Time Determination of Gas Extraction in Coal Seam Drilling

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Abstract: In order to determine the time of the gas extraction of the solid unstable coal seam, based on the characteristics of the change of gas concentration under the condition of continuous extraction of high negative pressure, the drilling gas parameters were tested on the spot and the gas concentration attenuation curve was drawn, and the law of attenuation of the drilling gas concentration was analyzed comprehensively using gas flow theory and geomechanics-related theory. The results show that the interval between the detection and drainage is 0 to 60d, the time of the extraction is 3d, the time of extraction is 60 to 120d, the time of the water testing interval is 7d, the extraction time is 120 to 180d, the time of the water testing interval is 15d, and the extraction time is 180 to 300d. The interval between the measurement of the flow is 30d.

1. Introduction
As a fundamental measure of coal mine gas disaster, coal seam gas extraction is often used for coal lane excavation strip pre-pumping or work surface grid extraction, and has been widely used at home and abroad [1-2]. However, the local gas enrichment area caused by uneven gas extraction is still a gas accident-prone area, the absolute gas outflow increases during the production of the back-picking work surface, which seriously restricts the safe and efficient production of the mine [3-4]. Therefore, it is very important to improve the extraction of the existing drainage.

In the past, scholars have done more research on the natural emission law of drilling gas extraction flow [5-6]. Chen Shao-Rong [7] compared the natural gas flow attenuation coefficient of drilling in different times by regression analysis, and then explored the shortest effective time to determine the attenuation coefficient of natural gas flow in the drilling according to the fit of curve attenuation. Based on the characteristics of single-hole gas flow attenuation under the condition of high negative pressure continuous extraction, the drilling gas parameters were tested on the spot and the gas flow and concentration decay curve were drawn, and the law of drilling gas flow attenuation was analyzed comprehensively using gas flow theory and geomechanics-related theory [8-9]. Lu You-Chang [10] studied the effect of drilling inclination on the evolution of gas extraction flow. Wang Zhao-Feng [11] combined with theoretical analysis, the main cause of gas extraction attenuation is the reduction of drilling hole leakage gas and coal seam gas pressure. Gas extraction flow is also closely related to the drilling impact radius, and even some researchers propose to use gas extraction flow method to determine the effective impact radius of the coal seam drilling [12-13]. Xu Jiang [14] analyzes the relative speed and direction characteristics of coal seam gas transport during extraction. Wei Guo-Ying [15] established a gas extraction model of drilling based on the negative index law of gas drilling attenuation.

In order to be able to analyze the law of gas extraction change on the recovery surface more comprehensively, so as to provide theoretical research basis for the evaluation of gas extraction...
standards and the preparation of work surface recovery, the timing of the measurement of the extraction parameters of the surface-drilling gas is optimized, and the gas attenuation coefficient and breathability coefficient are analyzed.

2. The mechanism of coal seam gas action

2.1 Natural gas flow characteristics of coal seam drilling

Coal is a kind of porous medium with solid, liquid and gas three-phase, under a certain pressure gradient, the gas flow in coal seam belongs to the combined effect of diffusion-seepage flow of two properties. Because of the small size of coal particles, diffusion flow is mainly controlled by the penetration movement of the coal seam crack network, and its effect on gas outflow is negligible. Therefore, the gas flow in the coal seam mainly depends on the pore structure of the coal body, so the gas flow is basically in line with Darcy penetration law.

2.2 Drilling gas out pouring factors

Theoretically, the amount of drill gas out pouring is mainly related to the original ground stress in the coal seam, the robustness coefficient of the coal seam, and the breathability coefficient to the raw gas pressure, and the weighting relationship of the influencing factors is as follows

\[ q = 2.8348 \cdot f^{0.1615} \cdot \sigma_0^{0.2106} \cdot \lambda_0^{0.6174} \cdot p_0^{-1.4575} \]  

In the formula, \( q \) is drilling gas flow; \( f \) is coal seam robustness factor; \( \sigma_0 \) is original ground stress in the coal seam; \( p_0 \) is original gas stress; \( \lambda_0 \) is breathability coefficient.

2.2.1 Coal seam gas pressure and content. The pressure of coal seam gas is produced by free gas, which determines the amount of gas content and the size of gas flow power, which is the concrete embodiment of the thermal motion of the free gas molecule of coal. The higher the gas pressure, the greater the pressure difference within the borehole, and the greater the resistance of gas flow that can be overcome. Vice versa. The gas content of the coal seam is the decisive factor that affects the gas outpouring, and it is also the source of gas outpouring. The higher the gas content of the coal seam, the greater the gas gushing out, and the faster the gas gushing out.

2.2.2 breathability coefficient. The breathability coefficient of coal seam is the parameter to measure the ease of gas flow in coal seam, and directly reflects the size of the gas flow resistance of coal seam. When the coal seam is not depressurized, the coal seam permeability coefficient not only determines the gas drainage effect, but also greatly affects the gas emission. Therefore, the coal seam permeability coefficient is an important parameter for gas migration, flow and gushing in the coal seam. When other conditions are timed, the greater the breathability coefficient of the coal seam, the faster the gas gushing out.

2.3 Gas flow characteristics of coal seam drilling and extraction

The actual determination of drilling gas flow is also affected by drilling sealing, trachea characteristics and measuring instrument resistance and other aspects:

\[ q_e = q \cdot f(x) = q \cdot f(l, m, d, f, r) \]  

In the formula, \( q_e \) is measuring drilling gas flow; \( f(x) \) is revise coefficient; \( l \) is actors related to the length of the guide pipe; \( m \) is coefficients related to the pipe material; \( d \) is factors related to the diameter of the guide pipe; \( f \) is factors related to drilling sealing; \( r \) is coefficients related to measuring instrument resistance.

2.3.1 Pump negative pressure. The negative pressure is one of the important factors that determine the efficiency of extraction, on the one hand, it provides the power for gas flow, the higher the negative pressure, the greater the power; On the other hand, due to the influence of negative pressure, it may lead to drilling leakage, which puts forward higher requirements for the sealing quality.
2.3.2 blow of drill hole. The sealing quality is one of the important factors that determine the effect of gas extraction, and the poor quality of the sealing hole and the failure of the sealing hole are the main reasons for the low concentration of gas extraction.

3. Test site and drilling arrangement
Ping-Qing coal mine area and local coal seam 12 layers, of which the current C7+8 coal seam from the C9 coal seam average 25.93 m. 117802 comprehensive mining surface is located in the northwest corner of the mine, the working surface to a long 760 m, tilt edgy length 200 m. 117802 working surface mining C7+8 coal seams, coal seam deposit is relatively stable overall, local areas are affected by small faults (break distance of about 2 to 3 m). From September 2014 to the end of June 2015, the completed drilling mainly includes: 117802 return wind lane (outer segment) w1 to w61, 117802 return cut eye section q16 to q21-1, 117802 return lane (inside) n1 to n146, 117802 machine lane j1 to j178, which has a total of 500 drains.

4. The evolution law of the concentration of drill gas extracted on site
4.1 The law of sampling concentration of ground-drilling gas over time
The pattern of changes in the extraction concentration of drilling at different times is shown in Figure 1.
Figure 1. Extraction Drilling Gas Extraction Concentration

From Figure 1(a), it can be seen that in the extraction time 0 to 60d, the initial concentration of single-hole gas extraction in the sub-layer drilling is very large, during the extraction period the size of the gas concentration changes violently, some of the drilling gas concentration has a small increase, but most of the drilling by the initial gas extraction concentration decreased slightly by about 20 to 30%.

From Figure 1(b and c), it can be seen that in the extraction time 60 to 120d, the initial concentration of the single-hole gas extraction concentration of the shun-layer drilling is larger, the size of the gas concentration changes more drastically during the extraction, but basically all the drilling by the initial gas extraction concentration decreased slightly by about 40 to 60%.

From Figure 1(d), it can be seen that within the extraction time of 120 to 180d, the initial concentration of single-hole gas extraction in the shun-layer drilling is larger, but the size of the gas concentration began to decline significantly during the extraction period, and basically all drilling by the initial gas extraction concentration decreased by about 60 to 80%.

As can be seen from Figure 1(e and f), within the extraction time of 180 to 300d, the initial concentration of single-hole gas extraction in the shun-layer drilling is small, the size of the gas concentration is basically small or unchanged during extraction, and most of the drilling by the initial gas extraction concentration decreased by about 80 to 90%.

4.2 Final determination of flow measurement time
According to the law of change of gas concentration in the extraction drilling, it is possible to determine the time of the monitoring interval of 117802 back-picking surface extraction drilling for the back-to-layer extraction of the coal seam in Ping-Qing coal mine, and the optimization results are shown in Table 1.

| location         | number  | total time (d) | gas extraction concentration (%) | Stream time (d) |
|------------------|---------|----------------|----------------------------------|-----------------|
| 117802 return wind lane | q16~21-1 | 180~300        | 5.58~26.68                       | 30              |
|                  | n1~146  |                |                                  |                 |
|                  | j1~49-1 | 120~180        | 5.17~9.56                        | 15              |
| 117802 machine lane | j50~135 | 60~120         | 14.50~47.75                      | 7               |
|                  | j135-1~178 | 0~60           | 31.00~68.17                      | 3               |
5. Conclusion
Through the statistical analysis of the index of extraction concentration of the surface-to-layer gas extraction on the 117802 surface, the following conclusions are obtained: According to the law of change of gas concentration in the coal seam extraction of the shun-layer extraction, the time of the water-measuring interval is determined for the conditions of coal seam extraction in Ping-Qing coal mine: the extraction time is 0 to 60d, and the time of the water-measuring interval is 3d; The extraction time is 60 to 120d, the time of the metering interval is 7d, the extraction time is 120 to 180d, the time of the pumping interval is 15d, the extraction time is 180 to 300d, and the time of the distance is 30d.

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