Research on quality inspection technology of gas drainage borehole sealing hole in Sihe Coal Mine

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Abstract. The quality of the hole sealing of coal seam gas drainage directly determines the efficiency of coal seam gas drainage. This paper uses the YFZ3 gas drainage borehole sealing quality tester to measure the gas drainage parameters at different locations in the borehole W33011 coal seam in Sihe Coal Mine. According to the change law of the measuring point data, it judges the quality of the sealing hole and determines the reasonable sealing depth. The research results show that Sihe Coal Mine should strengthen the training and supervision of underground plugging workers, and strictly control the details of the plugging process, such as the grouting pressure, water-cement ratio configuration and grouting volume during the plugging process. The detection borehole has a serious air leakage channel in the range of 12m~20m, and the sealing depth should be increased to 20m to increase the concentration of single-hole gas drainage.

1. Introduction
The geological occurrence conditions of coal seams in my country are complex, and gas disasters have seriously threatened the safety production of coal mines in our country for a long time [1-2]. Coal seam gas drainage is one of the important technical means to control coal mine gas. The difficult problem of mine ventilation can be effectively solved through gas drainage. Gas drainage mainly relies on drilling and hole sealing. The quality of the hole sealing seriously affects the overall effect of gas drainage. A reasonable sealing depth is a necessary condition to ensure the quality of the drainage borehole sealing and efficient drainage [3].

The sealing quality of coal seam gas drainage boreholes is one of the important factors that affect the efficiency of gas drainage. The quality of coal seam gas drainage borehole sealing directly affects the gas concentration of the drainage boreholes [4-6]. Therefore, combined with the law of gas migration in the coal seam gas drainage borehole, the author uses the YFZ3 gas drainage borehole sealing quality tester to test the quality of the borehole sealing of the W33011 coal seam of Sihe Coal Mine to improve the gas drainage concentration and drainage efficiency.
2. Sealing quality tester details

Coal seam gas drainage borehole sealing quality detector (YFZ3) is mainly used to measure the distribution of gas and oxygen concentration at different depths in the drainage borehole under the state of connected drainage to determine the sealing quality of the drainage borehole and the location of the gas leakage passage of the drainage borehole, so as to improve the sealing method and sealing parameters, and improve the gas drainage effect of the borehole [7]. The YFZ3 coal seam gas drainage borehole sealing quality detector [8] is mainly composed of a host, a gas parameter detection tube, and a quick-connect tee, as shown in Figure 1.

![Diagram showing the components of the sealing quality tester](image)

1. Coal seam, 2. Sealing material, 3. Gas drainage pipe, 4. Gas parameter detection pipe, 5. Quick-connect tee, 6. Drainage hose, 7. Sealing quality tester, 8. Combiner

**Figure 1.** Schematic diagram of the working principle of the sealing quality inspection device

3. On-site testing applications

No.3 coal seam is mined at W3301 working face of Sihe Coal Mine. The ground elevation is +760~+700m, the underground elevation is +475~+440m, the working face length is 1000m, the inclined length is 240m, and the average coal seam thickness is 6.31m. The working face adopts the longwall one-time full-height fully mechanized coal mining method, and the all caving method manages the roof.

3.1. Borehole No. SH-1

Borehole No. SH-1, bedding hole, hole diameter 94mm, dip angle +6°, hole depth 132m, sealing depth 12m, drainage time 18 days, drainage negative pressure 25kpa. The gas and oxygen concentration values of different hole depths in the borehole are shown in Table 1, and the change trend is shown in Figure 2.

**Table 1.** Gas and oxygen concentration values at different hole depths in the borehole No. SH-1

| Distance from orifice(m) | CH₄(%) | O₂(%) |
|-------------------------|--------|-------|
| 24                      | 40.3   | 6.2   |
| 18                      | 36.9   | 7     |
| 10.5                    | 14.9   | 14.2  |
| 4.5                     | 5      | 17.9  |

![Graph showing the change of CH₄ and O₂ concentration values with different hole depths in borehole SH-1](image)

**Figure 2.** The change of CH₄ and O₂ concentration values with different hole depths in borehole SH-1
It can be seen from Figure 2 that the gas and oxygen concentration of the hole SH-1 fluctuates greatly with the increase of the hole depth within the range of 4.5m~20m from the orifice. The gas concentration is reduced from 40% to 5%, and the oxygen concentration is rose from 7% to 17.9%. This shows that the quality of the hole-sealing of the borehole is poor, the air leakage channel around the hole is not effectively sealed during the hole-sealing process, and the depth of the hole is insufficient. The gas concentration value changes drastically in the range of 12m~20m, and the air leakage is more serious. It can be seen from the inspection of the sealing quality that the sealing effect of the hole is poor and the sealing depth is insufficient. The sealing depth should be increased from 12m to 20m. It is suggested that the mine should strengthen supervision and management of underground sealing workers, and provide regular guidance and training on the sealing work.

3.2. Borehole No. SH-2
Borehole No.SH-2, bedding hole, hole diameter 94mm, dip angle +5°, hole depth 90m, sealing depth 12m, drainage time 10 days, drainage negative pressure 25kpa. The gas and oxygen concentration values of different hole depths in the borehole are shown in Table 2, and the change trend is shown in Figure 3.

Table 2. Gas and oxygen concentration values at different hole depths in the borehole No.SH-2

| Distance from orifice(m) | CH₄(%) | O₂(%) |
|-------------------------|--------|-------|
| 24                      | 80     | 2.1   |
| 15                      | 65     | 5.7   |
| 9                       | 37     | 11.5  |

Figure 3. The change of CH₄ and O₂ concentration values with different hole depths in borehole SH-2

It can be seen from Figure 3 that the gas and oxygen concentration values of the borehole SH-2 within the range of 9m~24m from the orifice fluctuate greatly with the increase of the hole depth, and there are air leakage channels in this range. In the range of 9m~12m, the gas concentration value is reduced from 50% to 37%, and the quality of drilling and sealing is poor. In the range of 12m~20m, the gas concentration is reduced from 70% to 50%. The gas leakage in this range is serious, and the hole sealing depth is insufficient. In the range of 20m~24m, the gas concentration is reduced from 80% to 75%, and the leakage phenomenon is weak in this range.

It can be seen from the inspection of the sealing quality that the sealing depth of the hole is insufficient, and the sealing depth should be increased from 12m to 20m. It is suggested that the downhole plugging workers should pay attention to the details of the plugging, reasonably control the grouting pressure, water-cement ratio configuration, and the amount of grouting to improve the quality of the plugging.
4. Conclusion
Through the use of the sealing quality detector to test the quality of the sealing of the extraction borehole in Sihe Coal Mine, it can be known that the gas and oxygen concentration in the detected borehole fluctuates greatly with the increase of the depth of the hole, and the quality of the sealing needs to be improved. The training and supervision of downhole plugging workers should be strengthened, and the details of the plugging such as the grouting pressure, water-cement ratio configuration and grouting volume during the plugging process should be strictly controlled. Use the sealing quality detector to detect different working faces and different areas of the same working face, find the problems in the sealing process in time, and take corresponding improvement measures. Through the analysis and comparison of the detection data, the reasonable sealing depth in different areas is determined, and the quality of the drilling and sealing is improved. The detection borehole has serious air leakage channels in the range of 12m~20m. It is recommended that the sealing depth should be increased to 20m on site to increase the gas drainage concentration of single hole.

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