

## Research on Gas Drainage Technology of Low-permeability and High-gas Bedding

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**Abstract:** The Yangquan Kaiyuan Coal Mine 3# coal seam is a typical low-permeability high-gas coal seam, which has the problem of unsatisfactory gas drainage effect. For the status quo, the current status of gas drainage in Kaiyuan Coal Mine is summarized, and the main influencing factors affecting gas drainage are analyzed. Then the gas drainage of the 3# coal seam is carried out by using the three-dimensional cross-drilling gas drainage technology. Field practice shows that after the implementation of this technology, the average 100m extraction of the 3# coal seam working face reaches  $0.0212\text{m}^3/\text{min}\cdot\text{hm}$ , and the attenuation coefficient is  $0.0707\text{d}^{-1}$ , which has achieved good drainage effect.

### 1. Introduction

Shanxi Yangquan Coal Industry Group Kaiyuan Co., Ltd. is located 14km northwest of Shaxi Shouyang. At present, the actual production capacity of the mine is 3 Mt/a. The mine has a geological reserve of 390 million tons, a recoverable reserve of 140 million tons, and a design service life of 47 years. The mine shaft area is  $27.5\text{km}^2$ , the mining coal seam is No.3 coal seam, and the absolute gas emission amount is  $97.03\text{m}^3/\text{min}$ , which belongs to the high gas mine. The permeability coefficient of 3# coal seam is  $0.1127\text{m}^2/\text{MPa}^2\cdot\text{d}$ , the natural gas flow attenuation coefficient of the 100m coal seam of 3# coal seam is  $0.145\text{d}^{-1}$ . Moreover, the coal seam permeability coefficient is less than 0.1, and the Kaiyuan coal mine 3# coal seam is difficult to pump coal seam.

Mine gas drainage is currently the most effective way to solve mine gas emission and prevent gas overrun. Considering that the concentration of gas drainage in the 3# coal seam 9804 coal mining face is 20%, some even less than 10%, indicating that the pumping effect is not ideal. Therefore, according to the Basic Coal Mine Gas Drainage Index (AQ1026-2006), active and effective gas drainage technology must be adopted for the 9804 working face. The effect of gas drainage in coal seams is affected by many factors, which are mainly affected by the permeability coefficient of the coal seam, which plays a decisive role in the pumping effect. In addition, the drilling drainage effect is also affected by different factors such as pumping mode, drilling arrangement mode, drilling parameters, sealing effect, pumping and negative pressure. Therefore, this paper focuses on the effect of three-dimensional cross-drilling on the gas drainage effect of the 3# coal seam 9804 working face in Kaiyuan Coal Mine.

### 2. Analysis of influencing factors

According to the gas extraction technology and the mining technology of the fully mechanized mining face in coal mine production, the current situation of gas drainage in Kaiyuan Coal Mine of Yangquan Mining Area was analyzed and summarized. The main problem affecting gas drainage is that the pipeline pumping device is not Too reasonable, low gas drainage concentration, can not

effectively carry out gas drainage, drainage process, drilling construction process, pumping method and extraction system have to be improved and urgently need to improve the measurement of gas drainage and related test equipment, Promote the improvement of gas drainage. The main performance are as follows.

(1) Drilling construction. The mining face of the mining face is generally drilled in parallel along the working face. The distance between the holes in the groove is not more than 5m. Because the coal seam is soft and the hole formation rate is low, the drilling depth is generally between 30~120m.

(2) Sealing method. The drilling sealing material is made of polyurethane. The sealing length is generally not more than 3m, the sealing length is short, the drilling gas drainage concentration is low, and the gas drainage concentration of the bedding hole is below 20%.

(3) Extraction negative pressure. According to the actual collected data, the negative pressure of the pre-drainage of the working face is generally below 3 kPa, which cannot meet the requirements of pre-extraction of the coal seam.

(4) Drainage compliance. Mines generally lack the evaluation methods for the investigation of gas drainage effects. It is impossible to clearly understand the occurrence of gas content before extraction and the gas condition after extraction. It is recommended to establish a laboratory for direct measurement of mine gas content to investigate the effect of extraction. At the same time, it provides technical means for the next step of mine mining and gas control.

(5) Basic parameters of gas. There is a general lack of basic parameters for the occurrence of mine gas, and it is not possible to effectively incorporate the testing of basic gas parameters into the daily management process. It is recommended to study the law of gas occurrence in mining areas, establish a dynamic gas storage system for mines, and effectively grasp the mines. The occurrence of gas has laid the foundation for gas control.

(6) Extraction system aspects. The operation status of the mine drainage system is unreasonable, and the role of the extraction system cannot be fully utilized. There is a problem that the capacity of the extraction system is low, and the production scale of the mine does not match. It is necessary to evaluate and optimize the extraction system of the mine to facilitate Adjustments and modifications to the system.

### **3. Three-dimensional cross drilling layout**

According to the underground mine site of No. 3 coal seam of Kaiyuan Coal Mine, the test area for the study of the drilling technology of the three-dimensional cross-drilled pre-drained hole drilling is determined in the area of 9804 working face. The distance between the three-dimensional cross-drilling arrangement is 3m, 20 holes are drilled, the holes are arranged in a three-eye arrangement, and the holes are in the high position. The opening height is 1.5m, the working surface is 85°, and the drilling elevation angle is 3°. The hole with the opening in the lower position has a height of 1.3m, the elevation angle of the hole is 3°, and the working surface is 75°. After completion, 10 holes were selected for effect inspection. The arrangement of the three-dimensional cross-drilling is shown in Fig.1. The drilling parameters are shown in Table 1. The length of the drilling hole is 36~102 m, and the diameter of the drilling hole is 113 mm. The drilling sealing material is made of polyurethane, and the sealing tube is made of double-resistance (anti-static, flame-retardant) polyethylene tube, and the length of the sealing section is 8m. After the hole is sealed, the borehole sealing pipe is connected with the pumping pipe of the working face by a DN65 serpentine pipe.

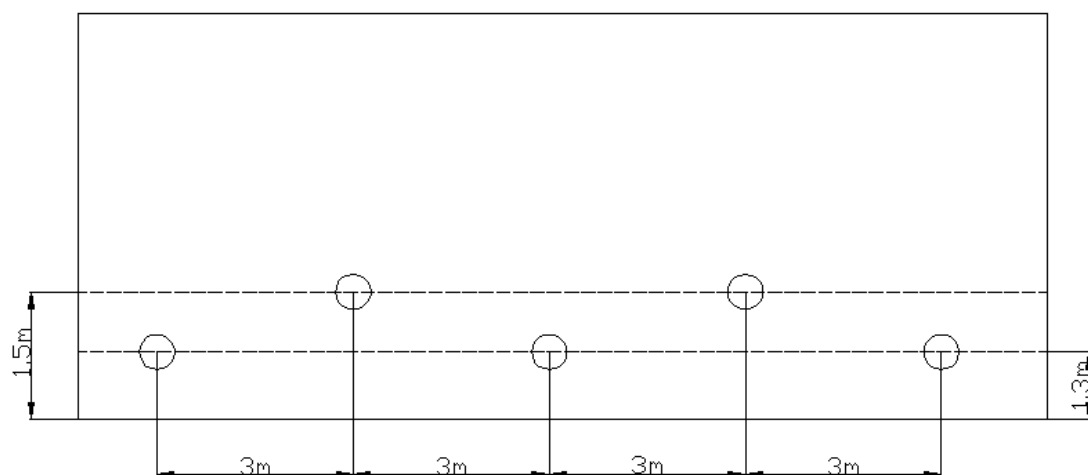


Fig.1 Three-dimensional cross drilling layout

Table 1 Three-dimensional cross-extraction drilling parameters

Hole number	Angle with the roadway/(°)	Inclination /(°)	Aperture/mm	Hole depth /mm	Drilling distance/m
1	85	2	113	94	3
2	75	2	113	100	3
3	85	2	113	91	3
4	75	2	113	100	3
5	85	2	113	35	3
6	75	2	113	42	3
7	85	2	113	102	3
8	75	2	113	100	3
9	85	2	113	60	3
10	75	2	113	44	3
11	85	2	113	102	3
12	75	2	113	36	3

#### 4. Three-dimensional cross-drilling drainage effect inspection

The influence of the extraction parameters on the single hole of 12 drill holes in the three-dimensional cross-drilling of the 9804 working face was carried out. The extraction characteristics of the No.1 borehole in the test are shown in Fig.2 and Fig.3. The negative pressure of the pumping is 0.5~4kPa, the extraction concentration is 66.5%~82.9%, and the single hole extraction amount is 0.013~0.028m<sup>3</sup>/min.hm.

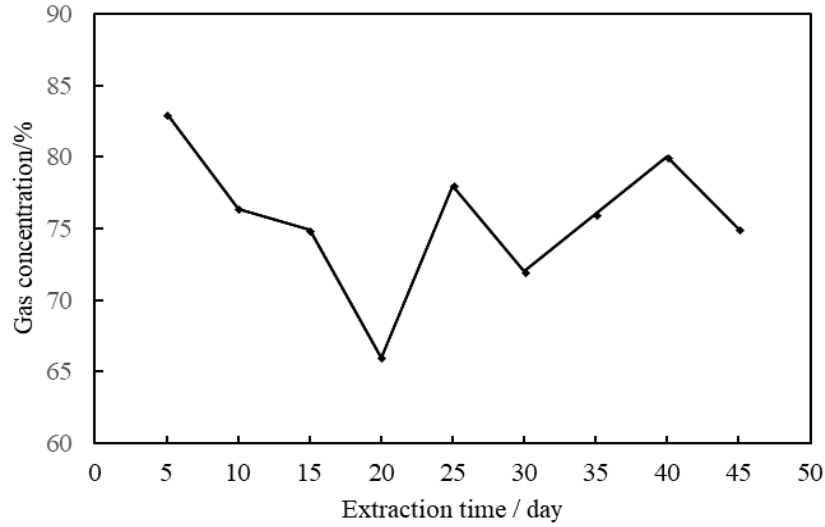


Fig. 2 Trend of gas concentration characteristics of test 1# borehole extraction

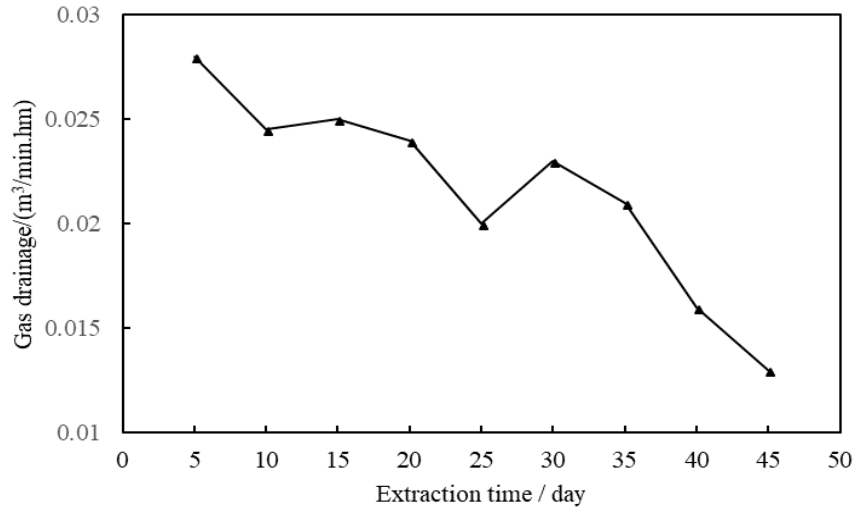


Fig.3 Trend of gas flow characteristics of test 1# borehole extraction

Through the summary analysis of the above test drilling, it can be known that the average 100-meter extraction volume of the three-dimensional cross-drilling hole reaches  $0.0212 \text{ m}^3/\text{min} \cdot \text{hm}$ , and the attenuation coefficient is  $0.0707 \text{ d}^{-1}$ .

## 5. Conclusion

The gas drainage of the 9804 working face of No. 3 coal seam in Kaiyuan Coal Mine is carried out by using the three-dimensional cross-drilling pre-draining layered borehole extraction technology. The average 100-meter extraction volume reached  $0.0212 \text{ m}^3/\text{min} \cdot \text{hm}$ , and the attenuation coefficient was  $0.0707 \text{ d}^{-1}$ . Through the field practice, it is confirmed that the three-dimensional cross-drilling gas drainage technology can achieve better gas drainage effect.

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