Research on Safety Technology of High Gas and Easy Spontaneous Combustion Coal Seam Based on Computer

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Abstract. Coal mining working face is easy to produce and gather gas, so the occurrence of coal mine natural fire is very easy to induce gas explosion accident, which further aggravates the damage of coal spontaneous combustion, making the current domestic coal mine safety production situation is not optimistic. On account of this, this paper first analyzes the current situation and problems of safety production in coal mining, then studies the characteristics and laws of spontaneous combustion of high gas coal seam, and finally gives the application of safety technology of high gas and easy spontaneous combustion coal seam on account of computer.

Keywords: Safety Technology, High Gas and Easy Spontaneous Combustion Coal Seam

1. Introduction
In recent years, with the technological innovation and management innovation, especially the in-depth application of modern technology represented by computer intelligent technology in coal mining activities, the probability of coal mining accidents has been significantly reduced. However, as one of the more serious accidents in coal mine, coal spontaneous combustion fire is still emerging from time to time in recent years, and has brought more serious consequences and losses. Due to the coal mining working face is easy to produce and gather gas, so the occurrence of coal mine natural fire is very easy to induce gas explosion accident, which further aggravates the damage of coal seam spontaneous combustion, especially for the coal seam with high gas and easy spontaneous combustion, the consequences of fire accident are often more serious.

For the high gas spontaneous combustion coal seam fire accident is often accompanied by large personnel and property losses, a serious threat to the normal and stable mining operations and activities of the coal mine, so it is necessary to strengthen the application of safety technology for high gas and easy spontaneous combustion coal seam. For the coal mine with high gas and easy spontaneous combustion, it often has several typical characteristics as shown in Figure 1, which makes the normal mining activities of coal face more serious impact and threat. In addition, because of the high gas and easy spontaneous combustion, the gas in the coal seam will overflow with the coal wall, and spread rapidly in the mining roadway. Therefore, it is necessary to maintain the ventilation
of the mining roadway; otherwise the gas concentration will exceed the limit and cause the hidden danger of gas explosion.

![Diagram showing complex occurrence conditions leading to high gas seams, large gas storage capacity leading to high coal seam gas content.](image)

**Figure 1.** Typical characteristics of the coal mine with high gas.

Due to the complex environment of coal mining face, the effect of reducing gas concentration by using traditional construction gas drainage roadway or borehole to drain gas from coal body and goaf is not very good\(^1\). Moreover, the improper operation of this method will bring more serious consequences, for example, it may lead to the high negative pressure in the goaf, so that the pressure difference inside and outside the gas exhaust roadway is too high, and the air leakage in the goaf will lead to spontaneous combustion of coal seam. And this method cannot reduce the gas concentration in the area with poor ventilation, so there is still the hidden danger of gas overrun. Therefore, it is urgent to carry out in-depth analysis on the safety technology of high gas and easy spontaneous combustion coal seam.

On the other hand, with the iterative development of computer intelligence technology, it plays an increasingly irreplaceable role in intelligent monitoring, early warning and management. Thus, the application of computer security technology in the mining process of high gas and easy spontaneous combustion coal seam can effectively guide the prevention and control of spontaneous combustion fire in high gas and easy spontaneous combustion mine, and improve the prevention and control technology level of coal seam spontaneous combustion fire, which can play a significant role. Therefore, it is of great practical value to study the prevention and control technology of spontaneous combustion of high gassy coal seam on account of computer.

### 2. Current situation and problems of safety production in coal mining

#### 2.1. Current situation of safety production in coal mining

In recent years, with the increasing importance of coal production to safety management, and the continuous application of new technology and new concept of safety management, coal mine death accidents in recent years show a significant downward trend\(^2\). From the analysis of the types of coal mining accidents, the total amount of roof, transportation and gas accidents is the largest, and the casualties caused by gas and roof accidents are the most. In addition, although the frequency of gas accidents is lower than that of transportation accidents, the mortality rate is higher, and it is the root cause of one-time extremely serious accidents.

Although the occurrence of coal mine fire is relatively small, its casualties account for a large proportion, which shows that once the coal mine fire accident occurs, it will cause more serious consequences and losses\(^3\). Figure 2 below shows the occurrence law of coal mine fire accidents and gas accidents in recent years. It can be seen that fire and gas are the key to control the casualties of coal mine accidents, and also the key to control large-scale coal mine safety accidents.
Figure 2. The occurrence law of coal mine fire accidents and gas accidents.

From Figure 2 and the above statistical analysis, it can be seen that gas and fire accidents have a great impact on major and extra major accidents in coal mine safety production and have strong correlation. Therefore, effective control of gas and fire accidents is the key to curb major accidents. For the coal seam with high gas and easy spontaneous combustion, the rationality of its ventilation system design and the scientificity of ventilation management have a significant impact on the safety management of gas mine and the normal operation of monitoring and monitoring system. Therefore, it is necessary to strengthen the management at the level of safety technology research and the application of new technology represented by computer technology.

2.2. Problems of safety production in coal mining

For high gas and easy spontaneous combustion coal seam, the different occurrence conditions will lead to significant differences in coal mining methods and application technology, which are mainly determined and restricted by coal mining technology and safety technology\[4\]. The current situation of safety production in the media industry is still not optimistic, the development frequency of major accidents and its consequences are still relatively serious, especially the frequency of gas accidents and fire accidents and the proportion of casualties and losses have been difficult to decline. Looking at the current situation of domestic coal mine safety production, especially the high gas spontaneous combustion coal seam safety production status, we can find that there are still many deficiencies and problems, specific performance of the following aspects. First of all, although the application degree of modern machinery and equipment in some coal mines is very high, but due to the unreasonable mining technology, the ventilation management of the mining roadway is not good, the gas concentration exceeds the standard, the gas overflow and the coal seam spontaneous combustion and other phenomena and realistic threats have always existed, which has become the important crux of safety production accidents.

In addition, at present, for the mining of high gas and easy spontaneous combustion coal seam, although some new technologies and new technologies are gradually applied and implemented, they only provide due guarantee for the safe mining activities of coal mines at the macro level. At the micro level, there are still many deficiencies, loopholes in many links of coal mining, and hidden dangers of safety accidents caused by human factors are still emerging in endlessly.

3. Characteristics and laws of spontaneous combustion in high gassy coal seam

3.1. Spontaneous combustion characteristics of high gas and easy spontaneous combustion coal seam

Spontaneous combustion of coal seam is caused by spontaneous reaction and heat release of coal and oxygen\[5\]. Its formation and development process has typical characteristics of slow and dynamic change, and it will experience a change process of heat release, heat accumulation and temperature rise, and eventually cause combustion. The principle curve of this process is shown in Figure 3 below.
Figure 3. Spontaneous combustion process of coal seam.

In addition, the spontaneous combustion of coal has different presentation on account of different coal types, but the spontaneous combustion of coal needs certain induction conditions, such as the state of floating coal, proper ventilation and oxygen concentration, appropriate thermal storage environment, etc. Only when these conditions are met at the same time, the coal seam will have a slow spontaneous combustion, and after a long dynamic change process, the formation of spontaneous combustion heat generation.

3.2. Spontaneous combustion law of high gas and easy spontaneous combustion coal seam

For high gas and easy spontaneous combustion coal seam, its spontaneous combustion process has certain typical characteristics and laws, which are specifically shown in the following aspects\textsuperscript{[6]}. First of all, the fire of high gas and easy spontaneous combustion coal seam generally occurs in the depth of a certain distance from the coal exposed surface, and only in the range of a certain depth from the loose coal surface, the coal temperature will rise and spontaneous combustion will occur. Secondly, in the process of coal spontaneous combustion, with the increase of coal temperature, the high temperature point always moves against the wind flow, and a lot of heat energy will be stored in the coal and surrounding rock. In addition, as a result of coal oxygen compound heat release, the oxygen concentration has a significant impact on the spontaneous combustion rate of coal. In addition to the high temperature of coal, there are a lot of toxic and harmful organic gases in the spontaneous combustion of coal seam, so it will bring more additional damage.

In addition, for the high gas and easy spontaneous combustion coal seam, its spontaneous combustion also has the following laws and characteristics, that is, the open off cut and stop line of the working face are seriously ignited, the upper and lower air roadways of the working face are seriously ignited, the dynamic movement of the goaf, the large and hidden high-temperature area of the goaf spontaneous combustion, and the difficulty in extinguishing the spontaneous combustion fire in the goaf.

4. Safety technology of high gas and easy spontaneous combustion coal seam on account of computer

4.1. Safety technology of coal seam with high gas and easy spontaneous combustion

The safety technology of high gas and easy spontaneous combustion coal seam on account of computer mainly includes nitrogen fire prevention and extinguishing technology and colloidal fire
prevention and extinguishing technology. In the aspect of nitrogen fire prevention and extinguishing technology, it is mainly on account of the inert effect of nitrogen to reduce the air leakage in the goaf, reduce the contact opportunities between coal and air, and reduce the concentration of oxygen, so as to inhibit the compound reaction speed of coal and oxygen. In addition, nitrogen injection can reduce the explosion limit of gas and other explosive gases, and its diffusion radius is large, and the scope of information coverage is wide. At present, the nitrogen fire prevention and extinguishing technology on account of computer is mainly on account of the computer monitoring results and early warning information to automatically select the timing of nitrogen injection and the amount of nitrogen injection. It has the typical advantages of high precision, fast efficiency and good effect, without manual intervention.

In addition, the technology of colloid fire prevention and extinguishing for coal seam with high gas and easy spontaneous combustion on account of computer is mainly on account of the principle of mixing the base material, accelerator and water solution in a certain proportion, and using the principle of absorbing heat and reducing coal temperature in the process of gelling to realize the principle of fire prevention. This technology has the typical advantages and characteristics of pollution-free, good heat absorption and cooling performance, low cost, simple gelling process and other typical advantages and characteristics, so it has gradually been widely used.

4.2. Safety management strategy of high gas and easy spontaneous combustion coal seam

First of all, from the design level, it should ensure the reasonable design of mining roadway, so as to create the basis of safety production. Secondly, scientific and reasonable mining technology and method should be selected and applied, and the mining technology, technology and sequence should be determined on account of the characteristics of high gas spontaneous combustion coal seam and environmental conditions. In addition, the ventilation roadway system should be further optimized to maintain the same division and low negative pressure operation, control the mining intensity and rhythm of coal seam, and strengthen multiple measures to prevent and control the occurrence and deterioration of coal spontaneous combustion.

5. Conclusion

In summary, as one of the most serious accidents in coal mines, coal seam spontaneous combustion fire still occurs in succession in recent years, and has brought serious consequences and losses. The traditional construction gas drainage roadway or drilling is not very good for reducing the gas concentration of coal and goaf. The application of computer safety technology in the mining process of high gas and easy to spontaneous combustion coal seam can effectively guide the prevention and control of spontaneous combustion fire in high gas and easy to spontaneous combustion coal mine, and improve the prevention and control technology of coal seam spontaneous combustion fire can play an important role. This paper analyzes the safety production problems of coal mining through the research of the present situation and problems of coal mining safety. Through the study of the natural ignition characteristics and rules of high gas and easy to spontaneous combustion coal seam, the law and characteristics of spontaneous combustion are analyzed. Finally, the research on the safety technology of high gas and easy spontaneous combustion coal seam on account of computer is carried out, and the application strategy of security technology is given.

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