Typical Coal Mines in Hancheng Mining Area of China and its Management Research

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Abstract. In order to promote the work of prevention and management of coal mine water disaster in China, it took Panlong coal mine, Xiayukou coal mine and Xiangshan coal mine in Hancheng mining area as object of study. Methods of prevention and management of Ordovician limestone water inrush and water inrush from old and empty areas were put forward. Some examples were chosen to approve these methods’ practicability. At last, enhancing management of coal mine and improving stuffs’ comprehensive quality were proposed.

1.Introduction
China is a big country of coal production and consumption. However, water disasters occur frequently in coal mining, which has caused great economic losses and casualties to the country. In the past, the study on the hydrogeological types of coal mines was focused on two aspects. One was about a single coal mine, so as to explore the hydrogeological types of the coal mine and the technical methods for water prevention and control [1]. The other was to analyze the characteristics and development of mine water division in China from the macro perspective of nation [2]. These two kinds of research have promoted the development of mine water prevention and control in China. Based on the research results, three representative coal mines in Hancheng mining area were selected to make a comparison, so as to analyze analyzes the characteristics and root causes of coal mine water disasters in Hancheng mining area from the perspective of regional hydrogeology (Table 1). In addition, the reduction of mine water disaster, not only depends on the advanced mining technology, but the precise management and high personnel quality [3]. Therefore, some methods from these three aspects were proposed to provide valuable references for relevant managers of coal mining enterprises.

Table 1. Comparison of water inrush points in typical coal mines

|                | Panlong coal mine | Xiangshan coal mine | Xiayukou coal mine |
|----------------|-------------------|----------------------|-------------------|
| Water inrush time | \                 | 1975.7.7             | 1975.10           |
| Water inrush site | \                 | 280 Gangue gate       | 240 Shaft drift   |
|                 |                   | Old waste dump slope outside ditch | The second gate in north |
2. Research on Typical Coal Mine

2.1 Technical Research

2.1.1. Research on control technology of Ordovician limestone water

The coal seam floor will be in a relatively safe state when the water pressure is low. Therefore, controlling water pressure is the main measure to avoid water inrush accident of Ordovician limestone[4]. The main methods include as followed.

1) Three-dimensional comprehensive exploration

This is a kind of comprehensive three-dimensional exploration that combines geophysical exploration, geochemical exploration and drilling, which is also with the combination of pumping test and water discharge test. At present, the advanced detection technology is widely used in mine production, that is, the geological exploration work is carried out before or during the production, first exploration, then excavation, and then treatment[5].

2) Water conveyance and depressurization

The Ordovician limestone water in the area where the water inrush coefficient of coal seam floor is greater than 0.6 can be pumped and dredged, reducing the aquifer head pressure below the critical water pressure value, so as to make safe mining work[6].

3) Grouting method

When encountering karst, structural fracture or rock joint, cement slurry can be injected to fill the gap of crack or joint. Grouting also can be used to increase the thickness of waterproof board of bottom plate to make it relatively safe.

4) Change of coal mining method

To reduce the mine pressure and improve the compressive capacity of water resisting floor, room and pillar mining, short wall mining, filling method and filling belt method can be adopted. For the sake of reducing or avoiding the risk caused by rock mass creep leading mechanical strength reduction, manual caving and rapid mining can be applied to reduce the time of hanging roof.

5) Carry out supplementary exploration

With the continuous extension of mine excavation, hydrogeological conditions including Ordovician limestone water and goaf water are constantly changing. It is suggested to carry out necessary hydrogeological supplementary exploration to further investigate the latest hydrogeological conditions of the mine field, so as to ensure the safe production of the mine[7].
2.1.2. Research on control technology of goaf water

The technical core work of water inrush prevention and control in goaf must be to strengthen the exploration and drainage of water in goaf, adjacent old roadway and small kiln, and implement drainage when necessary. The specific methods are as follows.

1) Excavation while exploring

When excavating in the same coal seams, mainly according to the position relationship between the occurrence of the coal seam and the adjacent faces, the method of simultaneous exploration and excavation can be adopted, namely drilling exploratory holes to the adjacent goaf according to a certain height difference or distance. The next steps are to confirm the water level, estimate the water volume, and carry out exploration and drainage.

2) Judging according to symptoms

When excavating between different coal seams, it is judged according to the distance between coal seams and water conditions. When the distance between coal seams is close, there will be water dripping and water drenching. The water accumulation line and water accumulation area can be roughly confirmed, and the water volume can be calculated, and then the water distribution and exploration and drainage can be carried out according to the specific situation.

3) Construction of water retaining wall and disaster resistant wall

Water retaining wall is constructed to block or control the flow passage between the abandoned and in use production system. At the same time, the disaster resistant wall also should be built to prevent the collapse of the original construction facilities in the abandoned system caused by water pressure, mine pressure or other disaster factors, resulting in water inrush and water disaster.

4) Strengthen monitoring

Safety monitoring can provide dynamic information for all departments and leaders, and data and information for commanding production, so as to take preventive measures. In addition, automatic alarm can be realized through data comparison and analysis. Therefore, in daily work, it is necessary to strengthen the monitoring of old pits and goafs.

2.2. Management Research

The total number of coal mines reported by China is 12985. 11504 coal mines of them has carried out the classification of hydrogeological types. There are 78 mines with extremely complex hydrogeological conditions, 827 complicated mines, 4141 medium mines and 6458 simple mines. Their proportion is shown in Fig. 1. However, in previous work of flood control, most of the staff in coal mine only pursue the advanced technology, but neglect the improvement of management system and cultivation of talent quality. Therefore, some methods should be improved.

1) Strengthen daily propaganda

Propaganda is a powerful guarantee for the existence and development of coal mine management. It creates a good atmosphere for safe production, wakes up the paralyzed psychology of the staff, makes the concept of safety production penetrate into the potential consciousness of the staff, strengthens the people’s desire for safety production subjectively and enhances the subjective initiative of safety production.

2) Establish and improve the rules and regulations

In the complex and dangerous work of coal mining, a strict and careful safety regulation is needed to restrict people’s operation and avoid accidents caused by improper operation or mistakes. It can be used to guide how to strengthen monitoring and inspection in rainy season and flood season, and how to specifically and normally operate various works and equipment. Therefore, the establishment of reasonable safety rules and regulations is the guideline and guarantee to guide people to work safely and realize prevention first.
3) Establish safety responsibility system
To achieve safe production, it is necessary to implement the responsibility to all levels of departments and production and business units, to achieve the goal of joint management, responsibility, reward and punishment. Honor and reward shall be given to the individuals and departments who have completed the production tasks continuously and safely or reported to avoid losses in time after discovering the hidden situation of water hazards. And the work units and individuals with responsibility for accidents shall be punished by criticism, dismissal, etc., and shall not be tolerated and dealt with strictly.

4) Improve the engineering and equipment of underground water prevention and control
From the previous coal mine accidents, due to lack of basic information, accident rate in small coal mines with backward equipment is far higher than that of complete information and equipped with advanced large coal mines. The conventional method is to set up waterproof gate in the mining area where has water inrush danger. In the mine where the geological environment is complex and it is not easy to set the waterproof gate, the advanced submersible electric pump with high power, large flow and high lift can be purchased for prevention.

5) Establishment of hydrogeological observation and early warning system
Hydrogeological observation system is a management system set up to timely grasp the change law of groundwater, including water pressure, water temperature, chemical composition and water inflow, and make accurate and reasonable judgment during normal operation. The hydrogeological early warning system refers to the system that informs the staff and leaders at all levels to avoid the disaster as soon as it occurs or is about to happen, which can greatly reduce the loss caused by flood.

6) Establish the management system of abandoned goaf
Water inrush in old goaf has been a persistent disease in the whole coal production, and the most effective treatment method has not been found. The reason is that the information about old pits and goafs is not clear. In order to avoid more potential safety hazards caused by future coal mining and prevent more water inrush accidents, it is necessary to report the important information of abandoned goaf.

2.3. The cultivation of personnel quality
1) Enhance the sense of responsibility
For every link of coal mine safety production, every personnel have corresponding responsibilities, which may affect not only whether the front-line mining workers can operate according to the regulations, but whether the coal mine information provided by the relevant safety departments is true or not. It may even influence whether the designers can make accurate and thorough analysis reports for each coal mine.

2) Increase professional knowledge
The existing personnel structure of China’s coal mining enterprises lack necessary professional knowledge. Many employees are unable to identify the warning information of water inrush, which leads to water disasters and tragedies. Therefore, regular and long-term supply of professional basic
knowledge and new knowledge and methods for coal mine technicians, as well as the cultivation and promotion of high-tech, high-quality talents, is another reliable guarantee for coal mine safe and sustainable production.

3) Supplementary rescue knowledge

It is an effective way to reduce casualties and increase the possibility of survival by providing emergency rescue knowledge to front-line staff\[14\]. After the occurrence of mine water inrush accident, the front-line staff must know the best escape means and first-aid knowledge. The coal mine unit should join this series of knowledge lectures in the usual staff training, and even hold disaster prevention practice exercises regularly to train employees’ escape skills in the disaster environment.

3. Conclusion

1) The prevention and control technology of Ordovician limestone water is presented from five aspects, including three-dimensional comprehensive exploration, water conveyance and depressurization, grouting method, changing coal mining method and carrying out supplementary exploration. It also gives the prevention and control technology methods of gob water from four aspects: exploring while digging, judging according to signs, building water retaining wall and disaster resistance wall, and strengthening monitoring.

2) The methods of management improvement proposed include six aspects, namely strengthening daily propaganda, establishing and perfecting various rules and regulations, establishing safety responsibility system, improving underground water prevention and control engineering and equipment, establishing hydrogeological observation and early warning system. The methods of the improvement of personnel quality are given from three aspects: strengthening sense of responsibility, increasing professional knowledge and supplementing rescue knowledge Qualitative method.

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