The Research of Coordination Extraction from the Stope Gas with Partition and Time-sharing

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Abstract. Based on the analysis of the distribution characteristics of the S-type overburden spatial crack field in a 3322 working face of a mine and the actual observations, it adopts comprehensive drilling modes such as ground drilling, high-drainage roadway drainage, and goaf buried pipe. "What time, where?" How much gas is extracted, and the effects of ground drilling, high-drainage roadway drainage, and underground pipe drainage in the goaf were evaluated, respectively, through space cracks in the S-type overburden The time-division extraction mode is adopted in the site, including comprehensive extraction methods such as high-draining lanes and buried pipes in the mined-out area. The gas extraction in the 3322 working face of the mine has reached the standard, ensuring safe and efficient mining at the working face.

1. Foreword

Gas partition extraction is mainly for different gas source problems, choosing different extraction methods and different combination methods. The district extraction is mainly for new and old mined-out areas and roof fissure areas. Through the analysis of the distribution characteristics of the S-type overburden spatial crack field of a mine 3322 working face and the actual observations, the comprehensive extraction modes such as ground drilling, high-level drilling, and goaf buried pipe were adopted to study the "when, Where is the problem of how much gas is extracted? The new mode of gas extraction in deep mining is discussed, which reduces the gas extraction rate of low-permeability coal seams by more than 70%, and relieves the pressure of air discharge. The zoning and time-sharing extraction modes of 3322 working face of a mine are shown in Figure 1 and Figure 2.
2. Combined extraction layout in fully mechanized caving face

2.1 Ground drilling extraction layout

After working face mining, the original stress state of the overlying N-group key layer was destroyed, and the stress around the stope was redistributed. From the top down, the overlying N-group key layer produced difficult desorption sinking zone, desorption crack zone, Drainage fissure belts and other gas drainage three belts, and ground drilling starts from the surface and drills all the way to the top of the roof. Through the three drainage belts, gas in the gas drainage drainage belts can be extracted [1].

Ground drilling extraction is an important part of green extraction, and the gas in the pressure relief belt is directly removed, and the height of the next drilling hole can be adjusted according to the height of the extraction fracture zone, which is more dynamic and can also be carried out according to the change of time Efficient extraction. Two holes were drilled at the initial working surface of a mine 3322. The drilling parameters are shown in Table 2. The initial two holes WL1 and WL4 were located 1m down from the roof, 36m from the back of the roof, and 10m above the roof. Shun back 41m. It is determined according to the range of the S-type crack field and the drilling accuracy of the drilling rig.
Table 1 Ground drilling parameters

| drilling label | drilling length (m) | End drilling position |
|----------------|---------------------|-----------------------|
| WL₁           | 929                 | 36m away from Huishun, 1m down from the top plate, 206.25m screen |
| WL₄           | 1045                | 41m away from Huishun, 32m advancing direction of cut-out, 10m above the top plate, 120m screen |

Figure 3 Calculation parameters of high pumping lane

2.2 The layout of high-drainage roadway

When gas extraction is carried out in high-drainage roadways, in order to make the parameters of high-drainage roadways reasonably arranged so that they are located in the middle and lower parts of the fissure zone, the height of the caving zone and the fissure zone must be determined. The high-level roadway should be arranged in the axial area of the S-type overburden space fissure field, which can not only cut off the gas migration channel, but also extract high-concentration gas, serve two purposes, and become a new gas migration highway. The high-level gas lanes are arranged in the coal seam roof fracture crack zone. When the roof collapses for the first time, the gas balance in the mined-out area and surrounding rock is destroyed, and the gas in the mined-out area and surrounding rock flocks to the gas drainage lane, and is discharged through the wind System to the ground [2-3].

The selection of the parameters of the high pumping roadway mainly depends on the height of the fracture zone of the overlying rock layer. According to the previous similar simulation and numerical simulation results, and then the calculation of the following formulas 1, 2, and 3, the setting parameters of the high pumping roadway are finally determined, as shown in Figure 3.

\[ H = h + \Delta h; \]  
\[ W = K' + \Delta K; \]  
\[ \Delta K = \frac{1}{2} \left( \frac{1}{2} x - K' \right) \]
\[
K' = \frac{h}{\tan \beta}
\]

\[
K = \frac{H}{\tan \alpha}
\]

In the formula, \( H \)—The height of the high-drawing roadway is too high for the coal floor, m;
\( h \)—Destroy falling height, 35m above the floor, about 3 times the mining height, m;
\( \Delta h \)—The height of the safety factor, which is 1~1.5 times the height;
\( K' \)—the horizontal projection length from the return air lane, m;
\( K \)—the horizontal projection length without pressure relief from the return air lane, m;
\( \Delta K \)—Horizontal distance from the high pressure extraction roadway to the full pressure relief boundary, m (depth horizontal projection length of the horizontal pressure relief belt);
\( x \)—Length of working face, 150m;
\( \beta \)—The rock falling angle of the roof, average 58~65\(^\circ\);
\( \alpha \)—Relief angle of roof rock, average 65~75\(^\circ\);
\( W \)—Horizontal projection distance from the high-drafting lane to the return air lane, m.

According to the formula calculation, the height of the high-draw roadway should be between 35m and 60m, and it is arranged in the middle and lower part of the fissure zone. Compared with the previous numerical simulation and similar simulation conclusions, the comprehensive judgment is that the high-draw roadway should be set at 40-60m from the roof between.

### 2.3 New and old goaf buried pipe extraction layout

Buried pipe extraction in the goaf can be divided into closed extraction in the old goaf and semi-closed extraction in the new goaf. Use the method of burying the drainage pipeline to extract the high-concentration gas in the goaf. The buried pipe in the goaf mainly extracts the low gas in the goaf. This part of the extraction must have time and quantity requirements. Blind extraction for a long time will cause spontaneous combustion.

For mines with a drainage system or a mobile drainage system, gas drainage in the goaf should be used as an important measure to prevent gas explosion or combustion in the goaf, that is, to change the gas through the negative pressure point at the end of the goaf Inner gas concentration distribution reduces the gas concentration in the mined-out area and pushes the explosion deep into the mined-out area \( [4] \). The general approach is to advance the work forward, bury the iron pipe in the deeper location of the goaf in the return air lane, the two pipelines are alternately buried in the goaf, and when one is too deep, open the other One pipeline is laid at the same time as another pipeline, and alternately drainage is performed, as shown in Figure 4.

![Figure 4 Layout of buried pipes in goaf](image-url)
A: With the cut-out as the base point (zero point), when the working surface is advanced to the position of 20m, the 1 # extraction pipe is buried.

B: When the working face is advanced to 40m, the 1 # pipeline starts to be pumped.

C: When the working face is advanced to 60m away from the opening, the 1 # pipeline continues to be pumped, and the 2 # pipe (with valve) is buried, and its length is 80m.

D: When the working face is advanced to 80m away from the cut, the 1 # pipe determines whether to continuously pump according to the monitoring results, and the 2 # pipe starts to pump;

E: When the working face is advanced to 110m away from the opening, the 1 # pipe stops pumping, and then determines whether to recover and re-pump according to the monitoring results. At the same time, the 3 # pipe (with valve) is buried and the branch pipe length is 80m;

F: When the working face is advanced to 140m from the cut, the 3 # pipe is drawn;

G: When the working face is advanced to 160m away from the opening, the 2 # pipe stops pumping, and the 2 # pipe is disconnected and recovered here, and the 4 # pipe (with valve) is buried;

H: Repeat the above work until the working face is finished.

When the stop line at the working face is very close, you can determine whether to bury the pipeline again according to the specific stop line position at that time. At the same time, after the stop of mining, permanent sealing shall be carried out to conduct sealed drainage.

3. Evaluation of gas drainage effect in S-type overburden space crack field of fully mechanized caving face

The gas extraction system adopts two sets of high and low pressure systems, and the low negative pressure system is used for the goaf, and the high negative pressure system is used for ground drilling and high extraction roadways. The level of gas drainage rate is an indicator of the gas drainage effect. In the S-shaped space composed of new and old goafs and working faces covered with cracks, ground drilling, high extraction roadways, goaf buried pipes, etc. are used. Means for gas drainage has achieved good results in a 3322 working face of a mine.

3.1 Evaluation of gas drainage effect of ground drilling

WL1 drilling gas drainage situation:
The drainage flow rate of WL1 borehole is 20~22m³/min, the extraction concentration is 54~80%, and the average extraction volume of borehole is 12.4m³/min.

WL4 drilling gas drainage situation
The drilling flow rate of the WL4 borehole is 20-28m³/min, the extraction concentration is 60-80%, the average extraction volume of the borehole is 15.6m³/min, and the total extraction gas volume of the borehole is 3.02 million m³. Two CDF-2BV3 drainage pumps are installed on the ground waste rock hill to connect with the drainage borehole to ensure the gas drainage work on the working face at any time.

At the beginning of the 3322 fully mechanized caving face, the relevant seals and boreholes were carefully observed, and the gas and pressure changes were observed every day. When the mining face was advanced to 41m, the gas concentration in the surface gangue mountain borehole began to gradually increase. The extracted gas concentration increased from 15% to about 76%.

3.2 Evaluation of gas drainage effect towards high-drainage roadway
The extraction concentration of high-level gas extraction roadway is between 20% and 51%, and the amount of gas extracted is between 7m³/min and 15m³/min. Concentrated gas can also block the migration of gas from the upper adjacent layer to the coal seam. The high-drain roadway designed in the 3322 working face can extract high-concentration gas, which solves the problem of gas exceeding the upper corner, as shown in Figure 6.

3.3 Evaluation of gas drainage effect of buried pipe in goaf
The gas flow rate of the buried pipe in the goaf is 3-9m³/min, and the gas extraction concentration is
between 40% and 80%. The purpose of the gas extraction in the old goaf is to reduce the gas emission to this working face. It can also be used to extract high-concentration gas.

4. Examples of coordinated extraction of gas-time space (zoning, time-sharing)
When the 3322 fully mechanized caving face advances to 160m, the sealed negative pressure in the overlying mined area increases (previously, the pressure difference in the enclosed area was relatively stable, there was no obvious change, and the drainage flow rate was also basically stable). At the same time, the gas in the return air flow from the working face has increased from 0.7% to 1%. According to the change of the sealing conditions and the analysis of the gas emission from the working face, the overburden cracks in the goaf and adjacent goaf have been connected. After further verification, SF6 tracer gas was released in the adjacent mined-out area and received in the return airway. A small amount of tracer gas could be received, proving that the overlying rocks in the new and old mined-out areas have been conducted. In the day shift of the day shift, the extraction system was adjusted to increase the extraction volume in the enclosed area. Among them, a SK-85 drainage pump was used to extract the enclosed area, and a 2BEC52 drainage pump was used to extract gas from the 3322 working face. Gas is extracted from the mined-out area with ground gangue mountain drilling holes. After adjusting the gas extraction volume at various points, the return air gas has dropped to between 0.7% and 0.8%. The time-divisional adjustment of gas extraction is of great significance. Can ensure safe mining [6-10].

5. Conclusion

5.1 Through the analysis of the distribution characteristics of the S-type overburden space crack field in the 3322 working face of a mine, the calculation and measurement of the three-zone overburden space cracks provide a theoretical basis for the gas drainage mode of the 3322 face.

5.2 Through the analysis of the extraction effect of the extraction measures such as ground drilling, high extraction roadway and buried pipe in the mined-out area, it meets the requirements of the extraction standard, guarantees that the gas does not exceed the limit, and the working face is efficiently advanced.

5.3 By adopting the time-division extraction method in the S-type overburden space fissure field, including comprehensive extraction methods such as high-draining lanes and buried pipes in the mined-out area, the 3322 working face has realized safe mining.

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