise of the dimensionless vibration amplitude (A_d) and the dimensionless vibration frequency (f_d), and v_a increases with the decrease of the sphericity of the intruder (Φ). v_a was also found to be linked to the orientation (α) of the intruder since the windward area (A_p) changes accordingly. Moreover, the porosity variation in the vibrated bed and the granular temperature were analyzed, which can be linked to the change of v_a. It was further found that v_a can be uniformly correlated to $A_d \cdot f_d^{0.5}$, while the critical change of the response of v_a to A_d and f_d occurs at Γ=4.83, Γ is the vibration intensity. Based

on these findings, a piecewise equation was proposed to predict v_a as a function of A_d, f_d, and Φ.
Keywords: non-spherical particle; ascending velocity; segregation; discrete element method

Numerical simulation research on particle slip velocity under turbulent flow

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Abstract: In turbulent flotation, the quantitative prediction of particle-bubble collision behavior is a long-standing problem, that restricts the research and development of fine-particle flotation equipment with turbulent mineralization as the core technology. Classical flotation kinetic theoretical models, have shown that the collision probability between particles and bubbles is directly proportional to the particle slip velocity. However, existing slip velocity models cannot accurately predict the slip motion of fine particles in turbulent flows. In this study, numerical simulations are conducted by coupling computational fluid dynamics (CFD) and discrete element methods (DEM) to investigate the effects of the particle shapes, particle densities, and turbulence intensity on the slip velocity of fine particles. Through experimental validation, the reasonability of the numerical simulation of the particle slip velocity in turbulence is proved with a minimum error 13%. In addition, the numerical results show that, although the particle shapes do not have a significant effect on the particle slip velocity, the slip velocity of flat or ellipsoidal particles is slightly higher than that of spherical particles. Moreover, the slip velocity of spherical particles increases with the turbulence intensity and particle density. Finally, a new correlation for the slip velocity is established, which is suitable for Stokes number between 0 and 3.012.
Keywords: turbulence; CFD-DEM; particle slip velocity; flotation dynamics

Optimizing the electrocatalytic performance of coal-based carbon materials

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Abstract: Tapping into the potentialities of coals as valuable resources that can be transformed into state-of-the-art energy-related materials is now a burgeoning and fascinating research area, which accords with the clean utilization of coals. Coals are cost-effective, earth-abundant and high-quality carbon sources with multiple organic macromolecular structures. The key points of preparing high-performance coal-based functional materials lie in activation and functionalization. In this lecture, simple, sustainable and reproducible methodologies are proposed to prepare functional coal-based electrocatalysts in terms of various energy applications. Carbon supports with tailored structures are able to enhance the electrocatalytic performance of electrocatalysts while protecting them during the electrolysis. Among a large array of carbon-based materials, medium/high-rank coals as exemplified by anthracite have naturally robust architectures, which can acquire both high corrosion resistance and high mechanical strength. Our investigations both yield fine details of the rational design of coal-based electrocatalysts and provide cutting-edge insight into the fields of clean utilization of coals that have long brought together energy scientists and engineers.
Keywords: coal; carbon; electrocatalysis; performance.

Topic 10: Resource Development and Utilization of Underground Space

An ultrasonic time-frequency method for evaluating the freezing state and frozen-section thickness of sandstone

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Abstract: Common problems in engineering projects that involve artificial ground freezing include inadequate thickness, strength and continuity of artificial frozen walls. But it is difficult to monitor

artificial frozen walls using only a few thermometer holes in fixed positions or with other existing approaches. Here we report a novel experimental design that investigates changes in ultrasonic properties (P-wave velocity, head-wave amplitude, frequency spectrum) measured during progressive upward freezing compared with those of a falling series of different but spatially uniform temperatures in order to determine the freezing state and frozen-section thickness in 150 mm cubic blocks of Ardingly Sandstone. Water content, porosity and density were estimated during upward freezing to ascertain water migration, porosity and density change at different stages of freezing. The period of the receiving wave increased substantially and coda waves changed from loose to compact during both upward freezing and at different temperatures. The trend of increasing wave velocity can be divided into three stages during a series of falling temperatures: (1) little increase at temperatures above -1 °C, (2) substantial increase between -1 and -5 °C, and (3) slow increase between -5 and -20 °C. During upward freezing, V_p increased more or less uniformly. Head-wave amplitude decreased continually at first, but later increased gradually during upward freezing and during the falling temperature series. The frequency spectrum gradually became more regular and single-peaked as temperature decreased during the latter. In contrast, a multiple-peak frequency spectrum always characterized upward freezing, and, as the cryofront reached the top of the block, the frequency components revealed the evolving cryotic regions. Wave velocity V_p and the centroid frequency f_c were adopted as ultrasonic parameters to evaluate quantitatively the temperature (T) of frozen sandstone. Determination of V_p provides a convenient method to evaluate the freezing state and to calculate the thickness of the frozen section of upward freezing sandstone, with accuracies of 73.37 to 99.23%.
Keywords: frozen sandstone; temperature series; upward freezing; ultrasonic testing; freezing state

Mechanical mechanism analysis of rock breaking after wear of shield disc cutter: Based on Mckyes-Ali model

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Abstract: Full section tunnel boring machine (TBM) is widely used in the construction of city underground space with the characteristics of fast driving speed, safety, and high efficiency. Disc cutter as an important part of cutting rock mass on TBM cutter head, disc cutter directly cuts and breaks rock mass during tunnelling construction, and wear problem of disc cutter is the most common and unavoidable problem during TBM tunnelling construction and the stress characteristics of disk cutter directly determine its service life. In this paper, the wear forms and rules of the disc cutter of shield machine are classified, based on the feedback information of tool wear during the TBM excavation construction of Shenzhen Metro Line 13. Then, based on the tribology theory of metal and rock breaking theory of mining, the mechanical models of rock breaking under different wear conditions and at different stages of disk cutter are established according to Mckyes-Ali model. At the same time, the J-C constitutive model and HJC model after failure are used to solve the nonlinear impact and dynamic response problems of the disc cutter broken rock mass with wear failure, which verifies the accuracy of the theoretical model. Finally, based on the key parameters of TBM driving and geological parameters, and the least square method is used to predict the wear condition of the disc cutter, in combination with the engineering practice the error optimization analysis is carried out and a better prediction result is obtained. This paper provides an important reference for mechanical analysis, cutter head optimization, driving parameter optimization, TBM design, and associated engineering works.
Keywords: disc cutter; cutting rock mass; dynamic response; Mckyes - Ali model; nonlinear analysis

Temporal and spatial distribution characteristics of hydraulic cracks propagation under the true triaxial loading using the direct current method

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Abstract: Hydraulic fracturing (HF) has been widely used in the coal and rock dynamic disasters prevention and control and coalbed methane production in underground coal mines. However, how to effectively and accurately monitor and evaluate the hydraulic cracks propagation process and impact range of HF has not been resolved. Therefore, we established a true triaxial HF direct current (DC)

monitoring experimental system for rocks. And then we conducted the first-ever HF-DC monitoring experiments under true triaxial loading conditions using rock blocks in the world. The response characteristics of the excitation current, apparent resistivity change, and apparent resistivity difference cloud map during the whole process of true triaxial HF are studied. The results show that the excitation current mainly reflects the overall electrical conductivity of the rock. And the apparent resistivity is mainly affected by factors such as the internal hydraulic cracks and the water content of the rock, which can reflect the initiation and propagation process of the hydraulic cracks. The cloud map of the apparent resistivity difference between two survey lines can accurately characterize the propagation process and spatial distribution of hydraulic cracks. According to the analysis of the evolution process of the apparent resistivity difference cloud map at different stages, it is found that hydraulic cracks are more likely to extend to areas with poor rock homogeneity. The formation of new hydraulic cracks will produce diversion phenomena and change the main drainage channels. The spatial network system of hydraulic cracks and their water-bearing status, the water seepage and wetting areas comprehensively affect the range and degree of the apparent resistivity response. As the hydraulic cracks network expands, a strong conductive channel will be formed inside the rock, which will change the conductive properties and patterns of the rock. The DC monitoring data contains a wealth of effective information on hydraulic cracks propagation. By comprehensively using the temporal and spatial evolution of the apparent resistivity difference cloud map and the regional apparent resistivity change curve, the DC monitoring method can accurately characterize the dynamic expansion and spatial shape of hydraulic cracks of rock.

Keywords: hydraulic fracturing; true triaxial loading conditions; direct current monitoring; apparent resistivity; cloud map evolution; hydraulic crack propagation

Seismic-derived discrete fracture networks method to understand the correlation between fluid injection and induced seismicity in faulted geothermal reservoirs

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Abstract: Seismicity induced by fluid injection in faulted geothermal reservoirs have been widely documented worldwide, where the fracture networks play a crucial role in bridging fluid flow and induced seismicity. The use of seismic monitoring data for the inversion of fracture networks remains an active topic of research to understand the correlation between fluid injection and induced seismicity. In this paper, a robust random sample consensus (RANSAC) method integrated with the alpha-Shape model has been developed to construct the discrete fracture networks (DFN) based upon seismic monitoring data. To calibrate the capacity of this method, a series of numerical simulation tests were carried out using Monte Carlo method to generate seismic events in the randomly simulated fracture planes, along with a certain number of noise events outside the fracture planes. Such seismic and noise events were then utilized to inverse the random fracture planes by the robust RANSAC model. To further validate the method, induced seismicity recorded at the Hellisheidi geothermal field in Iceland was fed into the RANSAC model to identify the fracture networks, which spatially correlate well with local fault structures dominating the fluid flow. Based on the seismic-derived DFN abovementioned, the seepage pipe was established by connecting the centroid of each fracture and the centre of the intersection line with another adjacent fracture. In this context, the distribution of head pressure in the DFN was simulated using Darcy's law under the realistic in-site fluid injection locations and behaviours. The results show that this seismic-derived DFN method could be a prevailed proxy to investigate and understand the correlation between fluid injection and induced seismicity in faulted geothermal reservoirs.

Keywords: induced seismicity; fluid injection; discrete fracture network; faulted geothermal reservoirs; RANSAC method

Experimental investigation into the mechanical behaviour of jointed rock using sand powder 3D printing

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Abstract: The presence of joints and other types of discontinuities has a significant effect on the mechanical behaviour of rock, thereby fundamentally influencing the stability of rock excavations. The main challenge associated with the experimental research on jointed rock lies in the difficulty of sample

preparation to represent the influence of discontinuities on the mechanical behaviour of the rock material. In this study, 3D printing is used as tool to examine the mechanical behaviour of rock-like samples made from sand powder. Artificial samples are prepared and tested in laboratory to verify the suitability of sand powder for simulating soft rock. Further 3D printed samples with different joint geometries (dip angle, aperture, and trace length) were tested, and the effect of each joint parameter on the sample macroscopic mechanical behaviour is investigated. As expected, the results show that the dip angle has the strongest effect on uniaxial compressive strength. The dominant failure mechanism tends to switch from tensile to shear failure with the increase of the dip angle. The influence of aperture and trace length on the mechanical behaviour is also determined and linked to the dip angle. Test results were further validated and analyzed with numerical modelling and analytical methods. The results of this study demonstrate the applicability of sand powder 3D printing as a suitable method for the simulation of soft rock mechanical behaviour. The methodology presented in this study could be further extended to other applications in rock mechanics.
Keywords: sand powder 3D printing; soft rock; joint rock mechanics; joint geometric parameters; experimental research

A real-time arrivals picker for microseismic waveforms based on deep learning

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Abstract: Microseismic (MS) monitoring technology is widely applied in early warning of rock-burst. Real-time arrivals picking of MS waveforms with low computational complexity is urgently needed, especially in terms of MS monitoring in smart mine. We constructed a real-time arrivals picking method named Real-Time Picking Network (RTP-Net), which combines the characteristics of recurrent and convolutional neural networks. This model includes three parts: a short-term feature extraction module based on convolution, a long-term feature extraction module based on gated recurrent unit (GRU) and a feature judgment module based on convolution. Considering the characteristics of MS arrival time picking, an improved receiver operating characteristic (ROC) curve is designed to evaluate the performance of RTP-net, which is proved to have good stability. 5-fold cross validation based on simulation data and measured data shows that, compared with Short Term Averaging/Long Term Averaging (STA/LTA), Akaike Information Criterion (AIC) and U-Net methods, RTP-net has higher real-time picking accuracy, which is 91.73% for P-wave and 86.67% for S-wave. Compared with U-Net, the computational complexity of RTP-Net is much lower and the processing time of each sampling point is 0.0621 millisecond, which means RTP-Net may have good application prospects in embedded MS sensors and real-time MS monitoring systems.
Keywords: microseismic; arrival time picking; deep learning; real-time processing

Study on the characteristics of the anchorage body under combined deformation

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Abstract: Under the working condition, the bolt is actually in a complicated state under the combined deformation of “tension, bending, torsion and Shear”. The numerical simulations and physical tests on the deformation mechanical characteristics of Anchorage System is carried out in this paper. Six different sets of experiments on the combination load of rock bolt have been conducted in laboratory. A series of numerical with ANSYS have been conducted to discuss the distribution of stress on different conditions: tension, bending, shearing and other combined patterns. The distributions of the maximum total displacement, axial displacement, stress and strain energy of the bolt under the combined action of tensile, torsion, bending and bending are analyzed. Then, the length and diameter of the bolt are changed, and its influence on the tensile strength of the bolt is analyzed. Last, the model of the anchor body has been established, and the boundary conditions are changed, the effects of the length of resin, the strength of resin, the strength of surrounding rock and the confining pressure on the strength of the anchorage body have been analyzed, and rules have been obtained. The result from these analyses have been compared with the date from the theoretical analyses.
Keywords: rock bolt; anchorage body; combined deformation; mechanical characteristics

Correlation between fluid injection and induced seismicity in faulted geothermal reservoirs: Insights from data-driven analyses and numerical modelling

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Abstract: Seismicity induced by fluid injection in faulted geothermal reservoirs have been reported worldwide. Although it is clear that fluid injection plays a crucial role in triggering fault slip and seismicity, the correlation between fluid injection-induced seismicity and underlying fault structures remains an active topic of research. In this study, induced seismicity recorded surrounding five injection wells at Hellisheidi geothermal field in Iceland over a half-year fluid injection period was first analysed using the k-means clustering model, which identified two clusters associated with the injection wells studied. Based on the clustered seismic events, a statistical approach, using locations of three seismic events to identify one fracture plane, was utilised to identify the dominant fault structures with dip angle and dip azimuth attributes, which spatially correlate well with local fault structures dominating the fluid flow. To be specific, the fluid injection rate and wellhead pressure for the five wells were separately analysed against the seismic-derived fault structure attributes using a rolling time window method, which shows a good correlation between fluid injection and fault structures in both spatial and temporal domains. Such seismic observations and fault structures were then integrated into a numerical reservoir modelling, which was calibrated first by history matching of bottom hole pressure time series at five injection wells. In this modelling, a fracture criticality, which refers to the gradient of critical pore pressure change to trigger seismicity, was proposed to achieve the probabilistic distribution of injection-induced seismicity in both fault and off-fault zones. The results show that relatively high probability of seismic event occurrence was estimated for fault zones around five injection wells, which were consistent with seismically-active areas over the seismic monitoring period. It can be concluded that the integrated analysis of induced seismicity, fault structures and fluid injection in spatial-temporal domains is crucial to understand the correlation between fluid injection and induced seismicity in faulted geothermal reservoirs.
Keywords: induced seismicity; fluid injection; faulted geothermal reservoir; numerical modelling; fracture criticality.

Transformation into museums as the chance of second life for former coal mines in Poland: Social aspects of projects

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Abstract: It is estimated that in contemporary Poland there are 74 mines for coal and other raw materials closed. Among them there are 43 hard coal mines, which, with twenty still operating, is a significant figure. The coal industry residues and post-mine facilities are the real relicts of a bygone industrial era. They are a resource that, in many cases, can be reused for new purposes. Developing industrial tourism offers a chance for a second life for these witnesses of the industrial revolution. The aim of the article is to present selected examples of the second life of mine objects and the social functions that the transformation of these objects brings. The already transformed hard coal mines will be taken into account (e.g., Guido, Adit Luiza, Ignacy, Old Mine in Wałbrzych), but also others - the ones which have successfully changed their purpose and functions - will be mentioned. The study will indicate educational, tourist, revitalizing, promotional, economic and other functions, played both in relation to the facility itself and its social environment, as well as the role of universities, including AGH, in this transformation. The background for the article is a contemporary shift from industrial to information society, where modern, dynamically developing new type of a society tries to save the legacy of its historical predecessor in many ways.
Keywords: transformation; revitalisation; coal mines; information society; social functions

Strong sliding floor heave mechanism and active anti-sliding controlling technology of concrete filled steel tube pile in deep roadway

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Abstract: Floor heave of deep roadway is very common, especially sliding mode floor heave is difficult to control. In this article law of strong large deformation of the track roadway of -850 level the north wing of Yangdong mine was studied. The mechanism of sliding and destroying of the roadway floor was analyzed by numerical simulation method, such as the active anti-sliding controlling floor heave technology of concrete filled steel tube pile and various support density are proposed in roadway floor. The experimental results have shown that high stress field environment, high clay mineral rock, and crack and engineering water accumulation are the main factors that lead to rock easy disintegrating with destruction and large deformation of roadway surrounding rock. The concrete pile of steel pipe has the function of restrain the formation of slip surface and improving the strength of sliding face. When the arrangement of anti-slip pile density was increased, the floor heave of roadway dropped gradually. The depth of the floor heave damage of the roadway was deceased and stabilized under certain support density. Therefore, the force of anti-slide pile was reached from outside to inside, which suggest that the pile support density is higher, the force of pile is lower, and the force of piles in the middle or inside of roadway floor are larger than that of piles on both sides. The results obtained in this work indicate that the floor heave of roadway is effectively controlled, and the roadway ensures normal use of production and transportation. Therefore, the concrete filled steel tube pile is a suitable and promising method to control floor heave.
Keywords: deep roadway; high stress field; sliding mode floor heave; concrete filled steel tube pile; anti-slide

Uncertainty analysis for the heat production from a heterogeneous artificial geothermal reservoir

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Abstract: An artificially stimulated reservoir volume (SRV) is critical to the geothermal energy extraction from natural dry hot rocks with low porosity and low permeability. However, the characterization of SRV shape and permeability distribution is not well solved due to the geological data availability and in-situ weak control of permeability enhancement. For simplicity, most of research papers assume a homogeneous cuboid space domain. This study introduces two new improvements: First, the SRV is constructed based on micro-seismic data. Three SRVs with the same volume but different features are preset and their energy productions are qualitatively compared through numerical simulations. Second, the spatial permeability distribution is scaled into the global certainty induced by artificial permeability enhancement and the local uncertainty in natural randomness. This distribution is introduced into the stochastic simulations on geothermal extraction. Third, a thermal-hydraulic-mechanical (THM) coupling model is developed for the heat production simulation on 500 cases with possible permeability distributions. Finally, the statistical features of energy production uncertainty are evaluated through the simulation results of these 500 cases. It is found that the permeability heterogeneity in SRV domain has a significant impact on heat production. The assumption of cuboid SRV domain will overestimate the energy production from a geothermal system. Ignorance of statistical local uncertainty will make the construction of enhanced geothermal system in low permeability dry hot rock reservoirs face a high-risk adventure with current stimulation technology.
Keywords: enhanced geothermal system; stimulated reservoir volume; permeability heterogeneity; global certainty; local uncertainty; geothermal heat production

Underground workings wet floor heave modelling - the new method

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Abstract: The floor heaving phenomenon occurs during drivage and use of every underground mining working or tunnel. Considerable tunnel convergence and considerable decrease of its dimensions led to the working suspension and additional costs of the partly support removal and a floor dinting. The floor heaving is very often caused by floor rock soaking and its gradual degradation, especially in clayey rock. Then there is a reduction of the floor rock strength and the change of rock mass quality. The paper presents the new modelling method considering waterlogged rock. The modelling was executed in two dimension state of strain for workings in a coal mine. For quantitative assessment of the rock mass parameters and their reduction due to water influence, first the laboratory investigations were carried out. The Young modulus, Poisson ratio and compressive and tensile strength of floor claystones were tested after 3, 6, 12 and 24 hours of submerging rock samples in water. Then, during modelling the mechanical rock parameters in destressed area in a floor was gradually decreased until the damage zone in the floor didn't

change and the rock parameters were the lowest. The efficiency of the method was tested in two coal mines. The final results of numerical calculations differ to the underground measurements no more than 11%. Hence, the developed method can be used successfully in roadways and tunnels.
Keywords: floor heaving; floor heaving modelling; underground measurements; floor rock soaking; underground working stability

Study on mechanical properties and deformation of coal specimens under different confining pressure and strain rate

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Abstract: In order to research the influence of confining pressure and strain rate on the mechanical properties and deformation of coal. The triaxial compression experiments of coal specimens under different strain rate and confining pressure were conducted. In this research, the strength, deformation behaviour and failure mode, etc. of coal specimens were evaluated by experiment. The experimental results show that the strain rate mainly impacts peak and post-peak stages of stress-strain curves. The peak strain increases and then levels off with the confining pressure increase at low strain rate. The peak strain increases with the increase of confining pressure at high strain rate, but the increasing rate tends to be reduced. Peak strength, cohesion and internal friction are positively correlated with strain rate, respectively. And there is significant linear correlation between peak strength and confining pressure. For numerical result, macroscopic cracks appear firstly in pre-peak stage under uniaxial compression and firstly appear in peak stage under triaxial compression. Many fine tensile macroscopic cracks appear with the increase of loading at low strain rate and a wide tensile crack and few fine cracks appear with the increase of loading at high strain rate. The numerical results are consistent with change law of AE signals, AE signals are mainly in the pre-peak stage under uniaxial compression and AE signals are mainly in the peak stage under triaxial compression. The AE signal of coal specimens under low strain rate is more active than that of coal specimens under high strain rate.
Keywords: coal; confining pressure; strain rate; acoustic emission; numerical simulation

The bond stiffness efficiency on the interaction between bolt and the rock

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Abstract: The interaction between bolt and the rock is one the key issue of its proper modelling. The effective bolt instalment depends on the bind/coupling type and its possibility to adhere to the rock in the drilled borehole and to the bolt surface. The paper consists of three sections, it firstly presents the results of laboratory research on three bond types: Fasloc - the bolt resin by DSI Underground, the concrete bond based on C20/25 cement and Verpensin organic mineral glue provide by DSI Underground. The bonds mechanical properties were checked and then pull-out test on bolts installed in the concrete were carried out. Above three bonds were used for the instalment. Their strength and bond stiffness were developed during the investigations. Afterwards, steel particles coupled bolts were tested by pullout tests, the particles were classified by varied diameter. Unlike the bond materials mentioned above, the particles group formed interlocking force which was basically different with the bond force. A set of this test was aimed to discuss the influence of the bond stiffness when a bolt was coupled by discrete elements. Based on the experiment data, numerical models were established to investigate the bond stiffness of the first three bond types, then the numerical model of particles coupled bolts was constructed by PFC to see the differences. The results noticed that the bond stiffness of the first three bond types was mainly depended on cohesion before the slip and interlocking or friction after the slip, whereas for the last coupling type the bond stiffness was mainly depended on mechanical biting before the slip and rotation-dominated dislocation after the slip. The results of this study can deepen our understanding of the interaction between bolt and rock, especially when their mutual mechanical response is transmitted by different types of materials.
Keywords: bond stiffness and bond strength; physical properties of bonds; bolt pull-out test; steel particles coupled bolts; interaction bolt-rock; bolt friction-slip behaviour

Experimental study of acoustic emission multi-parameter information characterizing rock crack development

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Abstract: Monitoring the acoustic emission (AE) signals released during rock fracture process can reflect the crack development and damage in the rock in real time. As that there are few rock damage indicators at present, it is unsuited to in-situ monitoring and early warning. Based on small-scale AE uniaxial compression experiments in the laboratory, through adopted phased AE source location and wave velocity tomography, it was found that the process of crack development and stress evolution in the rock would show discrete stages, and the regional damage and excessive local stress difference in the rock would accelerate failure of the rock. The phasic variation of the AE multi-parameter indicators introduced from the field of seismology can better characterize the four internal stages of the rock crack development (crack compaction-crack elastic deformation-crack expansion-crack propagation"), which is coupled with the internal crack distribution and degree of damage. The acoustic emission activity (AEA) and the acoustic emission fault total area (AEFTA) are positively correlated with AE signal amplitude, number of AE events and release AE energy of micro-fracture, while the AE b value is negatively correlated therewith. Based on this, the AE multi-parameter damage evaluation indicators which are suitable for actual engineering guidance of excavation and support operations can be established. In practical application, a large amount of data gathered on site is needed to correct the precursors of failure, to make the AE monitoring and warning more accurate.
Keywords: crack development; AE multi-parameter indicators; coupling law; monitoring and warning

New approach for determination of dynamic biot's coefficient and skempton's coefficient of sandstone samples from South-West of Poland

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Abstract: In this research, a new approach was used to calculate the values of the dynamic Biot's coefficient and the Skempton's coefficient of sandstone samples taken from a mine located in the south-west part of Poland. To do this, ten sandstone samples were prepared in the laboratory and the corresponding dry mass, wet mass, and porosity were recorded. The samples were then subjected to radial and axial pressure in the acoustic velocity measurement apparatus under undrained conditions. In this case, the dynamic elastic moduli including the bulk modulus and Poisson's ratio were measured. In the subsequent step, the undrained condition was changed to drained condition, and hence, the corresponding dynamic elastic moduli in drained condition were measured. Using poroelastic equations between undrained and drained elastic moduli, the values of the dynamic Biot's coefficient and Skempton's coefficient were calculated. Our findings demonstrate that the measurement of the drained and undrained dynamic bulk modulus and the Poisson's ratio is a fast and efficient approach to determine the values of the dynamic Biot's coefficient and the Skempton's coefficient, which are almost commonly difficult to calculate. The results demonstrate that as the confining pressure increases, the values of Biot's coefficient and Skempton's coefficient decrease. The values of Biot's coefficient and Skempton's coefficient varied in the range of 0.4 to 0.75 for the corresponding change in confining pressure from 0 to 50 MPa.
Keywords: poroelasticity; undrained condition; acoustic velocity measurement; compressional wave; shear wave; elastic moduli

Fracture zoning and discrimination method based on mining degree of overburden failure

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Abstract: Mining fractures in overlying strata is the key factor to achieve water-conservation mining, safe coal mining under water, efficient gas drainage and accurate ecological restoration in mining subsidence areas. In order to accurately clarify the evolution and distribution characteristics of overburden mining fractures, based on the key strata theory and the mining degree of overburden failure, the contact state at the top of the fracture zone in the middle of the goaf is analyzed from non-contact

separation to point surface, line surface and surface to surface contact after the overburden failure reaches the full mining degree, and expounds that the reason for the saddle shape of water conducting fracture zone is the same as the formation mechanism of surface subsidence. The overburden failure characteristics are analyzed by similar simulation, and it is pointed out that the permanent mining fractures are mainly concentrated in the overburden structure at the boundary of the working face. Meanwhile, the shear deformation test of hard rock (sandstone) in overburden fracture zone shows that rock damage is positively correlated with the shear stress, and the maximum subsidence deflection of rock layer under corresponding overburden load is 1% of the thickness of the rock layer when breaking. Combined with the similarity simulation and the deduced formula of maximum deflection under the critical condition of broken rock stratum, the consistency is verified, and the stability condition of overburden structure are analyzed. According to the strata separation rate and mining fracture distribution characteristics, the fracture zone is divided into four horizontal areas (namely original rock fracture area, tensile fracture area, structural void area and void compaction area), and a method for judging the regional range of fracture zone is proposed. The engineering practice is carried out, and the results show that the net gas drainage amount of directional boreholes arranged in the structural fracture area can reach 5.52 m^3/min, which can effectively extract the pressure relief gas in the goaf, and verify the rationality of fracture zoning based on the mining degree of overburden failure.
Keywords: overburden failure; overburden structure; mining fractures; fracture zone; regional distribution

Evaluation of carbon dioxide geological sequestration potential in coal mining area

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Abstract: Coal bases are the concentration areas of coal exploitation and use in China in which the carbon emission sources are concentrated, and carbon emission reduction is challenging. However, the carbon emission sources and geological sequestration sinks typically correlate well with coal bases, providing favorable conditions for clustering carbon capture, utilization, and storage (CCUS). CCUS is the only way for coal bases to achieve near-zero carbon emissions in the future. This study established the constitutive equations of CO_2 sequestration capacity for unexploited deep coal seams, residual coal in producing and abandoned mines, and mined-out areas based on their CO_2 sequestration form, geological background, and coal mining status. Then, the geological sequestration potential of one of the most important coal bases in east China was discussed according to the constitutive equations of CO_2 sequestration capacity by considering matching relationships between sequestration sources (coal-fired power plants) and sinks. The results showed that the coal base has excellent CO_2 geological sequestration potential. The total CO_2 sequestration capacity in coal seams is approximately 0.85 billion tons, including 0.76 billion tons in unexploited deep coal seams, 5.17 million tons in residual coal in producing and abandoned mines, and 82.45 million tons in mined-out areas. The source-sink matching relationships of CO_2 geological sequestration in the coal base provide favorable conditions for CCUS, and the average distance between the CO_2 sequestration sources and target sequestration sinks is only 10 km. The unexploited deep coal seams with buried depths of 1000-1500 m are primary reservoirs for CO_2 geological sequestration in the coal base. In the next 30 years, CO_2-enhanced coal bed methane recovery (ECBM) in unexploited deep coal seams and CO_2 sequestration in mined-out areas should become a special CCUS technology in the coal base due to their great CO_2 geological sequestration potential. CO_2-ECBM and CO_2 sequestration in mined-out areas are also significant for other coal bases in China.
Keywords: deep coal seam; residual coal; mined-out area; geological sequestration potential; source and sink matching; coal base

Effect of permeable and anisotropic coal reservoirs on CO_2-ECBM

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Abstract: Gas driving water can cause staged inhibition on CH_4 production, and reservoir permeability has a critical influence on it. Taking the Shizhuangnan coalbed methane development block in Qinshui Basin as the research background, the impacts of permeability and horizontal anisotropy on CH_4 production and CO_2 sequestration are simulated numerically and then discussed adequately, and the displacement profile in the processes of gas driving water is analyzed. The results show that the reservoirs with low permeability or weak horizontal anisotropy are harmful to enhancing CBM recovery, but beneficial to CO_2 sinking. With the rise of permeability and anisotropy, the hysteresis time and staged inhibition time are observably shortened, and the staged inhibition level is markedly weakened, while the CH_4 output and CO_2 injection volume are significantly increased. However, high permeability and strong anisotropy easily tend to premature CO_2 breakthrough and the producers' shut-off, resulting in cumulative CH_4 production, CO_2 injection, and storage volume lower than expected. Upregulating the limit of CO_2 breakthrough concentration appropriately can effectively ameliorate the situation. Additionally, along the displacement direction, the displacement profile consists of sequential CO_2 enriched zone, CO_2-CH_4 enriched zone, CH_4 enriched zone, H_2O enriched zone. Ultimately, for field projects, the producers in the dominant seepage direction possess more potential of enhanced recovery in the short term, while those in the inferior seepage direction avoid becoming invalid only if a long-time injection measure is taken into the injectors.
Keywords: the staged inhibition; permeability; horizontal anisotropy; dominant seepage direction

Towards sustainability and low carbon: Singapore prospective

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Abstract: Using Singapore as an illustrative example, this presentation intends to throw some lights on how a small country achieves sustainability and low carbon. The plan for Singapore to reduce its energy requirements from traditional sources to other sources such as solar energy and geothermal will be discussed. For the traditional sources, the use of gas is encouraged as it is more environmentally friendly as compared to oil. In addition, Singapore has already built an extensive network of submarine pipelines to facilitate gas supply from the neighboring countries. The recent installation of solar panels in its network of reservoirs will help the development of solar energy. The use of geothermal energy is still in its planning stage and the authority aims to develop a geothermal intensity map to evaluate the potential of sourcing geothermal energy from deep underground. The storage of energy in deep underground and other possible energy sources are also briefly reviewed in this presentation.
Keywords: energy; sustainability; solar; geothermal; gas

Research on geothermal tail water recharge technology of sandstone heat storage in Dezhou City under ecological civilization thought

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Abstract: Since the 18th CPC National Congress, the CPC Central Committee has given high priority to promoting ecological progress and made plans to win the battle against pollution. However, Shandong province is rich in geothermal resources. Based on the analysis of geothermal geology and geothermal water pressure, water temperature and water quality in Dezhou city, this paper focuses on the technical method of geothermal tail water recharge in sandstone heat storage. At the same time, the environmental geological problems caused by the continuous exploitation of geothermal water, such as falling funnel, resource exhaustion, ground subsidence and thermal pollution, are put forward. According to the development and utilization of geothermal resources in Dezhou, the “Dezhou model” of geothermal utilization has been built, a demonstration project of recharging tail water from sandstone heat storage has been established, and suggestions on environmental protection such as strengthening dynamic monitoring of science and technology pipe mines and geothermal Wells have been put forward.
Keywords: geothermal resources; sandstone heat storage; tail water recharge; demonstration project; Dezhou city

Research on support design of jointed rock roadway based on bonded block model and hybrid bolt components in 3DEC

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Abstract: In the process of deep coal mining, when the rock mass near the roadway contains some discontinuities such as joints and faults, how to ensure that the support design of the roadway can meet the stability of such jointed rock mass is very important. This paper mainly uses the numerical simulation method to analyse and study the support performance of jointed rock roadway. In this study, the geological model and support system of jointed rock roadway are simulated by using the bonded block model and mixed anchor member (simulating shear action) in 3DEC software. These models can well invert and understand the instability and failure process of roadway support system in jointed rock mass, and can also evaluate whether the current support system can meet the needs of mining safety production in the future. The simulation results show that the bolt in the original roadway support system is mainly broken and unstable under the high-level shear force of the joint, which leads to the instability and failure of the whole roadway. If the support components with stronger deformation coordination ability and lower yield strength or the support components with lower deformation coordination ability and higher yield strength are used to replace the original support system, the support effect will be significantly improved and the surrounding rock of the roadway will be stable. The research results of this paper have good guiding significance for the support design and optimization of jointed rock roadway under deep similar conditions.
Keywords: jointed rock roadway; bonded block model; hybrid bolt components; support design

Comparison of various rock-physical elastic parameters in surrounding rock classification

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Abstract: Surrounding rock classification is the foundation of tunnel design and construction. At present, BQ coefficient is used to classify surrounding rock in China, but this coefficient requires drilling rocks and measuring them directly, which is costing high, sampling hard and discontinuously. Using elastic wave continuous detection technology can help solve the above problems. In this paper, the elastic parameters of surrounding rock samples were measured by rock physics test, including: elastic wave velocity (P-wave velocity Vp, S-wave velocity Vs, and Vp/Vs ratio), elastic modulus (bulk modulus K, shear modulus μ, lame constant λ, young's modulus E and Poisson's ratio ν), anisotropic coefficients (ε, γ, δ, anisotropy of P-wave velocity Av, anisotropy of quality factor Aq), quality factor Q. Then, through cross-plot analysis between various parameters and BQ, the R^2 values comparison shows that 1) P-wave velocity Vp (R^2=0.70) and quality factor Q (R^2=0.62) are most suitable for surrounding rock classification; 2) S-wave velocity Vs (R^2=0.62), shear modulus μ (R^2=0.59) and Young's modulus E (R^2=0.55) are also suitable; 3) anisotropy parameters are very unsuitable (R^2<0.30); 4) other parameters are not suitable (0.20<R^2<0.38). The results make the elastic wave continuous detection technology more pertinently used in the surrounding rock classification and have a broad application prospect.
Keywords: surrounding rock classification; rock-physics; elastic parameter; quality factor; cross-plot analysis

Mechanical behavior of sandstone specimens saturated in brine: Experimental study and particle mechanics approach

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Abstract: The strength and deformation behavior of reservoir rock saturated in brine is of great interest to scientists and engineers in geological carbon dioxide (CO_2) sequestration in deep saline aquifers. However, the mechanical behavior of brine-saturated sedimentary sandstone under triaxial compression

with respect to different confining pressures has not been fully investigated, in particular in view of the numerical simulation. In this study, experimental study and numerical simulation were carried out on brine-saturated sandstone specimens to explore the mechanical properties, micro-crack or acoustic emission and energy dissipation in sandstone with various salinities of brine. First, laboratory uniaxial compression tests were conducted on brine-saturated sandstone specimens and the enhancement in strength and elastic modulus were observed with increasing brine salinity. The scanning electron microscopy results showed NaCl crystals deposited in the pore space, which provides an evidence of strength and modulus variation of sandstone after brine saturation. Second, micro parameters in PFC3D numerical model were calibrated for each brine salinity condition, and the numerically simulated results were compared with the experimental results. The numrical results agreed well with the triaxial compression test results, indicating the rightness and reasonability of calibrated models. Finally, the entire evolution of number of micro crack, cracking and energy dissipation in the numerical specimen were analyzed in PFC3D.
Keywords: sandstone; brine saturation; strength; micro crack; PFC3D

Mechanical behavior of thermal treated granite under cyclic loading-unloading compression investigated by GBM2D

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Abstract: During the excavation and using process of the High level nuclear waste (HLW) disposal repository, the surrounding rock bear the periodic loading, which has a significant effect on the safe and stable operation of HLW disposal repository. Therefore, GBM2D was adopted to investigate the mechanical behavior of thermal treated granite under triaxial tiered cyclic loading-unloading compression. The results show that the stress-strain curves of granite under cyclic loading are in good agreement with that under monotonic loading at room temperature, but cyclic loading lead to the grain fall off near the macro-crack. The difference of stress-strain between cyclic and monotonic loading is obvious when T = 600℃ under uniaxial compression, which due to that the increase of micro-crack during the loading and unloading process. However, confining pressure can restrain the increase of micro-crack during the unloading process and Felicity effect, and results in the difference of stress-strain curves between cyclic and monotonic loading decreases, but cyclic loading result in the grain crushing near the macro-crack. Due to a lot of thermal cracks were induced by high temperature when T = 600 °C, elastic modulus increases obviously at initial loading stage, and it more sensitive to confining pressure.
Keywords: rock mechanics; granite; cyclic loading-unloading compression; GBM; high temperature

Research on damage model of quasi-brittle rock by considering localization effect

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Abstract: The mesoscopic deformation and failure mechanism of quasi-brittle rock is that the microcracks initiate, develop, and coalesce to form macrocracks, leading to rock materials final failure. Based on the Mohr-Coulomb criterion, an elastoplastic localization damage constitutive model is built by considering the localization damage evolution. The strain hardening and softening behaviors of rock are described by the expansion and contraction of yield surface with the damage evolution as an inner driving variable. The acoustic tensor is taken as the onset condition of localization damage and damage evolution is defined by an exponential damage criterion in the process of rock fracture. The numerical implementation scheme of the model is introduced according to the return mapping algorithms. The validity of the proposed model is proven by comparing the numerical simulation results with the triaxial test data of Beishan granite and fine-grained sandstone. The results indicate that the model can better capture the main nonlinear deformation characteristics of brittle rock in loading condition, and the post-peak strain softening phenomenon is caused by the rapid increase of the localization damage. Therefore, the proposed model can reflect the localization deformation and failure characteristics of quasi-brittle rock. And the related research work can provide a new idea for the theoretical research of deep rock engineering.
Keywords: quasi-brittle rock; Mohr-Coulomb criterion; constitutive model; localization damage; constitutive integral algorithms

Experimental study on rock breaking with conical pick and abrasive water jet gridding pre-cutting combined method

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Abstract: Mechanical excavation is widely used in tunnelling, mining and other aspects. As a primary rock breaking tool, the conical pick mainly undertakes the task of rock breaking. However, when conical pick was used to break medium or high strength rock, there are some problems, such as insufficient rock breaking capacity, too fast pick wear, too high peak cutting resistance and too large average cutting resistance. To measure those problems, this paper proposes to use the abrasive water jet (AWJ) which can cut rock easily to cut gridding kerf on the rock surface, so as to weaken the rock and assist the pick to break the rock. In this paper, the effects of grid geometry, pick position and kerf depth on rock breaking are studied by orthogonal experimental method. Furtherly, the crushing volume of the rock specimen and the conical pick holder stress are measured. It is found that compared with the case without abrasive jet gridding pre-cutting assistance, the crushing volume of the conical pick with abrasive jet gridding pre-cutting assistance is increased by 322.81% on average, and the average equivalent principal stress on the cutter holder is reduced by 19.83%, the maximum stress on the pick tool holder decreased by 31.65% on average. On this foundation, conical pick and AWJ gridding pre-cutting combined method can improve the rock breaking ability of conical pick.
Keywords: conical pick; AWJ; rock breaking; cutting force; cutting stability

Discontinuity analysis of stability in Kalilingseng Kulon Progo ex-mining manganese ore tunnel based on rock mass classification

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Abstract: The Kalilingseng Tunnel is an ex-mining manganese ore mine located in Ngruno Hamlet, Karangsari Village, Pengasih District, Kulon Progo Regency, Yogyakarta Province. Now, the tunnel has been planned to be used as a geotourism where the stability of the tunnel is very important to research. Therefore, this survey was conducted to analyze the discontinuity of the tunnel to simulate in the original Young's modulus value, a decrease of 75% and 50% to the strength factor value and to analyze whether there is an influence of the seismic factor on the displacement and the strength factor. From the results of the rock mass classification investigation by Hoek and Brown's Rock Mass Rating, it was found that the strength factor value based on Finite Element Analysis with non-linier criterion failure was more than 2 where the results were categorized as safe without any support in the tunnel so that it could be used as a geotourism location.
Keywords: tunnel stability; discontinuity; rock mass; geotourism

Concept of an integrated registration approach for underground cavities

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Abstract: The utilization of underground space is currently influenced by far-reaching transformation processes. In addition to mining, new fields of application are being discussed. These include the construction of underground pumped storage power plants (UPSP) and the final disposal of radioactive waste. For this purpose, three-dimensional acquisition methods can play an important role. Apart from the widely discussed use of LiDAR, photogrammetric methods such as structure from motion (SFM) are also a suitable option with many capabilities. Therefore, an integrated registration and evaluation approach for underground cavities based on structure from motion will be presented. The combination of different existing (open source) software libraries for image alignment and processing of complex three-dimensional models is evaluated in detail. Such an approach could provide profound knowledge of underground space for future exploration and monitoring by simultaneously enabling tasks of surveying, monitoring, and specifically visualization. Powerful processing hardware and high-resolution camera sensors thus also enable acquisition in low-light environments. Image-based visualization methods are particularly suitable for ensuring transparency when conducting large-scale underground projects. Increased transparency can also help to obtain and maintain the social license to operate. This aspect is

particularly relevant for highly discussed projects with broad public interest. The presented approach is intended to provide better understanding of ongoing and planned underground activities in general. As a result, the approach can also contribute to the communication of technical issues in the context of current efforts for energy transition.
Keywords: structure from motion; photogrammetry; subsurface spatial planning; underground monitoring; cavity registration; multi-sensor data fusion

The thermo-hydro-mechanical (T-H-M) coupled effect on the macro mechanical response of the granite and its meso-mechanism

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Abstract: The thermo-hydro-mechanical coupling has significant effect on the macro mechanical properties of granite, and understanding the meso mechanism of the macro mechanical response is important for ensuring the safety of the disposal systems. In this study, the varied macro mechanical properties of granite subjected to thermo-hydro-mechanical (T-H-M) coupling were investigated, and the meso mechanism was fundamentally revealed from the evolution of the meso pore characteristics. The saturated granite samples were first subjected to different T-H-M couplings on the mechanical testing system, and the permeability of granites was simultaneously tested under coupled temperature (25-125°C), pore pressure (0-12 MPa) and confining pressure (15 and 20 MPa) conditions. Second, the evolutions of meso pore characteristics, including pore size distribution, pore quantity and pore aperture were studied on the THM-treated granite via NMR test and image processing. Finally, the uniaxial compression tests were conducted to investigate the coupled T-H-M effects on the macro mechanical properties of granites, and the meso mechanism of the varied macro mechanical properties was further analyzed and discussed based on the relationship between macro mechanical responses and meso pore characteristics. Results show that the weakening effect of pore pressure on the uniaxial compressive strength (UCS) appears as the pore pressure increases to 4 MPa, while the strengthening effect of moderate temperature on the UCS is weakened by the application of confining pressure and high pore pressure. The meso mechanisms for the varied macro mechanical properties of the granite subjected to T-H-M coupling can be revealed from the coupled positive and negative contribution of the confining pressure, temperature and pore pressure to the large pore percentage and pore aperture.
Keywords: thermo-hydro-mechanical coupling; NMR test; mechanical properties; meso pore characteristics

Cooperative project (CUMT/RWTH) on an underground pumped storage power plant (UPSP)

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Abstract: With the phasing out of the nuclear and the coal energy, Germany is undertaking its energy transition. The development of renewable energy mainly based on alternative energy (e.g. wind and photovoltaic) increases the need to store energy. A globally proven and commonly used method is *Pumped Storage Hydro Power Stations*. However, they depend on a suitable topography and are constrained by acceptability issues due to the considerable spacial footprint. Therefore, alternative solution such as *Underground Pump Storage Power Plants (UPSP)* have to be further developed. In the Ruhr area, abandoned coal mines with depths up to 1000 m are potential targets for the implementation of a UPSP. Identification of effects and potential impacts on structural stability is crucial before implementing and operating a UPSP. Several international research programs already discussed such possibilities in general. The focus of the DFG-Project by RWTH Aachen and cooperating CUMT partners is to investigate the effects of cyclical filling and emptying of an underground reservoir on the subsurface infrastructure. This interdisciplinary project covers hydrodynamic, aerodynamic, geologic, and hydro-geomechanic aspects. The impacts of relevant processes regarding all these disciplines will be considered in the course of the research project. Exemplary research topics performed by the RWTH research team will be the investigation of wave evolution and propagation in underground reservoirs based on physical experiments in a hydraulic laboratory and geological feasibility considerations for a real focus mine in the Ruhr area. The potential of implementing 3D registration methods and subsequent visualization into a long-term

monitoring system for the structural stability will also be examined. During the course of the project, there will be a constant exchange of information and results between the German and Chinese partners.
Keywords: underground pump storage power plant (UPSP); energy storage; energy transition; cyclical pump processes; subsequent use of abandoned mines; infrastructural long-term stability

Analysis of wear mechanism and prediction of wear quantity of disc hob of shield machine

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Abstract: The shield machine has the characteristics of fast tunneling speed, safety and efficiency, and is widely used in the construction of urban underground space. As an important part of the broken rock mass on the shield machine cutter head, the disc hob directly cuts and breaks the rock mass during the excavation process, so the wear of the hob is the most common and unavoidable difficult problem in the shield machine excavation construction. Based on the feedback information of tool wear during the excavation construction of Shenzhen Urban Rail Transit Line 13, this paper first classifies and counts the wear forms of the shield machine disc hob, and then analyzes the causes of different wear types of the disc hob mechanism. Based on the slip line theory, a prediction model for the normal wear of the disc hob was constructed, and the correctness and applicability of the prediction model were verified by the on-site wear data. Finally, the normal wear and abnormal wear of the hob were successfully reduced by means of tool shape parameter optimization, tunneling parameter optimization and hob reinforcement optimization, and good field benefits were achieved.
Keywords: slip line theory; rock breaking by hob; wear characteristics; uniform wear; prediction model; case validation

Analysis of stability tunnel based on rock mass classification in Kalilingseng Kulon Progo

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Abstract: The Kalilingseng Tunnel is an ex-mining manganese ore mine located in Ngruno Hamlet, Karangsari Village, Pengasih District, Kulon Progo Regency, Yogyakarta Province. Now, the tunnel has been planned to be used as a geotourism where the stability of the tunnel is very important to research. Therefore, this survey was conducted to analyze the discontinuity of the tunnel to simulate in the original Young's modulus value, a decrease of 75% and 50% to the strength factor value and to analyze whether there is an influence of the seismic factor on the displacement and the strength factor. From the results of the rock mass classification investigation by Hoek and Brown's Rock Mass Rating, it was found that the strongest factor value based on Finite Element Analysis with non-linear criterion failure was more than 2 where the results were categorized as safe without any support in the tunnel so that it could be used as a geotourism location.
Keywords: tunnel stability; discontinuity; rock mass; geotourism

In-situ synchrotron CT imaging of fracture network in coal with application to CO_2 sequestration

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Abstract: Anthropogenic energy-related carbon dioxide (CO2) emissions are higher than ever and continue to increase. Injection of CO2 into deep coal seams has great potential to sequester CO2, while simultaneously enhancing coalbed methane recovery (CO2-ECBM). However, one of the main technical barriers in coal seams needs to be resolved: Injecting CO2 reduces coal permeability and well injectivity.

Here, in-situ synchrotron X-ray microtomography coupled with flow experiments was conducted under reservoir conditions, which bridges pore scale observations to core scale behaviours. The dependency of fracture porosity, connectivity and permeability on stress and fluid injection (water, CO2 and N2) was directly observed. We provide the first observational evidence that injecting nitrogen (N2) can reverse much of this lost permeability by reopening fractures that have closed due to coal swelling induced by CO2 adsorption. Our findings support the notion that injecting minimally treated flue gas-a mixture of mainly N2 and CO2-is an attractive alternative for ECBM recovery instead of pure CO2 injection in deep coal seams.
Keywords: CO_2 sequestration; three-dimensional fracture network; X-ray computed tomography

Induced seismicity in deep rock excavation: Implications and challenges

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Abstract: Excavation-induced fault activation has become a major barrier in deep rock excavation. Multiple lines of evidence indicate that shear stress perturbation is one of the main causes of fault activation. However, prediction and control of shear stress perturbation during deep rock excavation remain challenging. Here we combine numerical modelling and machine learning to forecast the evolution of shear stress along pre-existing faults adjacent to the deep tunnel excavation. We simulate the shear stress distributions along the faults with various dip angles and distances to the tunnel under different in-situ stress conditions. We then train three machine learning models with the key factors collected from the numerical models and test the models to show a general trend of shear stress distribution along the faults. Our study demonstrates a better understanding of shear stress perturbation during deep rock excavation and suggests practical methods to control and mitigate the excavation-induced seismic events.
Keywords: underground excavation; fault slip; induced seismicity; numerical simulation; machine learning.

Key technology of rock mechanics experiment with multi strain rate dynamic and static load superposition

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Abstract: The surrounding rock of underground engineering is subjected to the superposition of multi strain rate loads such as in-situ stress static load, far-field stress wave transmission dynamic load, near field strain energy release dynamic load. In order to study the physical and mechanical characteristics of rock under the above complex mechanical environment, the key technology of rock mechanics experiment with multi strain rate dynamic and static load superposition was proposed. This key technology has solved four technical problems such as single-sided superposition of dynamic and static loads with multiple strain rates and rapid compensation of static loads, automatic balanced loading of creep loads, high-frequency cyclic loading of impact loads, integrated control of loading devices and coupling acquisition of multiple information. Thus, multi strain rate dynamic and static loads such as creep load ($< 10^{-5}$ s^{-1}), hydraulic static load ($10^{-5} \sim 10^{-2}$ s^{-1}), pulse dynamic load ($10^{-2} \sim 10^{0}$ s^{-1}) and cyclic impact dynamic load ($10^{0} \sim 10^{2}$ s^{-1}) can be superimposed on one side of the rock; the static load can be compensated quickly in the process of rock collapse and instability to simulated the rapid release process of elastic energy of surrounding rock in elastic zone; the lever can be leveled automatically during the continuous creep of rock to keep the gravity creep load constant. Through the above technology, a multi strain rate dynamic and static superposition rock mechanics experimental system was developed, and the dynamic and static superposition experiment of siltstone was carried out. The experimental results show that the greater the static load stress or the smaller the impact loading frequency, the greater the cumulative damage of rock, the smaller the peak strength, the greater the final strain and the smaller the failure duration. There is a strain rate effect on the damage evolution and peak strength of rock under dynamic and static superposition. The greater the static load, the greater the elastic energy accumulated at the rock crack tip, and the dynamic load enhances the rock brittleness. Therefore, with the increase of static load stress or the decrease of impact frequency, the rock failure form undergoes the transformation of “inclined shear failure-vertical tensile failure-overall burst failure”, and the rock burst position expands from the bottom to the whole.
Keywords: rock mechanics; multi strain rate load; superposition of dynamic and static loads; experimental technique; system development and application

Deformation and failure behavior of transversely isotropic composite rock under different confining pressures

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Abstract: In this research, the strength and deformation behavior of transversely isotropic composite rock-like material, which consists of a hard rock-like material and a weak rock-like material, are first investigated under different confining pressures by using a rock triaxial testing system. The triaxial compression results show that the composite rock-like material shows distinct anisotropy, the strength shows a "U" type variation with respect to the inclination angle, and the apparent friction angle value and cohesion value show dispersion with respect to the inclination angle. With the advance of scientific instrumentation, X-ray computed tomography (CT) scanning has been used as a powerful inspection tool and has been applied to many fields for non-destructive structure and failure analysis. After the compression tests, a Nanotom 160 high-resolution micro-CT was employed to investigate the failure mechanism of transversely isotropic composite rock-like material on the micro-level. The 3D volume renders are in good agreement with the actual surface crack photographs of transversely isotropic composite specimens, which demonstrating that X-ray micro-CT scanning can be used to explore the damage of rock-like material. The internal crack distribution and damage can be clearly observed from the vertical and horizontal cross-section images of 3D volume renders. It further reveals that the failure mode of transversely isotropic composite rock-like specimens is transformed from tensile failure at low inclination angles to shear slippage at medium inclination angles. The impact of confining pressure on the failure mode and crack distribution from the 3D volume renders, which is also discussed, reveals that the mechanical properties of hard and weak rock materials are the key to control the crack distribution with increasing confining pressure.
Keywords: composite rock; X-ray micro-CT; strength anisotropy; failure mode

Acoustic emission (AE) characteristics of rock under the disturbance stress paths

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Abstract: The deformation and failure of rock mass is affected to a great extent by the disturbance stress caused by the excavation activities, especially in the situation of the deep underground. The characteristics of the disturbed rock are the key issue for both academic and engineering fields. In this paper, the red sandstone specimens are employed to conduct a series of disturbance stress path tests by MTS815 Flex Test GT mechanical test system. Meanwhile, the AE signals generated during the tests are recorded by PCI-2 AE system. Then, the AE temporal-spatial distribution is compared under the disturbance stress paths (hydrostatic stress stage, initial loading-unloading stage, and disturbance stage) and the 3 disturbance modes (low disturbance mode mid disturbance mode, and high disturbance mode) to investigate the influence of the different disturbance stress modes on the damage of rock specimens under the confining pressure of 12.5 MPa. During the hydrostatic stress stage, under the 12.5 MPa, it can be found that there are a rapid stage and a moderate stage of AE energy and AE count. During the initial loading-unloading stage, it can be seen that the evolution of AE temporal-spatial distribution is inconspicuous. During the disturbance stage, the evolution of the AE temporal-spatial distribution of the specimens is sensitive to the disturbance modes under the 12.5 MPa. And the damage inside the rock specimens from serious to mild in proper order are: the high disturbance mode, medium disturbance mode, and low disturbance mode.
Keywords: acoustic emission; disturbance stress path; disturbance mode

Topic 11: Green and Low-carbon Technology for Urban and Rural Construction

Circular building and infrastructures: Some reflections of practices in South Australia

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Abstract: Buildings and infrastructure (e.g. roads, bridges, power station, wastewater treatment facilities, etc.) provide necessary functions to the residents of a community and city. The circularity performance of building and infrastructure, and their components will largely affect the sustainable communities and cities. The depletion of natural resources has attracted wide attention globally. The last decades have witnessed the strong push from various stakeholders (e.g. public, government and industry) towards more circular economy than linear economy. The traditional approach of make-use-disposal has attracted significant criticism while a close-loop approach has gained an increasingly level of recognition. As one of the largest consumers of natural resources, buildings and infrastructure have a major role to play in circular economy. A circular economy oriented building and infrastructure plays a significant role in achieving sustainable cities and communities (SDG 11). This presentation will showcase some practices in South Australia that aims to achieve circular buildings and infrastructure.
Keywords: circular economy; building; infrastructure

Advanced façades for end user energy demand reduction: A comprehensive evaluation from the system development to the occupants' perceptions

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Abstract: The building sector is responsible for 36% of global final energy consumption. The energy used in buildings is largely required for creating a thermally and visually comfortable environment for building occupants. Glazed façades play an important role in determining a building's energy performance and are called upon to perform a range of, sometimes conflicting, functions. They are required to i) regulate heat transfer to and from the external environment by solar and long wave radiation, conduction and convection ii) allow transmittance natural daylight to provide interior illumination, reducing the need for supplementary electric lighting and to provide an aesthetic function, both in terms of their influence on building appearance and providing occupants a visual link to the external environment. Improving fenestration energy performance can make a significant contribution to reducing building energy loads. It is reported that optimal glazing design could reduce residential building energy consumption by 10-50% in most climates, while for commercial, institutional and industrial buildings, a properly specified fenestration system could reduce lighting and air-conditioning costs by 10-40%. This project has designed and developed a novel PV integrated smart window (as shown in Fig). The window automatically responds to climatic conditions by varying the balance of solar energy between PV electricity generation and transmission into a building to provide of light and heat. Therefore, renewable electricity can be generated onsite while providing comfortable daylight and passive heat for buildings. The developed window has the potential to significantly reduce building energy loads and meet the building's electricity requirement.
A comprehensive model has been developed to accurately predict the thermal, optical properties and electrical output of the smart window systems, and a workflow developed to yield detailed daylight and energy performance (heating, cooling, lighting and power output) predictions of these systems when applied in buildings. Through this approach, the thermal characteristics of complex fenestration systems are obtained from a validated Computational Fluid Dynamics model, and a ray-tracing technique is used to obtain Bidirectional Scattering Distribution Function (BSDF) data to represent their optical characteristics. In addition, the electrical power output is realised through Sandia tests. These characterises may be used in building simulation software (in this case EnergyPlus) to obtain building heating, cooling, lighting energy and PV power output estimates for a room incorporating smart glazing systems. Detailed visual comfort predictions including useful daylight illuminance, daylight uniformity and glare may also be made, using a complementary optical model run using RADIANCE simulations. Finally, the occupants' visual perception for these smart windows in office environment were investigated through Virtual Reality conditions developed using physically based image techniques.
Keywords: advanced façade; thermal characterisation; optical characterisation

Practice of green urban-rural construction in Jiangsu Province

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Abstract: The report analyzes the road of green urban and rural practice development in Jiangsu since 2008 from setting goals, legislation, standard compilation, design leading, science and technology supporting, demonstration driving and so on. At the same time, for the goal of carbon peak carbon neutrality, combined with the specific situation of Jiangsu, put forward relevant thinking, contribute to Jiangsu plan.
Keywords: urban-rural; green; development; practice

Innovation through tradition: The humanistic design concept and practice approach of continuing regional green architecture

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Abstract: Through an overview review of the origin of the “green and healthy” architectural concept and its development after entering China, this presentation reflects on the importance of regional culture and the role of architects in green and healthy building design. On this basis, firstly, we focus on the re-examination of the construction wisdom of the regional buildings in Suzhou. Secondly, based on the architectural practice led by architects, we attempt to discuss the practice path and design strategy of regional green and healthy buildings. Finally, we point out the long-term significance of the humanistic design concept to the design of regional green and healthy buildings in China.
Keywords: continuity; critical regionalism; green and healthy; Suzhou garden; residential architectural form; design practices

Climate-configuring model of vernacular architecture, an inherent conversion structure between climate, space and energy

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Abstract: Climate adaption and environmental regulation is the basic motivation and process of architectural progressing. There has been accumulated inherent and stable structure in the long-term evolution of vernacular architecture, uncovering the relationship between physical transformation caused by energy flows, and environmental changes resulted from configuration adjustment, which is defined as Climate-configuring Model at this speech. It induces the bio-climatic type of the region, the mutual formation mechanism of space and energy, and the characteristic appearances of local tectonic system. It was the wisdom refined from the local tradition of construction, and need to be approached as an archetype to guide and regulate the valid path of contemporary sustainable design, construction and operation towards a carbon-neutral human habitat.
Keywords: climate-configuring model; vernacular architecture; climate; space; energy

Building sector embodied emissions in China - opportunities and challenges to achieving carbon neutral

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Abstract: China is one of the world's largest construction markets, where approximately 1.5 to 2 billion m2 of new construction is built every year. The massive use of cement and steel as building construction materials makes China one of the world's largest building embodied CO2 emitters. In this paper, we developed a detailed “bottom-up” model to capture the energy use and CO2 emissions of China’s major construction materials: cement, steel, aluminum, and glass. The integrated model considers China’s building sector construction activities and stock turnover of existing buildings and development of new construction to calculate annual building materials demand. The industrial sector model calculates the amount of final energy consumed to produce building materials and takes into account both commercialized and emerging technologies and practices in the areas of energy efficiency improvement,

process change, fuel switching, electrification, and alternative products. The study also modeled the implementation of carbon capture and storage (CCS) technologies, in terms of both energy requirements to operate CCS and CO2 mitigation potential. The research results showed that significant opportunities exist in reducing embodied emissions of building materials. Material efficiency strategies, such as extending building lifetime, increasing prefabrication, improving designs, and increasing reuse and recycling, have the most significant potential in both near-term (before 2030) and long-term (2030-2060). It is found that it is challenging to reduce embodied emissions to be "net-zero", without resorting to other measures, such as large-scale adoption of carbon removal and alternative cement products.
Keywords: buildings; embodied emissions; building material; carbon capture and storage; China; carbon dioxide

Integration technics of structure and insulation on low energy buildings

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Abstract: Along with the promotion of building energy conservation, the requirements of thermal insulation on walls are higher and higher. So the security of thermal insulation has become increasingly prominent. The purpose of integration technique of structure and insulation is to effectively combine the thermal insulation function with the envelope function, in order to get highly efficient insulation, convenient construction, safety and reliability and the same service life as the buildings.
Keywords: thermal insulation; structure; integration; reliability; service life

Practice of new building industrialization in Jiangsu province

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Abstract: Through the background analysis of the development of new-type building industrialization, the report puts forward the necessity of promoting new-type building industrialization in China at present; briefly introduces Jiangsu's practice of promoting new building industrialization from the aspects of promoting mechanism establishment, planning guidance, policy incentive, special fund support, standard system, evaluation system, scientific research support, quality supervision, quality improvement measures and so on ; from the market main body ecology, forecasts building scale, the application of technology system to observe the development of Jiangsu prefabricated building; analyzes the problems in development and brief development trend.
Keywords: new-type construction industrialization; prefabricated building; Jiangsu practice

The green construction practice based on carbon peaking and carbon neutrality goals

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Abstract: The carbon peaking and carbon neutrality goals are related to the sustainable development of the construction industry in the future, and green construction is the best practice for the construction industry to achieve green and low-carbon development. It is a new construction method characterized by "greening, productization, informatization, intensification and industrialization" to realize resource saving, environmental friendliness, efficiency improvement and quality improvement in the whole process of engineering construction. Based on the "double-carbon" strategy, this presentation analyzed the necessity of developing green construction, proposing the implementation path of green construction in the whole industry chain. Combining with project cases, the carbon emission reduction ratios between green construction and traditional mode were compared. The technical measures were expounded in detail for carbon emission reduction of green construction under the carbon peaking and carbon neutrality goals. Moreover, suggestions for promoting green construction were given from the aspects of top level design guidance, technical system, standard improvement, carbon emission management and industrial support.
Keywords: carbon peaking; carbon neutrality; green construction; whole process; whole industry chain

Practice and thinking of assembly decoration based on double carbon goal

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Abstract: In the post-epidemic era, people's demand for intelligent, refined design and quality of green health has greatly increased. Based on the needs of The Times and the requirements and goals of the national construction industry to achieve carbon peak carbon neutrality, assembly decoration design is full of opportunities and challenges. The report elaborated the "new understanding" of assembly and decoration, proposed the overall solution of assembly and decoration based on the top-level design thinking of industrialized products and the principle of "standardization, serialization and performance" of products, and shared the practice cases of integrated application of assembly and decoration.
Keywords: assembly finish; product thinking; carbon dioxide emission; carbon neutrality

Exploration and practice of resilience system for sustainable emergency architecture

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Abstract: According to the UN report, the number of flood disasters worldwide has more than tripled from 1,389 to 3,254 over the past 20 years, accounting for 40% of all disasters and affecting 1.65 million people. The core concepts of sustainable development are a long-term focus, scientific planning, and the pursuit of efficiency, and the highest level of care and support for disaster areas should also be sustainable. Combined with the international system, this research puts forward the framework exploration of post disaster emergency architecture design based on resilient human settlements. The resilient human settlement framework of BBBC is embodied in three levels: structural resilience, spatial resilience and energy resilience. According to the sequential characteristics of post disaster rescue, the response strategy of sustainable emergency architecture design is divided into four stages, including multi-functional disaster relief BAG, modular disaster relief BOX and flexible combination of disaster relief BUILDING. Under the management of intelligent disaster preparedness CLOUD, the three "B" can be flexibly combined according to the disaster relief requirements of different stages. This research aiming to seek better post disaster relief solutions, and enable displaced people to have a warm, comfortable home quickly after a disaster.
Keywords: sustainable emergency architecture; resilient human settlements; solar decathlon; net-zero building design

Towards climate adaptability of buildings: Modeling building envelope with phase change materials

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Abstract: Adapting to local climate is the nature of building. It has great potential to adjust indoor thermal environment by coupling passive solar heating, natural ventilation, and building thermal mass in Northwest China. The possible path is to improve building's thermal stability by integrating PCM. The key point is to simulate building thermal environment with variable physical materials. In present study, heat capacity method, 1-D dimensional finite difference method and successive over-relaxation iteration were adopted. Adaptive mesh generation and optimization of thermal conductivity calculation on interface were conducted. The results agree well with analytical and experimental verification. It has been applicated in demonstration projects.
Keywords: climate adaptability; building envelope; Western China; phase change material; demonstration projects

Artificial intelligence-based detection approach to assist demand-driven heating, ventilation, and air-conditioning (HVAC) systems

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Abstract: The COVID-19 pandemic has recently brought IAQ upfront and will play a crucial role in minimising the transmission of viruses suggesting to increase the outdoor ventilation however, this could create poor temperature and humidity in some buildings, affecting the comfort and health of occupants. This causes unnecessary energy consumption and wastage and compromises the HVAC efficiency. This is further exacerbated when the ventilation system is operated using fixed or static schedules and when spaces are partially occupied or unoccupied for significant periods, leading to unnecessary over-ventilation and -conditioning of spaces. A potential solution is the use of demand-driven or occupant centric control measures, such as demand-controlled ventilation (DCV) which varies the ventilation of a space according to the pollution level or occupancy. The present study investigated the potential of applying a live occupancy detection approach to assist demand-driven heating, ventilation, and air-conditioning (HVAC) systems to ensure adequate indoor thermal conditions and air quality were achieved while reducing unnecessary building energy loads to improve building energy performance. Faster region-based convolutional neural network (RCNN) models were trained to detect the number of people and occupancy activities respectively and deployed to an AI-powered camera. Experimental tests were carried out within the case study room to assess the performance of this approach. The count-based occupancy deep learning profiles were produced during the detection according to the real-time information about the number of people and their activities. To estimate the effect of this approach on indoor air quality and ventilation energy demand, scenario-based modelling of the case study building under four ventilation strategies was carried out via building energy simulation (BES). Results showed that the proposed approach could provide demand-driven ventilation controls based on dynamic changes of occupancy to improve the indoor air quality (IAQ) and address the problem of under or over-estimation of the ventilation energy consumption when using the static or fixed profiles.
Keywords: artificial intelligence; buildings; HVAC; modelling; ventilation

Calculation and assessment of life cycle carbon emissions of buildings for the whole design process

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Abstract: This research, based on the architect's vocabulary and thinking mode, constructed a "design-oriented" calculation method system for building carbon emissions. The prediction and assessment of the impact on the building environment in the process of building design are helpful to highlight the key points of carbon reduction, explore the potential hot spots of emissions reduction, and provide timely feedback to optimize the design, which has important theoretical value and practical significance for promoting the construction of low-carbon buildings.
Keywords: building carbon emissions; design process; conceptual design; scheme design; construction drawing design

Study on optimization of urban carbon emissions peaking path - Taking Dongtou district of Wenzhou as an example

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Abstract: Green and low-carbon development is nowadays the focus of China's development goals. In the context of the carbon peaking and carbon neutrality goals, carbon abatement has increasingly become the focal point of discussion of sustainable development. Cities, as the main source of carbon emissions, play a pivotal role in carbon emission reduction. This study is based on the action plan for carbon emissions peaking of Dongtou District of Wenzhou and the 14th Five-Year Plan. Taking the energy and economic data of Dongtou District as the data source, with referring to municipal and provincial data, the study constructs a practical optimization model of urban carbon emissions peaking path. By finding out the network connection and interactions among the various carbon emission reduction measures in the action plan of Dongtou District, the optimal implementation path in the time series was find out by planning the implementation time of each measure. Two optimization goals were considered: (1) the minimum cost investment of carbon emission reduction of the whole society, and (2) the shortest carbon peak time in the city. Based on Sequential Decision method, this study decomposed the implementation sequence problem of carbon emission reduction measures in Dongtou District in the next decade into independent sub-problems of when each carbon emission reduction measure is implemented. We constrained the sub-problems according to the actual situation, so as to achieve the overall optimal effect.
Keywords: carbon emission reduction; carbon emissions peaking path; sequential decision; optimizing model

From 0 to 1

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Abstract: “From 0 to 1”, the article briefly describes the author's journey in solar energy application research, and based on this, focuses on the research and development process of integrating PVT products with building roofing, which is used in SRF (A team of Shenzhen University School of Architecture and Urban Planning, Royal Melbourne University of Technology, Australia and Fanpower laboratory). The SRF team’s “Pixel House” work participated in the 2021 SDC (Solar Decathlon China) competition and received a lot of attention.
Keywords: energy; environment; photovoltaic; solar thermal

University-led innovations of green and low-carbon residence in solar decathlon China 2021

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Abstract: Solar Decathlon China is a university-led competition that challenges collegiate students to design and build energy-sufficient and low-carbon houses to mitigate climate change, pursue sustainable development, and improve our quality of life. This presentation introduces the major efforts in green and low-carbon residence made by the 15 entry teams of Solar Decathlon China 2021 with participants of over 600 students and faculty from 29 universities across 10 countries, supported by nearly 200 enterprises and organizations. Through innovations in climate responsive design, building-integrated photovoltaics, smart energy management with multi-renewable resources, DC appliances, and batteries, etc., this competition showcases a future low-carbon home life without compromising comfortability, affordability, and resilience. The following accomplishments are achieved. 1) A zero-energy community aiming for carbon neutral and energy self-sufficiency was presented in the competition village in Zhangjiakou, Hebei Province. The energy performance has been monitored for a winter period and is expected to be further substantiated since the beginning of the final competition in the upcoming summer period under more strict operational conditions. 2) Fast construction has been implemented as a competition rule to challenge participating teams to assemble a full-size house within 21 days. The purpose of streamlining the construction process as well as benefiting life cycle carbon reduction is realized. 3) Clean heating and cooling technologies with the expectation of promoting renewable space heating solutions in northern China are explored and demonstrated, acting in response to the national environmental protection policy. 4) As an interdisciplinary and international project, its uniqueness in collaborating with industry, education and research institutes, and international counterparts is deemed as an exemplary reference and is actively contributing to the green workforce development.
Keywords: low-carbon; residence; zero-energy community; clean heating and cooling; green workforce development; solar decathlon

Application of computer vision technologies in collecting HVAC control signals

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Abstract: Human centered design and operation are widely used in smart buildings. In the control loop, computer vision technologies can achieve the purpose of real time monitoring and identifying occupant related information, such as personnel positioning, occupied/unoccupied spaces, hot/cold conditions. In recent years, computer vision/video image processing technologies have been developed rapidly, which paves the way for real time non-contact monitoring. Based on relevant research achievements in the past five to ten years, systematically reviews research results and their robustness (pros and cons) of computer vision/video image processing technologies in identifying occupant’s behavior, catching hot/cold poses, monitoring physiological parameters, etc. Envisages applications in demand-controlled ventilation, individual environment control, and sleep environment monitoring.
Keywords: computer vision; video image processing; occupant behavior; hot/cold poses; physiological parameter; smart building

Starting from "zero" - Practice with the clue of energy efficiency, zero energy and energy plus under carbon peaking and carbon neutrality goals

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Abstract: Based on the research of architecture, energy and power engineering, environmental engineering and civil engineering, the team of CUMT has carried out collaborative design innovation around zero-energy buildings. Through the passive strategy, active technology and the utilization of renewable energy, the design has realized the goal of zero energy consumption of rural residential buildings which has a good prospect of industrialization. The achievements focus on the energy conservation and emission reduction of rural houses under the "carbon peaking and carbon neutrality" goals: The research on the collaborative design of zero energy consumption houses has been carried out to realize the self-sufficiency of building energy consumption by relying on solar photo-voltaic and heat collectors; At the same time, the smart home design concept has been organically integrated to realize the automatic service of residential system and visual control of household equipment; In terms of structural design, modular construction technology is used to provide possibility for large-scale industrialization and rapid construction; In terms of energy collection, landscape cheap heliostat technology and selective passive heat collection technology are organically integrated; In terms of environmental control, bio-degradation technology integrated with landscape is comprehensively used.
Keywords: zero-energy buildings; collaborative design; passive strategies; active technologies

Precise evaluation of light pollution of urban landscape lighting

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Abstract: A boosting nighttime economy in modern metropolis leads to a large scale application of colorful facade display lighting, therefore forming complicated and excessive artificial light at night (ALAN) and causing light pollution. However, there is a lack of quantification metrics regarding to the spectral impacts on eco-environment, especially for scales near the ground. This study conducts a first ground-level hyperspectral imaging (HSI) measurement and quantitative evaluation on luminous building facades from an observer's perspective. Based on the HSI data, the spectral compositions across regions using different lighting types were summarized, in which LEDs covered most of facade lighting types. We further derived the luminance and chromatic distribution maps of the regional facades, and performed a characteristic comparison. We further analyzed the potential biological effects and the features of spectral compositions corresponding to high- or low- impact. Results show that, first, using LEDs has drastically increased both the color gamut and intensity; second, spectra with narrow-band shapes, i.e. RGB LEDs, may well have higher photobiological effects than the others when matching species' sensitive bands; third, chromatic information of lighting is highly correlated with spectral impacts and therefore has potential for characterization. In this study, we clarify the general spectral features in night-time metropolis, and build up an ecological impact-oriented spectral assessment framework in urban lighting. This work provides fresh insights and feasible measures for the administrations in ground-level urban lighting masterplan, and proposes a possible way of real-time ALAN evaluation from redundant spectra. This work may provide references for lighting policy-makers, help relieve energy consumptions and carbon emissions, and decrease light pollutions for metropolis.
Keywords: artificial light at night; spectral quantification; photobiological effect; ecological environment

Refabricated green rural residence based on solar - hydrogen energy system-The participating building of the 2021 Solar Decathlon China

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Abstract: With the proposal of the strategic goal of "carbon peaking and carbon neutrality", building energy conservation and emission reduction has entered a new stage of development. How to further reduce building carbon emissions is an urgent problem to be solved in the architecture field. In the 2021 Solar Decathlon China, we built a near-zero carbon experimental house of about 150 square meters. The house plans to use a solar-hydrogen energy linkage system as an energy supply source, and use hydrogen energy and electric energy as a building energy storage unit. And the heat generated by the electrolysis of water for hydrogen production is stored in the water storage tank, so as to provide domestic hot water for the building and reduce the carbon emission during the operation stage of the building. At the same time,

the building adopts a prefabricated building system to improve the construction speed of the building and improve the recycling rate of the building during the demolition stage, so as to achieve near-zero carbon emissions of the building.
Keywords: severe cold region; rural residence; solar energy; hydrogen energy; near zero carbon

Design and evaluation of solar technology integration for zero carbon buildings

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Abstract: An effective combination of information technology-based design approaches and site-specific renewable energy technology systems is a necessary way to achieve zero-carbon buildings. The design and evaluation of solar technology integration for zero-carbon buildings requires systematic investigation. The focus of the design methodology for solar technology integration is to resolve the contradictory issues arising from the integration of related technologies, provide clear design steps and frameworks, and further revise and improve the design methodology through different goal-oriented evaluation models in the subsequent building operation phase.
Keywords: zero carbon building; solar technology integration; design methodology; multi-scenario evaluation

Carbon emissions of campus buildings based on machine learning

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Abstract: The direct and indirect carbon emissions from the building sector are about 9 GT in 2020 based on the IEA data. The buildings are still off track for carbon neutrality by 2050. Hence, it is important to explore the carbon performance of buildings. The machine learning technique can provide fast and reliable energy analysis of buildings. This research applies the four types of machine learning models (full linear model, multivariate adaptive regression spline, support vector machine, and gradient boosting machine) to create the surrogate building energy models in the campus buildings of Tianjin, China. Then the sensitivity analysis based on these learning models is used to determine the key factors affecting building carbon emissions. The multivariate adaptive regression spline model performs the best in estimating carbon emissions of buildings with the R^2 (coefficient of determination) above 0.99. The equipment heat gains are responsible for over 40% variations of carbon emissions in most of the campus buildings. The following three important variables are heating set-point during unoccupied periods, lighting heat gains, and infiltration rate. These four variables should be carefully checked to reduce the carbon emissions of campus buildings studied in this research.
Keywords: carbon emissions; machine learning; building energy; campus building

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