

Research on Pressure Relief and Effect Inspection of Upper Protection Layer Mining

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Abstract: Mining protective layers is an effective measure to prevent coal and gas outburst. Taking the mining of the upper protective layer of the Wulan coal mine as the research object, theoretical analysis was conducted to calculate the protection range after the mining of the protective layer and the impact range of the coal pillars left in the protective layer. On site inspection was conducted to analyze the outstanding danger of the protected layer. The research results indicate that the mining of the protective layer on the Wulan coal mine has a certain pressure relief effect on the protected layer. The maximum residual gas content of the protected layer in the protected area is 5.21 m³/t, and the maximum gas content of the protected layer in the coal pillar influence area is 6.11 m³/t. The mining area of the protected layer working face is already an area without outburst risk.

Keywords: Coal and gas outburst, Upper protective layer mining, Pressure relief, Danger.

1. Introduction

Coal and gas outburst is one of the most serious disasters in the underground mining process of coal mines [1-2]. At present, most coal and gas outburst mines both domestically and internationally adopt protective layer mining as a regional outburst prevention measure [3-5]. The mining of the protective layer can significantly change the stress strain state and gas dynamic state of the outburst dangerous coal seam, relieve the pressure of the protected layer, release the elastic potential of the coal seam, increase the permeability of the coal seam, facilitate the gas flow and desorption of the protected layer, thereby reducing the gas content of the coal seam and achieving the goal of preventing coal and gas outburst [6-9].

Wulan Coal Mine is one of the main mines of Shenhua Ningxia Coal Industry Group Company, with a designed production capacity of 2.4 million tons/a. The coal mine is a severe coal and gas outburst mine, and its main mining coal seams 2, 3, 7, and 8 are all outburst coal seams. At present, the mine is undergoing a two-level technical transformation. In order to alleviate mining continuity, a fully mechanized mining face, namely 5545 fully mechanized mining face, has been arranged in the locally minable No.5 coal seam. Due to the lack of identification of outburst coal seams in the No.5 Coal Seam, it is necessary to manage them according to the outburst coal seams. The No.3 coal seam overlying the 5545 working face has been mined, but there is a certain width of coal pillar left in the No. 3 coal seam corresponding to the 5545 return air passage, which has a certain impact on the pressure relief range of the No.5 coal seam. Therefore, taking the mining of the upper protective layer of the Wulan coal mine as the research object, this article mainly examines the scope and effectiveness of the pressure relief of the protected layer after mining in order to ensure the safe recovery of the protected layer.

2. Overview of the Working Face

The coal seam mined in the 5545 working face is the No.5

coal seam in the second level first stage (1350-1280 levels) of the southern wing mining area of Wulan Coal Mine. The ground elevation is 1548.2m~1559.2m, and the working surface elevation is 1280.8m~1347.7m. The surface is low and hilly terrain with no buildings. The working face has a strike length of 966m, a dip width of 134m, and an average dip angle of 22 ° in the coal seam. The No.3 coal seam in the upper part of the 5545 working face has been fully mined, but there is an average protective coal pillar of 25m (inclined width) left. The arrangement of the coal pillar is shown in Figure 1.

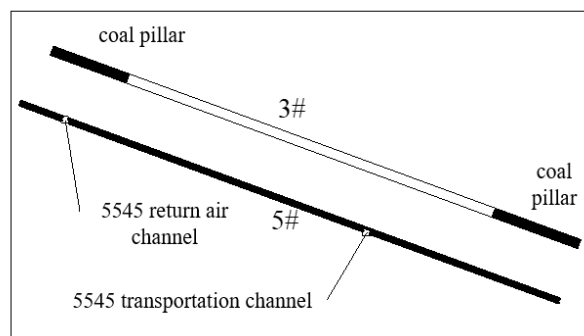


Figure 1. Schematic diagram of coal pillar reservation in No.3 Coal Seam

3. Analysis of the Outburst Prevention Effect of Upper Protection Layer Mining

3.1. Theoretical calculation of the protection range for mining protective layers

(1) Maximum protection vertical distance

The interval between the No.5 coal seam and the overlying No.3 coal seam is 15~25m, with an average of 22.3m. Maximum protection vertical distance of upper protective layer:

$$S=S' \beta_1 \beta_2$$

In the formula, S is the maximum protective vertical distance of the upper protective layer, m ; S' is the theoretical maximum protection vertical distance of the upper protective layer, m ; β_1 is the impact coefficient of protective layer mining; β_2 is the content coefficient of interlayer hard rock (sandstone, limestone).

Based on the actual situation of Wulan Coal Mine, the maximum protection vertical distance for the lower part of the No.3 coal seam after mining is 57.8m. The maximum interval between the No.5 and No.3 coal seams is 25m, indicating that the No.5 coal seam is within the effective protection vertical distance of the No.3 coal seam.

(2) Analysis of the scope of inclination protection

Due to the lack of inspection and analysis of the mining effect of the protective layer in Wulan Coal Mine, the pressure relief protection angle of the protective layer mining along the

coal seam inclination is based on the reference value given in the "Regulations on the Prevention and Control of Coal and Gas Outburst" [10], that is, after the mining of the No.3 Coal Seam, the pressure relief protection angle for the lower coal seam is 73° for the inclined upper part and 76° for the inclined lower part.

According to the results determined by the pressure relief angle, in the upper inclined part of the 5545 fully mechanized mining face, the influence zone of the coal pillar is 18m upward and 23m downward along the inclined direction of the return air channel of the 5545 working face. However, in the lower inclined part, the influence zone of the coal pillar is far from the mining range of the 5545 working face and can not be considered. The influence zone of the coal pillar in the No.5 coal seam is shown in the shaded part of Figure 2.

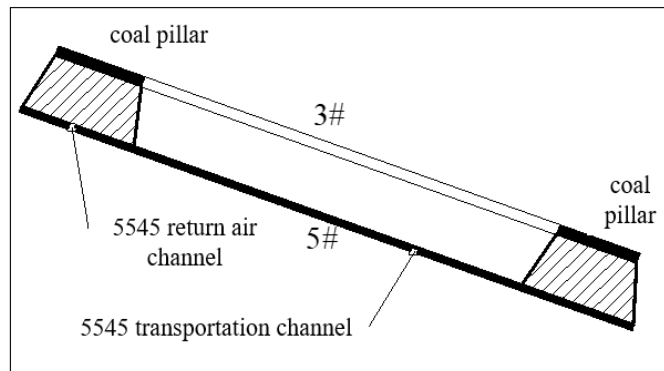


Figure 2. Impact scope of coal pillar in No.3 Coal Seam

(3) Analysis of protection scope

Along the strike direction, the 5344 and 5345 working faces arranged in the No.3 coal seam have all been mined out, and there are no coal pillars left in the strike direction. Therefore, the 5545 working face is within the protection range of the No.3 coal seam in the strike direction.

3.2. Risk analysis of coal seam outburst within the protection scope

In order to investigate the outburst risk of the 5th coal seam within the protection range after mining of the No.3 coal seam, several measuring points were arranged in the No.5 coal seam,

and the method of predicting the outburst risk of the coal seam area was used to analyze the outburst risk of the No.5 coal seam.

(1) Layout and setting of measuring points

Four measurement points are arranged within the mining range of the 5545 working face, and three through layer boreholes are constructed at each measurement point (as shown in Figure 3 for boreholes 1-1, 1-2, 1-3, 2-1, 2-3, 3-1, 3-2, 4-1, 4-2, and 4-3). After the borehole construction enters the coal seam, coal samples are immediately collected and the gas content of the coal seam is measured using the DGC gas content direct measurement device. The construction site of the borehole is the 1280 gas extraction roadway.

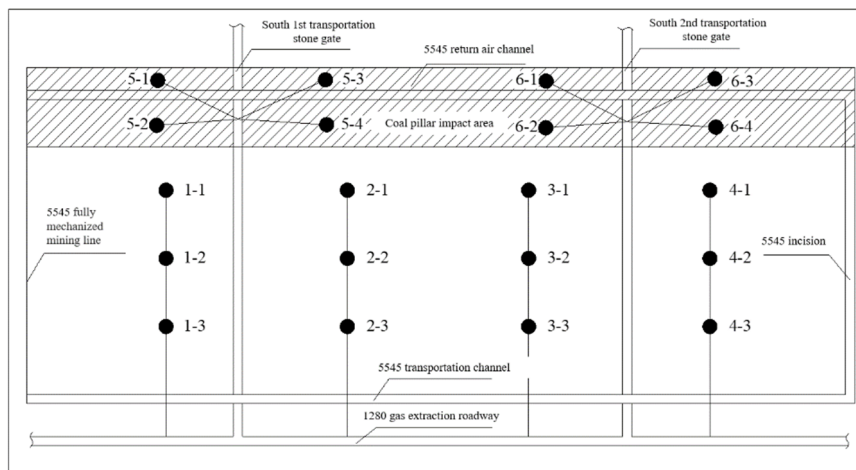


Figure 3. Layout of gas content measurement points in the No.5 Coal Seam

(2) Regional prediction results

The coal seam gas content measured at each measuring

point in the 1280 gas extraction roadway is shown in Table 1. From the Table 1, it can be seen that after the mining of the protective layer, the maximum gas content of the No.5 coal seam within the protection range is 5.21m³/t, which is less than the critical value of 8m³/t in the "Regulations on the Prevention and Control of Coal and Gas Outburst". This indicates that the No.5 coal seam within the protection range is an area without any risk of outburst.

Table 1. Measurement results of coal seam gas content within the protection range

Drill hole number	Gas content (m ³ /t)	Drill hole number	Gas content (m ³ /t)
1-1	4.53	3-1	4.34
1-2	3.86	3-2	4.67
1-3	4.72	3-3	4.86
2-1	3.60	4-1	5.04
2-2	4.02	4-2	5.21
2-3	5.11	4-3	4.78

3.3. Risk analysis of coal seam outburst in the coal pillar impact area

In order to predict the risk of coal seam outburst in the coal pillar affected area of the No.5 Coal Seam, four measurement points were arranged in the coal pillar affected area, and each measurement point was used to construct two through layer boreholes (see Figure 3 for boreholes 5-1, 5-2, 5-3, 5-4, 6-1, 6-2, 6-3, and 6-4), and samples were taken to determine the gas content of the coal seam. The construction sites of the measurement points are the South 1st Transportation Stone Gate and the South 2nd Transportation Stone Gate. The results of gas content measurement of coal samples at each measurement point are shown in Table 2.

Table 2. Measurement Results of Coal Seam Gas Content in the Coal Pillar Affected Area

Drill hole number	Gas content (m ³ /t)	Drill hole number	Gas content (m ³ /t)
5-1	5.56	6-1	4.90
5-2	5.98	6-2	5.69
5-3	4.64	6-3	6.11
5-4	5.61	6-4	5.75

From the Table 2, it can be seen that the maximum gas content in the No.5 coal seam within the coal pillar impact zone of the protective layer mining is 6.11m³/t, which is less than the critical value of 8m³/t in the "Regulations on the Prevention and Control of Coal and Gas Outburst". This indicates that the No.5 coal seam within the coal pillar impact zone is an area without outburst risk.

4. Conclusion

(1) According to the theoretical calculation of the parameters related to the mining of the upper protective layer, the maximum protective vertical distance of the No.3 coal seam after mining is 57.8m, and the No.5 coal seam is within the maximum protective vertical distance. In terms of

direction, the 5545 working face is protected; In terms of inclination, the 5545 return air trough is located 23 meters down the inclined direction in the coal pillar influence area.

(2) According to the results of the gas content measurement of the No.5 Coal Seam, the maximum gas content of No.5 Coal Seam within the protection range is 5.21m³/t, and the maximum gas content of No.5 Coal Seam within the coal pillar influence zone is 6.11m³/t. According to relevant regulations, the coal seam within the mining range of Working Face 5545 belongs to an area without outburst risk.

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