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Review

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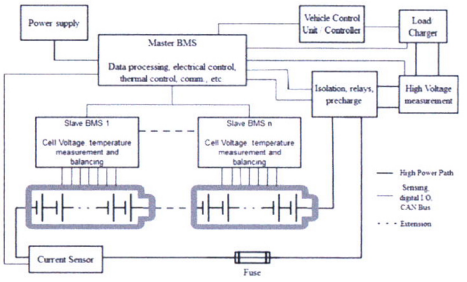
Critical review and functional safety of a battery management system for large-scale lithium-ion battery pack technologies

K. W. See, Guofa Wang, Yong Zhang, Yunpeng Wang, Lingyu Meng, Xinyu Gu, Neng Zhang, K. C. Lim, L. Zhao & Bin Xie

Abstract: The battery management system (BMS) is the main safeguard of a battery system for electric propulsion and machine electrification. It is tasked to ensure reliable and safe operation of battery cells connected to provide high currents at high voltage levels. In addition to effectively monitoring all the electrical parameters of a battery pack system, such as the voltage, current, and temperature, the BMS is also used to improve the battery performance with proper safety measures within the system. With growing acceptance of lithium-ion batteries, major industry sectors such as the automotive, renewable energy, manufacturing, construction, and even some in the mining industry have brought forward the mass transition from fossil fuel dependency to electric powered machinery and redefined the world of energy storage. Hence, the functional safety considerations, which are those relating to automatic protection, in battery management for battery pack technologies are particularly important to ensure that the overall electrical system, regardless of whether it is for electric transportation or stationary energy storage, is in accordance with high standards of safety, reliability, and quality. If the system or product fails to meet functional and other safety requirements on account of faulty design or a sequence of failure events, then the environment, people, and property could be endangered. This paper analyzed the details of BMS for electric transportation and large-scale energy storage systems, particularly in areas concerned with hazardous environment. The analysis covers the aspect of functional safety that applies to BMS and is in accordance with the relevant industrial standards. A comprehensive evaluation of the components, architecture, risk reduction techniques, and failure mode analysis applicable to BMS operation was also presented. The article further provided recommendations on safety design and performance optimization in relation to the overall BMS integration.



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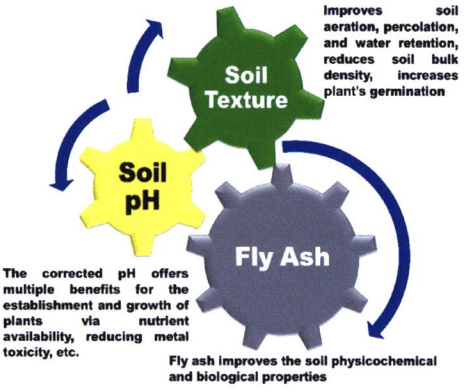
Coal fly ash: an emerging material for water remediation

N. B. Singh, Anupam Agarwal, Anindita De & Pragya Singh

Abstract: Coal fly ash (CFA) is a byproduct of thermal power plant and collected from flue gases by separator. Composition of CFA depends on the type of coal used and it has both crystalline and amorphous character. It is considered to be an environmental pollutant and used in number of areas. CFA is a useful material and widely used in cement production and as a promising adsorbent for water remediation. CFA used for remediation of wastewater solves problems related to water quality issues and waste management. The physical properties such as porosity, surface area, morphology, and chemical composition (iron oxide, alumina, silica, titania, etc.) make CFA efficient material for wastewater treatment. CFA is also converted to geopolymer, which is used as an adsorbent and photocatalyst. Dye, organic compounds, toxic heavy metal ions, etc. have been removed using CFA and modified CFA adsorbents. Different adsorption efficiencies have been reported for different adsorbate and CFA adsorbents. Numbers of adsorption isotherm and kinetic models have been discussed.



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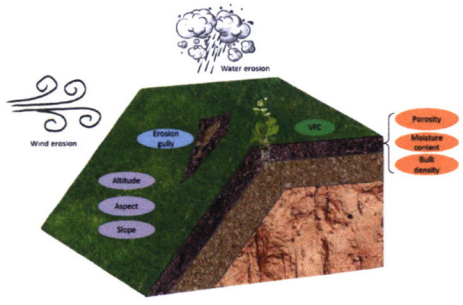

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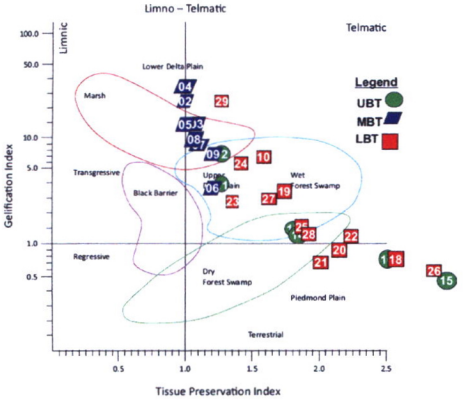
A drone- and field-based investigation of the land degradation and soil erosion at an opencast coal mine dump after 5 years' evolution of natural processes

Wu Xiao, He Ren, Tao Sui, Heyu Zhang, Yanling Zhao & Zhenqi Hu

Abstract: Opencast coal mining has a large impact on the land surface, both at the mining pits themselves and at waste sites. After artificial management is stopped, a reclaimed opencast coal mine dump is affected by wind and water erosion from natural processes, resulting in land degradation and even safety incidents. In this paper, the soil erosion and land degradation after 5 years of such natural processes, at the Xilinhot opencast coal mine dump in Inner Mongolia, were investigated. A multi-source data acquisition method was applied: the vegetation fraction coverage (VFC) was extracted from GF-1 satellite imagery, high-precision terrain characteristics and the location and degree of soil erosion were obtained using a drone, and the physical properties of the topsoil were obtained by field sampling. On this basis, the degree and spatial distribution of erosion cracks were identified, and the causes of soil erosion and land degradation were analyzed using the geographical detector. The results show that (1) multi-source data acquisition method can provide effective basic data for the quantitative evaluation of the ecological environment at dumps, and (2) slope aspect and VFC are the main factors affecting the degree of degradation and soil erosion. Based on above analysis, several countermeasures are proposed to mitigate land degradation: (1) The windward slope be designed to imitate the natural landform. (2) Reasonable engineering measures should be applied at the slope to restrain soil erosion. (3) The Pioneer plants should be widely planted on the platform at the early stage of reclamation.



DOI: https://doi.org/10.1007/s40789-022-00500-5

Petrographic composition of coal within the Benue Trough, Nigeria and a consideration of the paleodepositional setting

A. D. Mangs, N. J. Wagner, O. M. Moroeng & U. A. Lar

Abstract: The petrographic composition of Cretaceous-age coals hosted in the Benue Trough, Nigeria is presented and discussed in terms of the paleodepositional settings that influenced the coal-bearing formations. The Benue Trough is a failed arm of the triple junction of an inland sedimentary basin that extends in a NE-SW direction from the Gulf of Guinea in the south, to the Chad Basin in the north. A total of twenty-nine (29) coal samples were obtained from nineteen coal localities in the Upper (UBT), Middle (MBT), and Lower Benue Trough (LBT). The high average volatile matter yield, low average ash yield, high calorific value (24.82 MJ/kg, on average), and low sulphur values indicate good quality coal deposits. The organic matter is dominated by vitrinite, reported at an average of 59.3% by volume (mineral-matter free). Variation was noted in the inertinite content across three sub-regions. Liptinite macerals were not commonly observed in the studied samples and were absent in the MBT samples. Coal facies studies decipher the paleoenvironmental conditions under which the vegetation accumulated. Indices commonly used are the gelification index (GI), tissue preservation index (TPI), ground water index (GWI and variations), vegetation index (VI), and wood index (WI). Comparing the array of coal facies models applied, the MBT samples differ from the UBT and LBT samples, concurring with the coal quality

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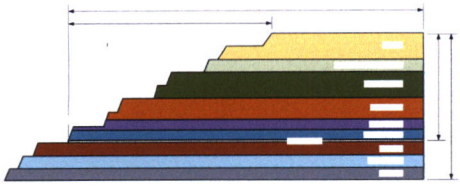

DOI: https://doi.org/10.1007/s40789-022-00504-1

Stability analysis of rib pillars in highwall mining under dynamic and static loads in open-pit coal mine

Haoshuai Wu, Yanlong Chen, Haoyan Lv, Qihang Xie, Yuanguang Chen & Jun Gu

Abstract: The retained coal in the end slope of an open-pit mine can be mined by the highwall mining techniques. However, the instability mechanism of the reserved rib pillar under dynamic loads of mining haul trucks and static loads of the overlying strata is not clear, which restricts the safe and efficient application of highwall mining. In this study, the load-bearing model of the rib pillar in highwall mining was established, the cusp catastrophe theory and the safety coefficient of the rib pillar were considered, and the criterion equations of the rib pillar stability were proposed. Based on the limit equilibrium theory, the limit stress of the rib pillar was analyzed, and the calculation equations of plastic zone width of the rib pillar in highwall mining were obtained. Based on the Winkler foundation beam theory, the elastic foundation beam model composed of the rib pillar and roof under the highwall mining was established, and the calculation equations for the compression of the rib pillar under dynamic and static loads were developed. The results showed that with the increase of the rib pillar width, the total compression of the rib pillar under dynamic and static loads decreases nonlinearly, and the compression of the rib pillar caused by static loads of the overlying strata and trucks has a decisive role. Numerical simulation and theoretical calculation were also performed in this study. In the numerical simulation, the coal seam with a buried depth of 122 m and a thickness of 3 m is mined by highwall mining techniques. According to the established rib pillar instability model of the highwall mining system, it is found that when the mining opening width is 3 m, the reasonable width of the rib pillar is at least 1.3 m, and the safety factor of the rib pillar is 1.3. The numerical simulation results are in good agreement with the results of theoretical calculation, which verifies the feasibility of the theoretical analysis of the rib pillar stability. This research provides a reference for the stability analysis of rib pillars under highwall mining.

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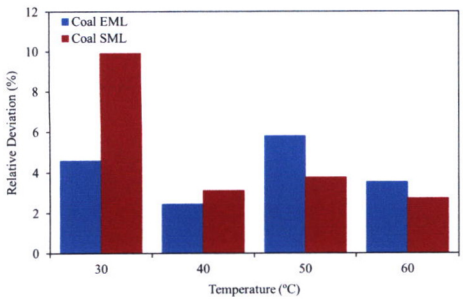
Modelling and thermodynamic properties of pure CO_2 and flue gas sorption data on South African coals using Langmuir, Freundlich, Temkin, and extended Langmuir isotherm models

Major Mabuza, Kasturie Premlall & Michael O. Daramola



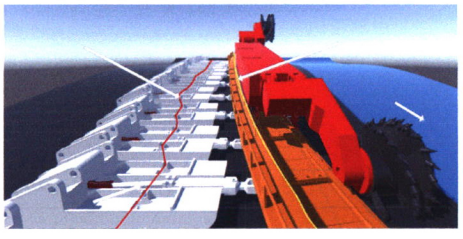
Abstract: Carbon sequestration in unmineable coal seams has been proposed as one of the most attractive technologies to mitigate carbon dioxide (CO_2) emissions in which CO_2 is stored in the microporous structure of the coal matrix in an adsorbed state. The CO_2 adsorption process is hence considered one of the more effective methodologies in environmental sciences. Thus, adsorption isotherm measurements and modelling are key important scientific measures required in understanding the adsorption system, mechanism, and process optimization in coalbeds. In this paper, three renowned and reliable adsorption isotherm models were employed including Langmuir, Freundlich, and Temkin for pure CO_2 adsorption data, and the extended-Langmuir model for multicomponent, such as flue gas mixture-adsorption data as investigated in this research work. Also, significant thermodynamics properties including the standard enthalpy change ($\Delta H°$), entropy change ($\Delta S°$), and Gibbs free

energy ($\Delta G°$) were assessed using the van't Hoff equation. The statistical evaluation of the goodness-of-fit was done using three (3) statistical data analysis methods including correlation coefficient (R^2), standard deviation (σ), and standard error (SE). The Langmuir isotherm model accurately represent the pure CO_2 adsorption on the coals than Freundlich and Temkin. The extended Langmuir gives best experimental data fit for the flue gas. The thermodynamic evaluations revealed that CO_2 adsorption on the South African coals is feasible, spontaneous, and exothermic; and the adsorption mechanism is a combined physical and chemical interaction between the adsorbate and the adsorbent.

DOI: https://doi.org/10.1007/s40789-022-00510-3

A virtual test and evaluation method for fully mechanized mining production system with different smart levels

Jiacheng Xie, Fuxiang Ge, Tao Cui & Xuewen Wang



Abstract: A smart fully mechanized coal mining working face is comprised of various heterogeneous equipment that work together in unknown coal seam environments. The goal is to form a smart operational system with comprehensive perception, decision-making, and control. This involves many work points and complex coupling relationships, indicating it needs to be performed in stages and coordinated to address key problems in all directions and along multiple points. However, there are no existing unified test or analysis tools. Therefore, this study proposed a virtual test and evaluation method for a fully mechanized mining production system with different smart levels. This is based on the concept of "real data processing–virtual scene construction–setting key information points–virtual operation and evaluation." The actual operational data for a specific working face geology and equipment were reasonably transformed into a visual virtual scene through a movement relationship model. The virtual operations and mining conditions of the working face were accurately reproduced. Based on the sensor and execution error analyses for different smart levels, the input interface for sensing, decision-making, and control was established for each piece of equipment, and an operation evaluation system was constructed. The system comprehensively simulates and tests the key points of sensing decision-making and control with various smart levels. The experimental results showed that the virtual scene constructed based on actual operational data has a high simulation degree. Users can simulate, analyze, and evaluate the overall operations of the smart mining 2.0–4.0 working face by inputting key information. The future direction for the smart development of fully mechanized mining is highlighted.

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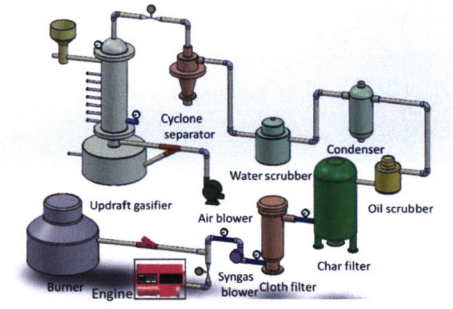
Mobile power generation system based on biomass gasification

Lu Ding, Mingming Yang, Kai Dong, Dai-Viet N. Vo, Douglas Hungwe, Jiahan Ye, Alexander Ryzhkov & Kunio Yoshikawa

Abstract: Disaster-hit and/or un-electrified remote areas usually have electricity accessibility issues and an abundance of plant-derived debris and wood from destroyed wooden structures; this can be potentially addressed by employing a decentralized ultra-small biomass-fed gasification power generating system. This paper presents an assessment of the technical viability of an ultra-small gasification system that utilizes



densified carbonized wood pellets/briquettes. The setup was run continuously for 100 h. A variety of biomass was densified and carbonized by harnessing fugitive heat sources before charging into the reactor. Carbonized briquettes and furnished blends exhibited inferior gasification performance compared to the carbonized pellets. In the absence of tar blockage problems, steady-state conditions were achieved when pre-treated feedstock was used. Under steady-state conditions for carbonized pellets gasification operated at an equivalence ratio of 0.32, cold gas efficiency and carbon conversion achieved 49.2% and 70.5%, respectively. Overall efficiency and maximum power output of 20.3% and 21 kW were realised, respectively. It was found that the system could keep stable while the low heating valve of syngas was over 4 MJ/m^3 on condition that avoiding tar blocking issues. The results indicate that the proposed compact ultra-small power generation system is a technically feasible approach to remedy power shortage challenge. In addition, process simulation considering carbonized wood gasification combined power generation was formulated to produce syngas and electricity. Woody pellets with the flow rate of 20 kg/h could generate a 15.18 kW power at the air flow rate of 40 Nm^3/h, which is in a good agreement with 15 kW in the 100 h operation. It is indicated that the gasification combined power generation cycle simulated by Aspen simulator could achieve reliable data to assist the complicated experiment operation.

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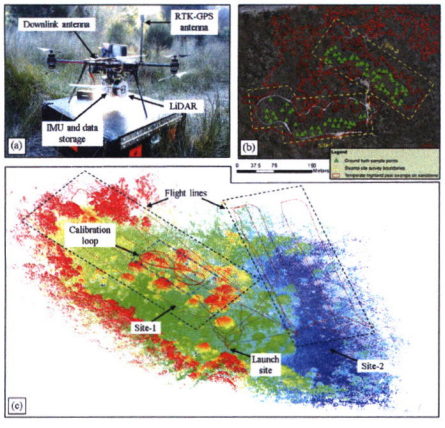
Mapping sensitive vegetation communities in mining eco-space using UAV-LiDAR

Bikram Pratap Banerjee & Simit Raval



Abstract: Near earth sensing from uncrewed aerial vehicles or UAVs has emerged as a potential approach for fine-scale environmental monitoring. These systems provide a cost-effective and repeatable means to acquire remotely sensed images in unprecedented spatial detail and a high signal-to-noise ratio. It is increasingly possible to obtain both physiochemical and structural insights into the environment using state-of-art light detection and ranging (LiDAR) sensors integrated onto UAVs. Monitoring sensitive environments, such as swamp vegetation in longwall mining areas, is essential yet challenging due to their inherent complexities. Current practices for monitoring these remote and challenging environments are primarily ground-based. This is partly due to an absent framework and challenges of using UAV-based sensor systems in monitoring such sensitive environments. This research addresses the related challenges in developing a LiDAR system, including a workflow for mapping and potentially monitoring highly heterogeneous and complex environments. This involves amalgamating several design components, including hardware integration, calibration of sensors, mission planning, and developing a processing chain to generate usable datasets. It also includes the creation of new methodologies and processing routines to establish a pipeline for efficient data retrieval and generation of usable products. The designed systems and methods were applied to a peat swamp environment to obtain an accurate geo-spatialised LiDAR point cloud. Performance of the LiDAR data was tested against ground-based measurements on various aspects, including visual assessment for generation LiDAR metrices maps, canopy height model, and fine-scale mapping.

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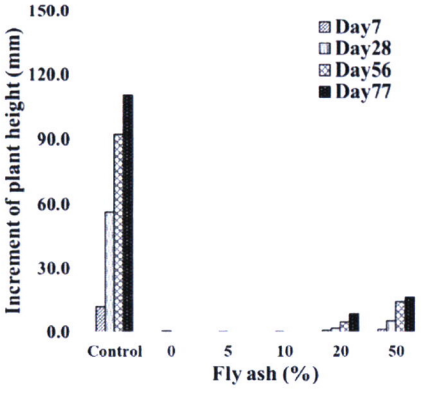
Amelioration of acidic soil using fly ash for mine revegetation in post-mining land

Akihiro Hamanaka, Takashi Sasaoka, Hideki Shimada & Shinji Matsumoto

Abstract: This paper described the use of fly ash for soil amelioration of acidic soils to promote plant growth. In mining sites, acid sulfate soils/rocks, which contain sulfide minerals (e.g. pyrite FeS_2), have appeared as a result of overburden excavation. The excessively acidic condition inhibits plant growth due to the dissolution of harmful elements, such as Al, Fe, and Mn. Fly ash, an alkaline byproduct of coal combustion generated in thermal power plants is expected to be adopted to ameliorate acidic soils. However, the mixing ratio of fly ash must be considered because excessive addition of fly ash can have a negative impact on plant growth due to its physical/chemical properties. The pot trials using *Acacia mangium* demonstrate the evolution of plant growth with a 5%–10% addition of fly ash into acidic soil. When the acidic soil has a high potential for metal dissolution, the metal ions leached from the acidic soil are large, making it difficult to improve plant growth due to osmotic and ionic stress. This work suggests that the effects of fly ash on metal ions leached from the soil have to be considered for the amelioration of acidic soil.

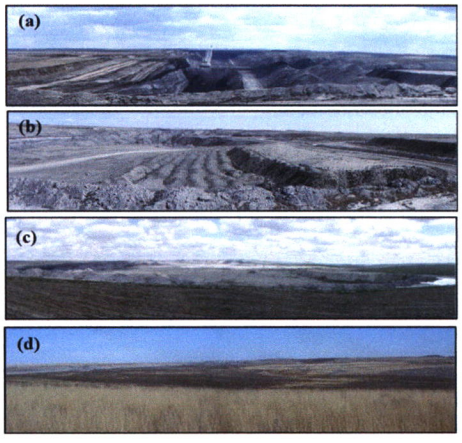


DOI: https://doi.org/10.1007/s40789-022-00502-3

Sustainable reclamation practices for a large surface coal mine in shortgrass prairie, semiarid environment (Wyoming, USA): case study

Anna Krzyszowska Waitkus

Abstract: Sustainable reclamation practices for large surface coal mines in USA semiarid environment contribute to the quality of the environmental on a long term basis where environmental resources are protected for future generation. Land, after reclamation, must be suitable for the previous use of greatest economic or social values to the community area. In the semiarid climate of USA, non-developed land is mainly utilized for crops, grazing, and wildlife. Completion of various stages of the reclamation processes includes verification and approval of reclamation criteria and performance standards created by state agencies. The sustainable reclamation practices were investigated at the USA's largest surface coal mine of the semiarid environment in Wyoming. These practices include building post-mining topography to the approximate original contour and reestablish a stable hydrologic system to drain surface water. All available spoil material is backfilled and graded to achieve the post-mining topography which closely resembles the pre-mining topography. No overburden material or other coal waste material is left in stockpiles at the mine. Detailed planning until the end of mining, the knowledge of available volumes of suitable backfill material and soil is necessary for sustainable management practices. Diverse and permanent vegetation capable of stabilizing soil surfaces and capable of self-regeneration is established. Sustainable management of the reclamation effort is achieved by enforcement processes developed by the state and federal agencies. Monthly inspections of mining and reclamation operations and reviews of annual reports submitted by the operator help determine if the reclamation processes are occurring according to the permit plan.



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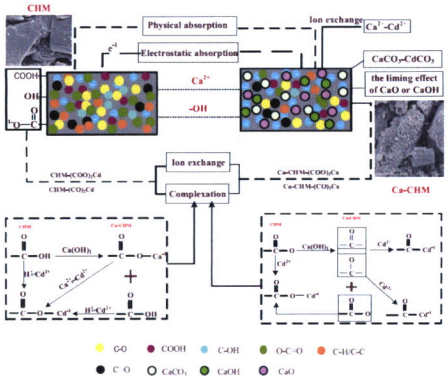

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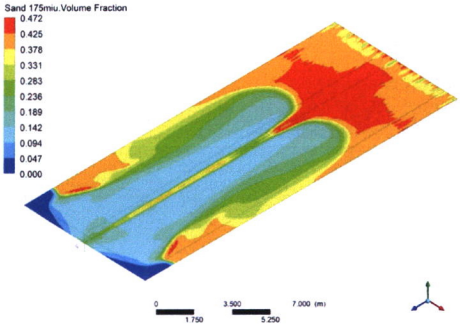
Adsorption mechanism of Cd(II) by calcium-modified lignite-derived humin in aqueous solutions

Ping Wang, Zhanbin Huang, Zhanyong Fu, Peng Zhao, Zeshen Feng, Yao Wang & Fangze Li

Abstract: Lignite-derived humin (CHM) was extracted from raw coal in Heihe City, China, producing calcium-modified lignite-derived humin (Ca-CHM) by $Ca(OH)_2$. The physical and chemical performances of CHM and Ca-CHM were analyzed with SEM, ^{13}C spectra and XPS techniques. The results show that Ca-CHM exhibited weaker aliphatic, more aromatic polar compared with CHM, which improves the adsorption capacity for Cd(II). XPS analysis indicates that Ca(II) has been loaded onto Ca-CHM successfully after modification. This batch adsorption experiments report the adsorption performance of CHM and Ca-CHM for Cd(II). The adsorption process of CHM and Ca-CHM for Cd(II) conform to pseudo-second-order model, which is chemical adsorption, and the adsorption data presented good fits to the Langmuir model. The maximum adsorption amount (Q_m) of Cd(II) onto CHM and Ca-CHM by the Langmuir model is 15.29 mg/g and 41.84 mg/g, respectively. Based on the results of SEM, ^{13}C spectra, and XPS analysis, we concluded that the main adsorption mechanism of Ca-CHM on Cd(II) was ion exchange of Cd(II) for Ca(II), static-adsorbed and surface complexation. Therefore, Ca(II) can be loaded on the surface of Ca-CHM by chemical modification, improving the adsorption capacity of materials in aqueous solutions.



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Sediment settlement rate and consolidation time of filling reclamation in coal mining subsidence land

Linghua Duo, Zhenqi Hu, Kun Yang & Yanan Li

Abstract: With the continuous growth of the population and the continuous reduction of cultivated land, China's food security is greatly threatened. In addition, China's coal mining has been mainly underground mining, causing land subsidence and damaging existing cultivated land. This effect intensifies the contradiction between the growth of the risk population and the reduction of cultivated land. The reclamation of mining subsidence land with Yellow River sediment is often used as an effective way to improve the recovery rate of cultivated land. Shortening the reclamation time and realizing continuous filling are significant issues. The work presented in this paper studied the sediment settlement rate and consolidation time by combining theory, field filling and reclamation tests and numerical simulations. A field filling test study was carried out in the lowlands of Jibeiwang Village, Qihe County, Shandong Province, China. By calculating the drainage consolidation time, the consolidation factor of 0.015656 m^2/d, and the time factor for sediment consolidation of 0.575 were determined. The sediment consolidation time for this test was 9.18 days. The calculation of sediment deposition rate and consolidation time is of great practical significance to guide the Yellow River sediment filling, realize continuous filling, and save reclamation time and cost.

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