ISSN: 1813-4890

Analysis of the Current Situation of Coal Mining and Gas Control in Pingdingshan Coal Mine

Zhendong Zhang [1,2]

[1] China Coal Technology and Engineering Group Chongqing Research Institute, Chongqing 400039, China;

[2]State Key Laboratory of Coal Mine Disaster Prevention and Control, Chongqing 400039, China)

Abstract

In response to the current state of coal mine production, this study focuses on a specific coal mine in Pingdingshan to conduct an in-depth exploration of its mining and gas control status, challenges, and improvement strategies. Through an examination of the mine's general overview, mining intensity analysis, gas occurrence characteristics, gas control technical measures, and effectiveness evaluation, this research unveils the gas control hurdles encountered by the mine during the mining process and proposes tailored improvement recommendations. The findings indicate that the mine has effectively mitigated the risk of gas disasters by implementing a series of gas control measures. Nevertheless, there remains a necessity to further refine the mining process and gas control technologies to attain safe and efficient production.

Keywords

Coal mine; mining intensity; gas control; gas occurrence; control technology.

1. Introduction

With the rapid development of China's coal industry, the depth of mine mining has been continuously increasing, leading to a growing prominence of gas disaster issues [1-2]. As a typical coal and gas outburst mine, the gas control efforts at a certain coal mine in Pingdingshan are directly linked to the mine's safety production and economic benefits [3-4]. Therefore, conducting in-depth research on the mining intensity and current state of gas control at this coal mine holds significant importance for enhancing the mine's gas control level and ensuring safe production.

This certain coal mine in Pingdingshan is affiliated with Pingdingshan Tian'an Coal Mining Co., Ltd. and is located 17 km northeast of Pingdingshan City, Henan Province. The mine field stretches 15 km east-west and has a width ranging from 2.3 to 5.0 km north-south, covering an area of 53.63 km^2. The mine has a designed production capacity of 1.8 million tons per year, which was verified to be 2.1 million tons per year in 2008. The mine employs a combined vertical and inclined shaft development method and is divided into two levels for mining, with only the first level (-525m) currently being mined. The mine currently has three production mining areas. The mine primarily mines the No. 2_1 coal seam (Ji 15-17 coal seam and Ji 16, 17 coal seam), with significant variations in coal seam thickness, averaging 5.88m. The gas content within the mine field is relatively high, classifying it as a coal and gas outburst mine [5]. According to the "2019 Annual Mine Gas Measurement Report," the relative gas emission rate of the mine is 12.06 m^3/t, and the absolute gas emission rate is 36.75 m^3/min. Gas occurrence is influenced by various factors such as geological structure, coal seam thickness, and burial depth, exhibiting uneven distribution characteristics [6-7]. The eastern region, influenced by tectonic controls, has higher gas content and more pronounced outburst tendencies. Based on

ISSN: 1813-4890

this, this paper aims to comprehensively understand the mining intensity and current state of gas control at this coal mine through field research, data collection, and analysis, evaluate the control effects, identify existing problems, and propose targeted improvement suggestions.

2. Analysis of Coal Mine Mining Intensity

2.1. Current Status of Mining Intensity

During the mining process at this mine, it faces complex geological conditions and the risk of gas disasters. To ensure safe production, the mine has implemented various measures to control mining intensity while strengthening gas control efforts. Currently, the mining intensity of the mine is primarily reflected in aspects such as the advancement speed of coal faces, daily output, and monthly output.

The advancement speed of coal faces at this mine is influenced by multiple factors, including gas control and geological conditions. In terms of gas control, the mine has reduced the gas pressure and content in coal seams by implementing regional and local outburst prevention measures, thereby creating conditions for the rapid advancement of coal faces. However, due to the complex geological conditions, including well-developed faults and significant variations in coal seam thickness, the advancement speed of coal faces is still somewhat limited.

The daily and monthly outputs of the mine are influenced by various factors, such as mining intensity, equipment performance, and management level. In recent years, with the improvement of gas control levels and the optimization of mining processes at the mine, both daily and monthly outputs have increased. However, there is still a gap between the actual output and the verified production capacity, necessitating further increases in mining intensity and production efficiency.

2.2. Impact of Mining Intensity on Gas Control

An increase in mining intensity leads to an increase in gas emission, thereby increasing the difficulty and risk of gas control. During the mining process at this mine, a series of gas control measures have been implemented to effectively control gas emission and ensure safe production. However, with the further increase in mining intensity, gas control will face even greater challenges. Therefore, it is necessary to further optimize mining processes and gas control technologies to adapt to the increase in mining intensity.

3. Technical Measures for Gas Control in Coal Mine

This coal mine has established a comprehensive gas extraction system, including both surface permanent and underground mobile gas extraction systems. It employs methods such as cross-layer drilling (wide extraction range but high cost), along-layer drilling (simple construction but affected by coal seam permeability), and upper corner pipe burying (simple operation but requiring maintenance) to optimize processes and enhance efficiency. Regional outburst prevention measures include mining protective seams (prioritizing the mining of low-risk coal seams for pressure relief), pre-extraction of coal seam gas (long-term, large-scale extraction), and hydraulic slotting (increasing permeability using high-pressure water jets). Local outburst prevention utilizes advanced drilling (rapid pressure reduction), hydraulic punching (increasing permeability in hard coal seams), and metal frameworks (supporting soft coal seams).

3.1. Gas Extraction Technology

The mine has established a sophisticated gas extraction system, encompassing both surface permanent and underground mobile extraction systems. The surface permanent system is primarily responsible for high-vacuum extraction, while the underground mobile system is

ISSN: 1813-4890

flexibly deployed according to the needs of mining and excavation faces. Extraction methods mainly include cross-layer drilling extraction, along-layer drilling extraction, and upper corner pipe burying extraction. By optimizing extraction parameters and processes, the efficiency of gas extraction has been improved.

(1) Cross-Layer Drilling Extraction

Cross-layer drilling extraction is mainly used for pre-extraction of coal seam gas in mining areas. Drilling is arranged in the coal seam floor or roof, penetrating the coal seam for extraction. This method has the advantages of a wide extraction range and good effects, but drilling construction is difficult and costly. The mine focuses on the layout parameters and construction quality of the drilling during implementation to ensure extraction effectiveness.

(2) Along-Layer Drilling Extraction

Along-layer drilling extraction is mainly used for gas extraction in the same coal seam, with drilling arranged parallel to the coal seam. This method is simple to construct and cost-effective, but the extraction effect is significantly influenced by coal seam permeability. The mine optimizes drilling parameters and extraction processes during implementation to improve extraction efficiency.

(3) Upper Corner Pipe Burying Extraction

Upper corner pipe burying extraction is mainly used for gas control in the upper corner of coal mining faces. Extraction pipes are buried in the upper corner to extract accumulated gas. This method is simple to operate and effective, but requires attention to pipe maintenance and explosion-proof issues. The mine strengthens pipe maintenance and monitoring during implementation to ensure extraction effectiveness.

3.2. Regional Outburst Prevention Measure

The mine has adopted various regional outburst prevention measures, including mining protective seams, pre-extraction of coal seam gas, and hydraulic slotting, to reduce gas pressure and content in coal seams and eliminate outburst hazards.

(1) Mining Protective Seams

Mining protective seams is an effective regional outburst prevention measure. By prioritizing the mining of non-outburst-hazardous or less hazardous coal seams, the protected seam undergoes pressure relief and gas emission, thereby reducing its outburst hazard. The mine has promoted soft rock protective seam mining technology in the Ji San mining area, achieving good outburst prevention effects. By mining soft rock protective seams, the gas pressure and content in the protected seam have been effectively reduced, providing a guarantee for the safe mining of subsequent coal faces.

(2) Pre-Extraction of Coal Seam Gas

Pre-extraction of coal seam gas is another important regional outburst prevention measure. It involves long-term, large-scale gas extraction from coal seams before mining and excavation to reduce gas pressure and content. The mine has formulated detailed pre-extraction plans based on coal seam occurrence conditions and gas emission situations, and strictly implements them. Through pre-extraction, the outburst hazard of coal seams has been effectively reduced, ensuring the safe progress of mining and excavation work.

(3) Hydraulic Slotting

Hydraulic slotting is a new regional outburst prevention technology that uses high-pressure water jets to cut coal bodies, increasing coal seam permeability and improving gas extraction efficiency. The mine has trialed hydraulic slotting technology in some areas, achieving initial success. Through hydraulic slotting, coal seam permeability has been effectively increased, improving gas extraction efficiency and providing new technical means for regional outburst prevention.

ISSN: 1813-4890

3.3. Local Outburst Prevention Measure

In addition to regional outburst prevention measures, the mine has also adopted various local outburst prevention measures, including advanced drilling for gas emission, hydraulic punching, and metal frameworks, to address outburst hazards in specific areas.

(1) Advanced Drilling for Gas Emission

Advanced drilling for gas emission involves arranging a certain number of drill holes in front of mining and excavation faces to emit gas from the coal seam, reducing gas concentration and pressure in the face. This method is simple to operate and effective, making it a common local outburst prevention measure. The mine focuses on the layout parameters and construction quality of the drill holes during implementation to ensure emission effectiveness.

(2) Hydraulic Punching

Hydraulic punching uses high-pressure water jets to impact coal bodies, forming holes and emitting gas. This method is suitable for hard coal seams with poor permeability, as punching can increase coal seam permeability and improve gas extraction efficiency. The mine has trialed hydraulic punching technology in some areas, achieving initial success.

(3) Metal Frameworks

Metal frameworks involve driving a certain number of metal rods into the coal seam to form a framework structure, increasing coal body stability and outburst resistance. This method is suitable for soft coal seams prone to outbursts, and the supporting effect of metal frameworks can effectively prevent coal and gas outburst accidents. The mine focuses on the material and layout parameters of the metal rods during implementation to ensure supporting effectiveness.

3.4. Evaluation of Gas Control Effect in Coal Mine

(1) Gas Extraction Effects

By comparing and analyzing data such as gas concentration, pressure, and extraction volume before and after gas extraction, the gas extraction effects are evaluated. Results indicate that the mine's gas extraction system operates stably with high extraction efficiency, effectively reducing gas pressure and content in coal seams. Especially after implementing the new "three-zone linkage" gas control mode above and below the mine, the gas extraction rate has increased from 40% last year to over 75%, achieving a historic breakthrough.

(2) Regional Outburst Prevention Effects

By monitoring gas pressure, content, and outburst hazard indicators in coal seams, the effects of regional outburst prevention measures are evaluated. Results show that the regional outburst prevention measures adopted by the mine have effectively reduced the outburst hazard of coal seams, ensuring the safe progress of mining and excavation work. Especially in mining protective seams and pre-extracting coal seam gas, significant outburst prevention effects have been achieved.

(3) Local Outburst Prevention Effects

Through on-site observation and data analysis, the effects of local outburst prevention measures are evaluated. Results indicate that the local outburst prevention measures adopted by the mine have played an important role in addressing outburst hazards in specific areas, effectively preventing coal and gas outburst accidents. Especially in advanced drilling for gas emission and hydraulic punching, good outburst prevention effects have been achieved.

4. Discussion

4.1. Existing Problems

(1) Contradiction between Mining Intensity and Gas Control

ISSN: 1813-4890

As mining intensity increases, gas emission also rises correspondingly, posing greater challenges for gas control. Despite implementing a series of gas control measures during the mining process, this mine still struggles to fully meet the gas control demands brought about by increased mining intensity.

(2) Need for Further Improvement in Gas Control Technologies

Although the mine has achieved certain results in gas control, there is still a need for further improvement in gas control technologies. For instance, in terms of gas extraction, there is still room for enhancing extraction efficiency. In regional outburst prevention, there is a need to further explore new outburst prevention technologies and methods.

(3) Room for Improvement in Safety Management Levels

Safety management is a crucial guarantee for gas control. Although the mine has made certain achievements in safety management, there is still room for improvement in safety management levels. For example, in areas such as on-site supervision and inspection, as well as hidden danger identification and treatment, further strengthening is needed.

4.2. Improvement Suggestions

(1) Optimize the Matching between Mining Processes and Gas Control Technologies

To address the contradiction between mining intensity and gas control, it is suggested to further optimize the matching between mining processes and gas control technologies. For example, in terms of the advancement speed of coal faces, reasonable adjustments can be made according to gas control needs. In gas extraction, extraction parameters and processes can be optimized to improve extraction efficiency.

(2) Strengthen the Research and Application of Gas Control Technologies

To address the need for further improvement in gas control technologies, it is recommended to strengthen the research and application of gas control technologies. For instance, new gas extraction technologies and methods can be explored to enhance extraction efficiency. New regional and local outburst prevention technologies can be developed to reduce the outburst hazard of coal seams.

(3) Enhance Safety Management Levels

To address the issue of safety management levels needing improvement, it is suggested to strengthen safety management work. For example, on-site supervision and inspection, as well as hidden danger identification and treatment, can be strengthened to ensure the effective implementation of various safety measures. Safety education and training can also be enhanced to improve employees' safety awareness and operational skills.

5. Conclusion

This paper, through an in-depth analysis of the current state of mining intensity and gas control at Pingdingshan Coal Mine, has unveiled the challenges faced in gas control during the mining process and proposed targeted improvement suggestions. By implementing a series of gas control measures, the mine has effectively reduced the risk of gas disasters. However, in the future, the coal mine should continue to strengthen research and practice concerning the balance between mining intensity and gas control, continuously optimizing mining processes and gas control technologies. Moreover, it is crucial to enhance communication and collaboration with other mines to jointly drive progress and development in mining intensity and gas control technologies within the coal industry. Through sustained efforts and innovative practices, the mine can further elevate its mining intensity and gas control standards, thereby making greater contributions to safety production and economic efficiency improvements.

ISSN: 1813-4890

References

[1] Guo Huaiguang. Research and Discussion on the Inducing Mechanism of Gas Dynamic Disasters in Deep Coal Seams [J]. China Coal, 2023, 49(05): 43-49.

[2] Yang Ke, Guo Penghui, Yuan Liang, et al. Research Progress on the Main Controlling Factors and Mechanisms of Typical Dynamic Disasters in Deep Mining Coal Mines [J/OL]. Journal of China Coal Society, 1-23.

[3] Zhang Fazheng. Analysis of the Current Situation of Gas Control in Pingmei No.13 Mine [J]. Inner Mongolia Coal Economy, 2021, (02): 68-69.

[4] Sun Xiaomin. Demonstration on the Selection of Protective Seams for Outburst-prone Coal Seam Groups in Pingmei No.13 Mine [J]. Shandong Coal Science and Technology, 2024, 42(10): 69-73+100.

[5] Gao Jiancheng, Ning Xiaoliang, Qin Muguang. Application of Outburst Prevention Early Warning Technology for Coal Seams with Deep Dynamic Disasters in Pingmei No.13 Mine [J]. Coal Mine Safety, 2020, 51(05): 150-153.

[6] He Shudong, Zhu Feng, Pu Yang. Research and Practice on Anchor-grouting Support Technology in Pingmei No.13 Mine [J]. Coal Technology, 2015, 34(08): 76-78.

[7] Han Futao, Yang Xiaofeng, Zhao Xuguang. Development Characteristics and Distribution Patterns of Tectonic Coals in Pingmei No.13 Mine [J]. Energy and Environmental Protection, 2018, 40(05): 148-150.