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Experimental Study on the Temporal and Spatial Variation Law of Gas Flow in Different Rock Pillar Drainage Boreholes

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Abstract: In order to study the temporal and spatial variation of gas flow in different rock pillar extraction boreholes, gas pressure, gas content, gas emission from 100-meter coal holes and coal seam permeability coefficient were measured on site. The site inspected the gas flow in the boreholes at 15m, 7.5m, directly above, 7.5m, and 15m at the lower slab of different rock pillar floor roadways. It analyzed the change law of gas flow in boreholes of 710 floor lanes and 505 floor lanes, which provided a basis for the layout of gas drainage boreholes.

1 B4 coal seam gas basic parameter test

1.1 Coal seam gas pressure

This time, the pressure measurement and sealing were carried out with a grouting pump for grouting and sealing. To ensure the quality of the sealing, the whole rock section was sealed with grouting from the upward borehole. When it is estimated that the injected cement slurry is about to reach the position of the screen hole, a technician or senior skilled worker should observe whether there is a backflow phenomenon of clear water at the pressure measurement nozzle. This phenomenon is called slurry return or slurry return. If the grout return is successful, immediately stop the power supply of the hole-sealing pump and the grouting of the hole is completed. Completely close the gate valve of the grouting pipe and disassemble the high-pressure grouting pipe. After the drilling is sealed, it should be cleaned in time to prevent the cement slurry from solidifying or depositing in the grouting pump and high-pressure slurry pipe.

For upward pressure measurement boreholes, if there is water (non-pressure water) in the borehole, when the pressure measurement is finished and the pressure gauge is removed, the amount of water released from the borehole should be measured, and the hole should be sealed according to the drilling parameters The parameter calculates the hydrostatic pressure of the water in the borehole and removes it from the measured pressure.

According to coal seam development and roadway layout conditions, in accordance with the relevant provisions of the "Pressure Measurement Standard", the gas pressure is determined by the direct method, which is the grouting plugging method and the passive pressure measurement method. The measurement results are shown in Table 1.

Table 1. Gas pressure measurement result table

Measurement location	See coal elevation (m)	Gas pressure (MPa)
710 Floor Lane	-622.5	6.0
505 Floor Lane	-783	2.0
-650m Dongda Alley	-615	2.50
-650m West Bypass	-632	1.98

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1.2 Coal seam gas content

Utilize the constructed boreholes, take coal samples and use DGC gas content measuring device to directly measure the gas content of the B4 coal seam. The measurement results are shown in Table 2.

Table 2. B4 Coal Seam Gas Content Measurement Results

Measurement location	**See coal elevation (m)**	**Gas content (m^3/t)**
710 Floor Lane	-622.5	8.99~13.79
505 Floor Lane	-746.9	8.28~22.45
-650m Dongda Alley	-615	14.64
-650m West Bypass	-632	12.52

1.3 Gas emission from 100-meter coal holes and coal seam permeability coefficient

The survey adopts the simple drainage method, and the measured gas emission and attenuation coefficient of 100-meter coal holes are 0.075~0.571 and 0.26~0.4 respectively. The air permeability coefficient of the coal seam is measured by the drilling radial flow method. The main steps are: first, the pressure measurement drilling is constructed in the vertical coal seam, the drilling is sealed and the original gas pressure of the coal seam is measured. When the gas pressure of the pressure measuring borehole stabilizes at the highest value, the pressure gauge is removed to reduce the pressure in the borehole to the ambient atmospheric pressure, so that the borehole naturally discharges gas, and the gas flow rate of the borehole is measured. Finally, substitute the relevant formula to calculate the coal seam permeability coefficient. Through calculation, the air permeability coefficient of B4 coal seam in Shangzhuang Coal Mine is 0.0259~0.0961.

2 Investigation plan for gas flow in drainage boreholes

The simple drainage method is used to test the gas flow in the borehole[1~5]. The hole diameter is Φ75mm. The inspection sites are 710 floor roadway and 505 floor roadway. The thickness of the two roadways and the rock pillars of the overlying coal seam are 15m and 19m, respectively. After the borehole construction, 5 survey boreholes are arranged for each survey content, namely 5 survey positions, which are 15m on the lower bank, 7.5m on the lower bank, directly above, 7.5m on the upper bank, and 15m on the upper bank. Each roadway is tested in three groups, and the specific inspection locations are shown in Table 3.

Table 3. Investigation location of gas flow in drainage boreholes

Roadway	Inspection location (from the head of the tunneling: m)		
	The first group	The second group	The third group
710 Floor Lane	139	95	55
505 Floor Lane	204	168	100

3 The law of gas emission from different boreholes

The simple drainage method was used to measure the gas flow in the boreholes within 15m on both sides of the roof of the 710 and 505 floor lanes in Shangzhuang Coal Mine. The measurement results are shown in Tables 4 and 5, respectively.

Table 4. Measured results of gas flow in boreholes of 710 wind tunnel floor lane (unit: m^3/d)

Number of groups	Time (d)	Lower 15m	Lower 7.5m	Right above	Upper 7.5m	Upper 15m
Head-on 139m (First group)	1	5.28	6.25	14.62	9.14	5.53
	3	5.06	5.94	10.56	5.80	5.53
	4	4.57	5.40	8.64	4.75	4.75
	5	4.40	4.32	5.59	5.06	4.57
	6	3.66	3.55	4.42	4.10	3.77

Head-on 95m (Second Group)	1	4.75	5.96	12.03	7.59	5.21
	3	4.48	5.56	9.64	6.40	4.30
	4	3.83	5.32	7.55	5.67	3.84
	5	3.49	5.71	8.06	4.98	3.91
	6	3.35	5.00	6.92	4.79	3.63
Head-on 55m (The third group)	1	4.17	5.07	8.91	6.23	4.54
	3	3.77	4.88	8.31	6.40	4.30
	4	3.83	4.79	7.55	5.67	3.84
	5	3.49	4.44	8.06	4.98	3.91
	6	3.09	4.37	5.77	4.22	3.29

Table 5. Measured results of gas flow in boreholes of 505 wind tunnel floor lane (unit: m^3/d)

Number of groups	Time (d)	Lower 15m	Lower 7.5m	Right above	Upper 7.5m	Upper 15m
Head-on 204m (First group)	1	3.23	5.66	13.24	9.01	3.39
	3	2.98	5.90	8.11	5.35	2.69
	4	2.67	4.77	9.75	5.79	2.98
	5	2.58	4.11	8.61	6.30	2.61
	6	2.50	3.29	6.67	5.58	2.48
	7	2.38	2.97	8.16	3.64	2.40
Head-on 168m (Second Group)	1	3.33	5.36	11.44	9.01	4.09
	3	2.98	4.90	10.11	7.35	3.19
	4	2.67	4.77	9.75	6.79	1.98
	5	2.58	4.11	8.61	6.30	1.61
	6	2.50	3.69	7.67	5.58	1.48
	7	1.38	2.97	8.16	3.64	1.70
Head-on 100m (The third group)	1	3.23	5.26	9.24	7.01	3.39
	3	2.28	4.90	8.11	6.35	2.89
	4	1.67	4.37	7.75	5.29	2.98
	5	1.58	4.11	6.61	4.30	2.41
	6	1.50	3.49	6.67	3.58	2.18
	7	2.08	2.87	5.16	3.24	2.50

From Tables 4 and 5, we can see that the gas flow in the boreholes at the same observation time at different locations in the 15m coal seams above the 710 and 505 floor lanes is directly above the coal seam, 7.5m lower, 7.5m upper, and lower. 15m, upper upper 15m, and show a trend of gradual attenuation with the passage of time, the order of attenuation is the same as the order of gas flow from large to small. It can be seen that the pressure relief effect of the coal seam above the floor roadway, from strong to weak, is directly above the coal seam, lower bank 7.5m, upper bank 7.5m, lower bank 15m, and upper bank 15m.

The initial gas flow of the boreholes in the 15m coal seam on both sides of the 710 floor lane is the largest directly above, followed by 7.5m on both sides, and the smallest on both sides 7.5~15m. The maximum values are 14.62, 9.14, 5.53m3/d, respectively. The initial gas flow in the 15m coal seam on both sides of the 505 floor lane is the largest directly above, followed by 7.5m on both sides, and the smallest on both sides 7.5~15m. The maximum values are 13.24, 9.01, 4.09m3/d, respectively. It can be seen that the pressure relief effect of the coal seam directly above the floor roadway is in order of 7.5m and 7.5~15m directly above the coal seam, on both sides. The initial gas flow rate of boreholes at the same location shows a gradual decrease from the first group to the third group. It can be seen that with the increase of the excavation time of the floor rock roadway, the amount of gas emission corresponding to the borehole gradually increases, and the pressure relief effect gradually increases.

4 Conclusion

Through the test, it is found that the gas pressure in the B4 coal seam of Shangzhuang Coal Mine is 1.98~6.0MPa, the gas content is 7.04~22.45m^3/t, the coal seam attenuation coefficient is 0.26~0.4d-1, and the gas flow

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rate of the 100-meter borehole is 0.075~0.571m^3/t. Coal seam permeability coefficient is 0.0259~0.0961m^2/ MPa^2•d.

The order of gas emission from the coal seam above the pressure relief floor rock roadway is directly above the coal seam, 7.5m lower, 7.5m upper, 15m lower, and 15m upper. With the increase of the excavation time of the floor rock roadway, the pressure relief effect of the upper coal seam gradually increases, and the amount of gas emission corresponding to the borehole gradually increases. The initial gas flow in the borehole directly above the coal seam is the largest, the maximum is 14.62m^3/d; the second is 7.5m on both sides, the maximum is 9.14m^3/d; the second is 7.5~15m on both sides, the maximum is 5.53m^3/d d. The gas flow in the same relative position of 710 floor lane is greater than that of 505 floor lane.

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