Current status and prospects of coal and gas outburst prediction and prevention technology

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Abstract. Predicting the sensitivity index accurately is an important prerequisite for the current status and future development of coal and gas outburst prediction technology. Technical operators and researchers must briefly analyze the traditional coal and gas outburst prediction and prediction methods. On this basis, optimization techniques and analysis methods, including mathematical and physical theories, databases, data mining and other information technologies, GIS technology, three-dimensional geological simulation technology, radio wave perspective detection technology, etc., can ensure the better development of this work. Different technical methods can be configured in combination with different usage scenarios to ensure satisfactory usage effects.

1. Introduction
In the process of underground coal mine operations, coal and gas outburst is one of the most serious natural disasters. Once it occurs, an explosion may occur directly, which greatly threatens the personal safety of grassroots construction personnel in the operation area [1]. With the structural adjustment of my country's coal industry and the large-scale changes in the production layout, the technical difficulties and characteristics of coal mine safety production have become more and more complex and more numerous. In order to effectively prevent and control coal and gas outburst disasters, my country’s experts and scholars in this field combine the most advanced digital and information technologies [2-4]. At the same time, combined with outstanding research in mathematics and physics, many new technical methods have been discovered, which will gain more technical and theoretical support for coal and gas outburst prediction and prevention.

2. Coal and gas outburst traditional forecasting methods
In the "four-in-one" comprehensive outburst prevention system, coal and gas outburst prediction and forecasting are a relatively important link. After long-term research by professional scholars and mining technicians, my country's coal and gas outburst prediction and forecasting technology has achieved considerable progress [5]. However, there are still some details to be perfected at the technical use level [6]. For example, traditional coal and gas outburst prediction methods use static and discontinuous contact prediction technology. This method mainly quantifies the properties of gas-containing media and its occurrence conditions, including gas indicators, coal seam property indicators, and ground stress.
The effective statistics of these comprehensive indicators, such as indicators, can make the predicted results more referential. At the same time, it is mainly through the method of whether these indicators exceed the critical value to predict whether effective technical measures need to be processed. When the technicians actually operate the static method, drilling and parameter determination technical methods, they need to spend a lot of working time and space. Due to the complicated technical operation, some operational errors are prone to occur in the whole process. In addition, the internal gas content of coal seams and media is different, and the distribution area is also different \([7-8]\). Therefore, the prediction results obtained near the drill cannot cover all, let alone the whole effectively predict the extent of coal and gas outburst within the forecast range. When technicians value the prediction results, they are only temporary and static, rather than dynamic and permanent. Therefore, it is impossible to represent the outstanding danger of the entire media before it stabilizes.

3. **New achievements in the field of coal and gas outburst research**

3.1. **Mathematics and physical theories promote coal and gas outburst prediction**

From the perspective of the internal mechanism of coal and gas outbursts, the relationship between the two is extremely complicated, and the law between outburst influencing factors and outburst events is not very precise, and there is strong ambiguity. So, it is based on experience., or the application of traditional forecasting technology based on mathematical modeling and statistical forecasting methods is increasingly restricted. Therefore, more advanced computer simulation, fuzzy mathematical theory, grey system theory and other methods have begun to be widely promoted in the process of quantitative evaluation and analysis of coal and gas outbursts, and at the same time, better application effects can be obtained. From the perspective of the application of research methods on outburst mechanism of gas-containing coal and rock, the most common and well-applied methods include observation statistics, logical deduction, experiment and numerical analysis. Powerful research on nonlinear problems, theoretical tools and methods, and the application of fractal geometry theory in the coal industry are also favored by professional and technical personnel. At the same time, many professional researchers have also conducted effective research on the granularity classification of its prominent media, and found that the fractal characteristics of prominent media can not only professionally describe the media’s ability to resist external forces, but also learn from the mechanical behavior of the media. From the perspective, highlight the characteristics of media and non-prominent media for effective understanding. The most important point is to be able to effectively evaluate the media’s ability to absorb and release gas, which is of greater predictive significance for a deep understanding of the prominent dangers of the media structure.

3.2. **The development of information technology such as database and data mining has opened up new ways for coal and gas prediction**

From the current level of technological development, database technology has evolved from a single commercial database technology to a distributed database technology that can be combined with distributed technology, and a parallel database technology that can be combined with parallel technology. The effective integration of this technology and technology has enabled the manual card-style traditional management method to be effectively optimized. At the same time, the database technology in the statistical classification of coal and gas outbursts has also achieved comprehensive disaster management. A huge success, it is widely favored by professional researchers. With the progress and development of the times, data mining technology developed on the basis of databases is also a scientific analysis and decision-making method. In the actual application process, this technology can be based on a large number of fuzzy and frequently changing basic data, and be integrated with database technology to ensure that computer technology can play a higher value in the mining and analysis of historical data. At the same time, it can effectively stimulate the role of the internal relationship model of historical data.
in decision-making optimization, and ensure that the prediction of coal and gas outburst hazards is more accurate and more practical.

3.3. **GIS technology and 3D geological simulation technology put forward new ideas for the quantitative research of coal mine gas**

With the advent of the information age and the emergence of GIS and three-dimensional geo-simulation technology, the development of mining has also been effectively promoted, especially in the areas of mineral resource evaluation, gas content in mining areas, and the search for distribution rules, playing a surprising role. Some professional scholars have combined these advanced technologies with the production business in a certain area and found that the application of GIS technology in the prediction project of gas outburst areas in the mining area can enable the development of quantitative, scientific and dynamic monitoring of data prediction. With more effective technical support, more accurate data can be obtained after the technical actions are executed. At the same time, some scholars, relying on the technical support of GIS, have developed a management and interpretation system for comprehensive geophysical information in geological disaster exploration. This system not only has strong spatial information management and analysis functions, but also enables effective geological disasters in mining areas. The forecast has been blessed by the characteristics of informatization, digitization and quantification.

3.4. **Radio wave perspective detection technology has achieved results in the study of coal and gas outburst prediction**

Some scholars in my country conducted systematic tests on the physical parameters of different types of media and prominent media based on data from different mining areas and different coal types. The conclusion is that the same coal type and the same type of destruction coal have a relatively close resistivity. At the same time, the resistivity of outburst coal and non-outburst coal are quite different, and the resistivity characteristics of coal with different metamorphic degrees are different. When the radio wave tunnel perspective technology is used to study the telecommunication response characteristics of the outburst coal seam formed by the combination of outburst coal and non-outburst coal, it is found that the conductance and dielectric constant between outburst coal and non-outburst coal are quite different. Therefore, the characteristics of the anisotropic layered medium of the outburst coal seam are outstanding, and the radio wave response of different types of media combinations also has certain rules.

4. **Anti-outburst countermeasures and technical outlook**

4.1. **Conscientiously implement the "four-in-one" comprehensive anti-outbreak measures**

In order to prevent unexpected accidents in the production area of the mining area, technicians should pay attention to two aspects in the actual implementation of work responsibilities. The first is to prevent outstanding accidents, because once a prominent accident occurs, the consequences may be unpredictable. Therefore, in the process of organizing and implementing comprehensive measures, scientific and effective anti-outburst measures and safety protection measures must be combined with the actual production in the mining area. In the daily safety maintenance process, regular inspections should also be carried out to prevent any emergencies in the implementation of this work. State-owned key coal mines have achieved good results after applying comprehensive outburst prevention measures. The second is to prevent the large scale of the prominent accidents and even cause the casualties of grassroots mineral construction personnel. Whether it is a technician or a supervisory staff, it must be combined with the actual mining operation in the mineral area to ensure that the coordinated comprehensive prevention measures are more scientific and effective.
4.2. Improve the accuracy of prominent hazard prediction
In order to make the risk prediction work more accurate, technicians should combine the specific conditions of the highlighted mine to ensure that the coordinated risk prediction and protective measures are more scientific, and then play a stronger role in predicting accuracy. At the same time, technicians must also combine scientific experiments to ensure that the critical values for highlighting and predicting sensitive indicators and marking highlight hazards can be effectively determined. The use of indicators such as acoustic emission, gas gushing, dynamic changes and electromagnetic radiation will be effective for highlighting hazards with carrying out dynamic and continuous non-contact prediction to ensure that the hazard is highlighted, the prediction accuracy is higher, and the reference is stronger.

4.3. Improve the effectiveness of anti-outbreak measures
With the development of the times, especially the arrival of the information age, the degree of mine mechanization is getting higher and higher. Therefore, the outburst prevention measures used by enterprises in the production areas of large mining areas on the mining face of machine mining machines are becoming more and more advanced. It can directly start from the perspective of preventing electrical outbursts and effectively reduce the depth of mechanical uncovering. At the same time, the inspection work is advanced at a more uniform speed to ensure that the support condition of the working face is effectively improved. And it can also make the media stress in front of the work move forward at a more uniform speed, preventing the formation of greater concentrated stress during the movement, and bringing greater danger to the inspection work. At the level of improving the effect of anti-outburst measures, it is also possible to use improved mechanical devices to ensure the effect of mine production. At the same time, it saves resources and energy waste. For example, the widespread use of coal ploughs on the mining face of the outburst coal seam, and the use of a roadheader with an advance digging and unloading groove machine on the machined working face can ensure the mineral output while ensuring the safety and efficiency of the mining process.

4.4. Prioritize the use of regional outburst prevention measures such as mining protective layers and pre-draining coal seam gas
Prioritize the use of regional outburst prevention measures such as mining protective layer and pre-draining coal seam gas, which are the most effective anti-outburst measures. In order to make the protection effect better and the protection scope can be effectively expanded, the operation process of mining the protective layer It should be fully combined with gas drainage. At the same time, improving the gas drainage rate in a single outburst dangerous coal seam is another major technical problem in the field of coal mine gas drainage in the world that needs to be solved urgently. Therefore, many researchers have conducted a large number of scientific experiments in this area. Although major technological breakthroughs have been made, such as the invented methods of hydraulic fracturing, network hole layout, and directional pressure relief blasting, these technical methods cannot be produced in mining areas due to their complicated processes and high costs. Large-scale operation and promotion in the process. Therefore, the improvement technology of coal seam gas drainage effect that adapts to the outstanding mine production conditions still needs the key research of the majority of scholars. In the research and development process of the outburst prevention technology, it is also a relatively important topic and needs to be paid attention to by relevant personnel.

4.5. Strengthen gas geological work in outburst mines
Paying more attention to the mine gas geological survey and intensifying research will help to improve the coal seam storage conditions and prediction effects of the mine geological structure, and it can also effectively prevent the occurrence of misoperations that expose outburst coal seams. The most important point is that the gas content, gas pressure and in-situ stress change law of coal seams in various geological structures can be effectively and dangerously prominent.
5. Conclusion
In the field of coal mine safety technology, the prevention and control of coal and gas outburst has become a technical problem that needs to be overcome. After arduous research by a large number of scholars around the world and decades of scientific and technological advancement, my country’s coal mine production practice has formed a “four in one” anti-outburst technology system has been widely used and promoted.

However, due to the complexity of the mining environment in the mineral area and the increasing difficulty of technical operations, such comprehensive anti-outburst measures still need to be effectively optimized and improved in the actual application process to ensure that the results of outstanding predictions have higher accuracy and the operation safety can ensure higher safety guarantee for the production process of the mine.

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References
[1] Dai Linchao, Liu Yanbao, Cao Jie, et al. A Study on the energy condition and quantitative analysis of the occurrence of a coal and gas outburst [J]. Shock and Vibration, 2019, 8651353.
[2] Long Nengzeng, Yuan Mei, Wang Guanliang, et al. Research on real-time early warning of coal and gas outburst based on data mining [J]. China Mining, 2020, 29(11): 88-93+99.
[3] Wang Enyuan, Li Zhonghui, Li Dexing, et al. Application of electromagnetic radiation monitoring technology and equipment in monitoring and early warning of coal and gas outbursts [J]. Coal Mine Safety, 2020, 51(10): 46-51.
[4] Duan Tianzhu. Application of multi-frequency radio wave perspective detection technology in coal seam erosion zone detection [J]. Coal Mine Safety, 2019, 50(05): 146-149.
[5] Du Jianpeng, Dong Zhiqiang, Zhang Xu, et al. Coal Mine Quality Improvement and Efficiency Management Innovation-The specific practice of "Four in One" operation and management mode implemented by Gengcun Coal Mine of Yima Coal Industry Group [J]. China Coal, 2020, 46(06): 29-34.
[6] Shu Dongfang. Omen and prevention of coal and gas outburst [J]. Inner Mongolia Coal Economy, 2019(04): 90+95.
[7] Niu Jizhan. Analysis of gas control methods in coal and gas outburst coal mining face in coal mines [J]. Inner Mongolia Coal Economy, 2019(03): 120-121.
[8] Li Yuehua, Zhao Ke, Jiang Heng. Experimental study on sensitive indicators of local outburst prediction in coal mines [J]. Energy and Environmental Protection, 2019, 41(09): 1-4+9.