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Editorial

Special Issue "Process Safety in Coal Mining"

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As an important natural resource, coal plays a critical role in social and economic development. Due to increasing energy demands, the amount of coal mining is also increasing, precipitating many safety problems. Determining a method whereby the safety level of the coal-mining process can be improved while ensuring acceptable levels of coal production is a problem to which we must attach great importance. However, in the current instantiation of the coal-mining process, coal mine disasters occur frequently, and the levels of coal mine safety management and control are still very insufficient. Therefore, there is an urgent need to further understand the process safety control related to and new technologies used in coal mining. Process safety in coal mining refers to the implementation of measures and practices to identify, prevent, and mitigate potential risks and hazards associated with mining operations. It focuses on ensuring the safety of workers, protecting the environment, and preventing accidents that could result in injuries, fatalities, or damage to equipment and infrastructure.

This Special Issue of *Processes*, titled "Process Safety in Coal Mining", collects the latest work of the main researchers in this field, covering the theory and technology behind coal mine disaster prevention and control, safety management and control in the process of coal mining, mineral processing and green-mining engineering, mining-related environmental protection and sustainable development, and other aspects of safety technology research, focusing on coal mine production safety. Despite the interdisciplinary nature of the different studies included, the ultimate theme of security closely links the different studies contained within this issue.

Coal mine production safety concerns the measures taken to prevent accidents in mines and address and control accidents quickly and effectively in order to ensure the safety and health of the miners. The safety of coal mine production involves many aspects, including mine ventilation, fire and explosion prevention, gas drainage, coal dust prevention, the safety equipment employed, etc.

Due to the complex stress of the surrounding rock, the support and arrangement of roadways play a key role in ensuring the safety of coal mining and the mines themselves. There is a close relationship between changes in surrounding rock stress and mine support. Linlin Chen and coworkers [1] used the equivalent circle method to solve a problem regarding a loose circle of a rectangular roadway and used numerical calculations to obtain the deformation and stress distribution laws of the surrounding rock under the excavation conditions of large section whole coal cavern groups (WCCGs). Guosheng Xu and coworkers [2] studied the variation law of surface dynamic motion based on the surveying and mapping line above the working face of Beigou Coal Mine. The prediction function of the subsidence velocity of the main surface sections and overlying strata in Peigou Coal Mine was established. Using Dongliang Coal Mine as a model for engineering, Li Li and coworkers [3] studied three typical forms of basic roof movement. They obtained the critical fracture conditions of three forms using theoretical calculations. Adopting the resulting state of roof strata movement as the different overlying boundary conditions of the

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top coal, the influence on the recovery rate was simulated, and the interaction mechanism between the roof base and the top coal was explored. Chen Li and coworkers [4] expounded on the mechanism behind strong rock behavior. They proposed a treatment method for the manifestation of strong strata behaviors by using hydraulic fracturing technology to break the key stratum. Zhengzheng Xie and coworkers [5] revealed the preconditions required for such damage and a bidirectional deterioration mechanism for the deformation and stress of the surrounding rocks. They built an anchorage mechanical model for the thick layer of a roadway roof and proposed a cross-boundary anchor-grouting (CBAG) differential support technique. Xiao-He Wang and coworkers [6] conducted a field test to monitor surface displacement. They used the FLAC3D numerical simulation software to analyze the main stress levels, the shapes of the plastic zones, deformation variables, and the connectivity between the plastic zone of the roadway and the plastic zone of the residual coal pillar in different positions. Qiang Fu and coworkers [7] studied the instability mechanism of cross-section coal pillars and roadways under the dual effects of the bottom support pressure of the remaining coal pillars in the overlying coal seam and the mining of the lower coal seam's working face. They proposed a stability control method for long anchor cable reinforcement support.

The content of coalbed methane directly affects the amount of coalbed methane and mine gas emitted, which is critical to the appropriate design of mine ventilation, gas drainage, and outburst risk assessments. Coal is a kind of porous medium with a complex structure. Adsorption pore structure is a critical parameter influencing the recovery rate of coalbed methane. Gas extraction is critical to the prevention and control of mine gas disaster. Hongyan Lei and coworkers [8] developed a mathematical model for the rapid prediction of coal seam gas content. Wendi Wang and coworkers [9] tested the adsorption pore structure parameters of four coal samples with different metamorphic degrees and discussed the main factors affecting the complexity of pore structure and the influence of fractal characteristics on coal adsorption performance. Hongyan Lei and coworkers [10] used COMSOL software to carry out a three-dimensional numerical simulation, explained the mechanism behind gas migration under negative pressure drainage, and studied the borehole spacing when multi-holes were used to extract gas. Xiaoyang Cheng, and coworkers [11] proposed a data-driven fine control method for gas mining. The technical methods they provided allowed for the fine control of pumping hole design, construction, measurement, and repair. Shuanlin Wang and coworkers [12] combined rock mechanics and fracture mechanics to analyze the influence of the shadow effect of the stress field between cracks on the evolution of equivalent stress and the plastic zone. Zhie Wang and coworkers [13] analyzed the deformation characteristics of boreholes under three typical coal–rock conditions and analyzed the stress, strain, and plastic deformation of rocks around boreholes with different diameters. They simulated the effect of casings on borehole stability.

Mine fires are among the principal disasters that threaten the safety of coal production. It is critical to study coal-related spontaneous combustion and mine ventilation systems to facilitate the prevention and control of mine fires. Jueli Yin and coworkers [14] constructed a large-scale acoustic emission test system for the spontaneous combustion of coal and experimentally tested the acoustic emission signals during the spontaneous combustion of coal. Lina Qu and coworkers [15] constructed a macromolecular model of coal gas in the Huainan mining area. Haiyan Wang and coworkers [16] constructed two typical mine ventilation networks: a parallel branch and a diagonal branch.

Coal and gas outburst and coal–rock composite dynamic disasters refer to the phenomenon wherein coal and gas outbursts occur in the working face of a coal mine due to the interaction between the coal seam and surrounding rock during coal mining, which is accompanied by rock mass instability, mine roof cave-ins, and other rock dynamics disasters. Dongling Sun and coworkers [17] theoretically analyzed the microscopic formation process of a burst shock wave. They deduced the relationship expression between outburst gas pressure and outburst shock wave intensity and proposed a concept concerning the equivalent sound velocity of coal gas flow. Feng Li and coworkers [18] revealed the vibration response characteristics of the interface between coal and rock under an impact load. Haitao Sun and coworkers [19] further clarified the occurrence and developmental mechanism of coal–rock gas composite dynamic disasters in an engineering-scale mining environment and provided guidelines for the prevention and control of coal–rock gas dynamic disasters in deep mines. Haibo Sun and coworkers [20] observed the law behind the evolution in the number of cracks in the process of coal specimen instability via DEM-based numerical simulation.

Safety evaluation management plays an important role in coal mine safety. It is a comprehensive and systematic assessment and analysis of all aspects of a coal mine production system that is conducted to identify potential safety risks and hidden dangers, provide a scientific basis and decision support, and promote the implementation of effective safety management measures in coal mines, thereby improving the safety level of coal mines. Xidi Jiang and coworkers [21] used the Python language to analyze the main body of 'people' exhibiting unsafe behavior. Twenty-four attribute factors were selected from five aspects of individuals, namely, their emotions, motivations, abilities, personalities, and stresses, to construct a comprehensive model of human behavior dubbed SMAPP (sentiment, motivation, ability, personality, and pressure). Zhiliu Wang and coworkers [22] developed an interval trapezoidal fuzzy soft set method to realize the dynamic risk assessment of a high slope. Jing Li and coworkers [23] constructed a coal mine noise simulation experiment system and concluded that the noise level should be reduced to 90 dB to reduce miners' propensity to cause accidents.

Large-scale, high-intensity coal mining in the western mining areas of China has led to reduction in groundwater resources. The implementation of a coal mine in an underground reservoir is an effective means of realizing the protection and utilization of water resources in China's western mining areas. One of the important standards for the safety of underground reservoirs in coal mines is to monitor the development of cracks in coal pillar dams. Bao Zhang and coworkers [24] studied the optimum width of a coal pillar dam using a mechanical model, numerical calculations, and a similar simulation method. Aiming to address the safety problems caused by goaf and water accumulation in open-pit mines, Sheng Zhang and coworkers [25] combined a shallow three-dimensional seismic method with a transient electromagnetic method to detect the distribution range and water-forming conditions related to goafs. Combined with a determination of the special terrain conditions of open-pit mines, they proposed a reasonable data interpretation method, which greatly improved predictive capacity in relation to goaf and water accumulation conditions.

In addition to the safety of coal mining, many ancient architectural structures have different degrees of peeling and foundational problems on the inner surface of their retaining structure due to their long history of construction. To solve the problem regarding the accumulation of moisture inside palace buildings, using an ancient wooden palace building in Beijing as a model, Fang Liu and coworkers [26] used the control variable method to simulate and analyze the influence of outdoor relative humidity, soil moisture, wall moisture, and other factors on the indoor heat and moisture transfer of ancient buildings.

The above articles have furthered the discussion and research on theories, experimentation, and simulation with respect to coal-mining safety research. These articles have solved the outstanding challenges related to production safety in different fields from the perspectives of theory, experimentation, and application, and there is still much to be explored in the future. The Special Issue covers a broad range of topics consistent with the mission outlined by *Processes* to become a highly visible outlet for publishing novel studies in systems modeling, process engineering, and associated applications. The journal will continue to solicit high-quality contributions in these domains.

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