Study on the secondary plugging technology of drilling through the floor through drainage

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Abstract. According to the analysis and research results of the leakage channels of the boreholes in the coal mine face, the secondary plugging area of the leakage boreholes was determined, and the secondary plugging technology of "new extraction pipe + ‘one plug, one injection’" was formulated. And field test investigation was carried out. The research results show that after adopting the new secondary plugging technology for gas drainage, the concentration of gas drainage increases by 5~20 times, and the pure flow rate of gas drainage increases by 5~23 times, indicating that the drainage effect has improved significantly, which proves the feasibility of the secondary plugging technology.

1. Introduction

The Daping Coal Mine of Zhengzhou Coal Group is 1820~3800m long from north to south, 1700~2400m wide from east to west, with an area of 4.7652km². The approved production capacity is 900,000 tons/year. The mine development method adopts vertical shaft single-level up and downhill development. The main shaft and auxiliary shaft are both vertical shafts. The main shaft is 254.00m deep, the shaft diameter is 4.50m, the auxiliary shaft depth is 262.83m, and the shaft diameter is 6.00m. The bottom of the shaft is the roof of the 21st coal seam. The 21 coal seam was not exposed. The coal mining method is the strike (inclination) longwall blasting and top coal caving at one time, the full height and all caving mining method. The mine is mainly mining the 21st coal seam, with a limited mining elevation of +229m~ -250m. The mine adopts the extraction ventilation method and the mixed ventilation method, the auxiliary shaft is the air inlet shaft, and the east and south air shafts are the return air shafts. After years of mine gas level identification, the absolute gas emission is 2.28~28.88m³/min, the relative gas emission is 5.55~18.94m³/t, and the mine gas level changes from low to high to outburst[1-2]. The mine is equipped with a separate source and separate gas drainage system combined with the upper and lower shafts, with a total installed capacity of 590m³/min. One set of permanent surface gas drainage pumping stations and four underground gas drainage pumping stations have been established.

At present, Daping Coal Mine is mainly used to extract coal seam gas by arranging floor-through drilling. The drainage system is designed to meet the drainage requirements, the pre-drainage time is sufficient, and the drainage negative pressure is the maximum rated drainage negative pressure that the
gas drainage pump can reach. However, in the process of gas drainage, the gas concentration in the borehole decays quickly and the pure flow of the drainage is small, which seriously affects the safe production of the mine [3-5].

2. Analysis of the secondary plugging section of the drilling hole through the floor through the layer
The study area is located in the west section of the upper exploration lane of Daping Coal Mine 21, and along with the east section of the upper exploration lane of 21 and the undercut tunneling, drill through the seam in the 21091 working face to pre-drain the coal seam gas in the 21091 working face. Through-bed drilling adopts the "one plug, one injection" sealing process, that is, the bottom of the borehole is blocked with polyurethane, and cement mortar is injected along the grouting pipe to the drainage hole, and the cement mortar is stopped after returning from the flower eye section of the drainage pipe grouting work.

The length of the sealing section is the actual length of the extraction pipe. Through sealing quality inspection and air leakage channel analysis, it is found that the air leakage channels of floor penetration boreholes are mainly concentrated in the range of 0~10m from the orifice. This area is the pressure influence zone of the roadway and mine that suffering from stretching, dislocation, etc., the extraction pipe and sealing material are damaged, forming a leak channel.

Combined with the phenomenon of flattening and fracturing found in the drilling extraction pipe during the field observation, it is determined that the floor penetration drilling extraction pipe and the sealing material have been completely destroyed under the action of the mine pressure, and the drilling gas leakage has been formed the main channel. The key area for the secondary plugging of air leakage drilling should be to plug the air leakage cracks of the original plugging section, rebuild the plugging section, and focus on plugging the cracks within 0~10m from the orifice.

3. Secondary plugging technology for drilling through the floor through layer drainage
3.1. Blocking technology
The technical process of the secondary plugging of the bottom penetration drilling should follow the principles of no drilling, simple process, practical and effective. Based on the above-mentioned principles, this study makes full use of the original low-concentration boreholes, and proposes two technical processes to directly plug the air leakage channels of the original boreholes.

(1) Using the original extraction pipe, implement "two plugs and one injection" grouting under pressure in the hole

The idea of this plan is to use the original extraction pipe of the low-concentration borehole, put a self-made mechanical "two plugs and one injection" plugging device into the extraction pipe, implement pressure grouting, plug the leaking channel, and repair the For the damaged sealing section, after the grouting is completed, the sealing device is withdrawn and the original drainage pipe is used to continue drainage. The two ends of the "two plugs and one injection" sealer are capsule sealers. The capsule sealer is filled with high-pressure water, and the two capsules are filled with expansive cement. The water injection expansion pressure of the capsule is 1 MPa, and the pressure of the cement slurry under pressure is 1 MPa. The grouting section is set in the area where the gas concentration in the borehole drops sharply. The schematic diagram of "two plugs and one injection" secondary plugging is shown in Figure 1.

Before the secondary plugging, close the valve at the junction of the drainage borehole and the drainage pipe network, and disconnect it from the drainage pipe network. The secondary plugging device is connected with the grouting pipe. Then send the connected grouting equipment along the extraction pipe into the borehole to the predetermined grouting position, and use the manual high-pressure water injection pump to inject water into the capsules at both ends, and then use the grouting pump to inject the cement mortar into the capsules after reaching the predetermined pressure. The reserved grouting section in the space, the grouting pressure is 1MPa, and to keep the pressure for half an hour after
grouting. After the holding time reaches the predetermined time, the capsule is depressurized, the sealing device is withdrawn, and the excess cement mortar is discharged.

Figure 1. Schematic diagram of secondary plugging of "two plugs and one injection"

According to field tests, due to serious borehole deformation, the original plugging pipes have various degrees of flattening and fracturing. The self-made plugging device cannot be sent to the predetermined plugging section, and the secondary plugging cannot be effectively implemented.

(2) Use the original extraction pipe to feed the thin casing, and implement "one plug, one injection" grouting in the hole

The idea of this scheme is to use the original extraction pipe of low-concentration boreholes, put a thinner extraction pipe and a thin grouting pipe in the extraction pipe, and use anchoring agent to seal and fix the orifice, and use grouting the pipe injects cement slurry into the gap between the new extraction pipe and the original extraction pipe to block the leaking channel and repair the damaged sealing section. After the grouting is completed, the new extraction pipe is used to continue the extraction.

The new extraction pipe and grouting pipe are aluminum-plastic pipes with a diameter of 16mm. The length of the new extraction pipe shall not be less than the length of the original extraction pipe (pipe section containing flowers), one end is pierced with flowers, and the other end is connected to the extraction pipe network. The length of the grouting pipe is 2m. When implementing on-site, the new extraction pipe is first sent to the bottom of the borehole, and then the grouting pipe is inserted, and the orifice is blocked and fixed with an anchoring agent. The cement slurry is sent into the gap between the new extraction pipe and the original extraction pipe through the grouting pipe. When the new extraction pipe returns to the slurry, the grouting is stopped. After the cement has solidified for 48 hours, the new extraction pipe is connected to the extraction pipe network for extraction. Figure 2 shows a schematic diagram of "one plug, one injection" secondary plugging.

Figure 2. Schematic diagram of "one block, one injection" secondary plugging
3.2. Examination of blocking effect
The secondary plugging technology of "new extraction pipe + ‘one block, one injection’" was tested in drill holes 607, 608, 609, 610, and 612 in this study. The second plugging test was conducted and completed on September 19, 2017. After the second grouting, let it stand for two days until the cement is completely solidified, and then the network is drained.

After network drainage, observe the gas concentration and pure gas flow at the orifice of the drainage borehole, and measure every two days. The measurement results are shown in Figure 3 and Figure 4.

![Figure 3](image1.png)
Figure 3. The change curve of the drainage concentration before and after the secondary plugging of the borehole

![Figure 4](image2.png)
Figure 4. The curve of the pure flow rate of the drainage before and after the secondary plugging of the borehole

From Figure 3 and Figure 4, after the second plugging of the leaking boreholes, the gas drainage effect is significantly improved, the gas drainage concentration increased by 5~20 times, an average of
12 times; the pure gas drainage flow increased by 5~23 times, an average of 13 times. The test results directly prove that the serious damage of the original sealing section is the main reason for the leakage of the borehole, and it also verifies the feasibility and reliability of the secondary plugging technical scheme for the drainage borehole, which can be used as a secondary remedial measure for the leakage borehole.

4. Conclusion
According to the analysis and research results of the borehole air leakage channel, the secondary sealing area of the air leakage borehole was determined, and the secondary sealing technology of "new extraction pipe + 'one plug and one injection" was formulated, which was examined by field tests. It proves that the effect of gas drainage is very obvious. It proves that the secondary plugging technology developed in this study is feasible and effective, and it also proves that the destruction of the plugging section of the bottom plate penetration drainage borehole is the main reason for the leakage of the borehole.

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