Confirmation of Effective Influence Radius byDraining Boreholes in Fengcheng Mining Area

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Abstract. In order to solve the problems of the drilling layout for preventing coal and gas outburst in Fengcheng mining area, using numerical simulation method to analysis the draining radius of the draining borehole, The law of stress and gas flowing around the draining boreholes was studied, meanwhile the draining radius were examined in site, the effective influence radius of draining borehole was determined in this mining area, the reasonable parameters and the important reference were provided for preventing local coal and gas outburst in the mine.

1. Introduction

Coal and gas outburst is one of the major dynamic disasters in mines. Due to the complexity of mine dynamic phenomena and the diversity of production geological conditions, the task of prediction and prevention is extremely difficult [1]. With the implementation of large area gas extraction in the outburst mine, the regional outburst prevention problem of coal seam has been well solved. However, when the coal in front of the regional verification face fails to completely eliminate the outburst risk, If the large-scale and high-intensity regional measures are continued, the safety investment in the mine will be increased imperceptibly and the burden will be increased at the same time. It is particularly important to implement local measures for areas that have no effect on regional process elimination based on regional verification results. So far, borehole gas discharge is one of the most effective and commonly used measures for outburst prevention. Its essence is to release the elastic energy accumulated in coal seam by using borehole drainage, relieve pressure of coal seam and promote gas desorption, and eliminate the outburst danger of working face. The effective influence radius of the discharge borehole not only reflects the pressure relief range of the borehole, but also reflects the channel of gas desorption, which is the most basic parameter and basis for the reasonable arrangement of the discharge borehole[2]. Therefore, it is of great theoretical significance and practical application
value to study the effective influence radius of the drainage borehole to carry out effective prevention measures and improve personnel safety.

2. Background

Fengcheng mining area is located in fengcheng, jiangxi province. The main mining area is B4 coal seam, belong to the outburst coal seams. According to the measured, the coal seam gas pressure is 5.8 MPa, coal seam gas content is 18.6 m³ / t, the coal seam buried deeply an average of 600 m, average thickness of coal seam is 2.5 m. Before the coal seam is excavated, a large area of regional pre-extraction is carried out in the mine, such as pre-extraction of coal roadway gas by drilling through the bottom seam, pre-extraction of coal roadway gas by drilling along the coal seam and pre-extraction of gas in the mining area by drilling along the coal seam. After the regional gas extraction, the regional measure effect test is carried out by using the method of direct determination of the gas content in the coal seam. The mining operation can only be carried out when the gas content in the residual coal seam ahead of the effect test is less than 8 m³/t. In the process of mining, according to 《the provisions on prevention and control of coal and gas outburst》, regional verification shall be carried out. If the verification results show that the outburst danger has not been completely eliminated in areas, outburst prevention measures shall be taken immediately. At this time, if the measured coal seam gas desorption index K1 value in the area with incomplete process elimination is greater than or equal to 0.5ml.(g.in1/2)-1, then according to k1-p curve, the minimum gas pressure in this area should be 0.76mpa, and comprehensive anti-outburst measures should be taken in this area.

3. Stress distribution and gas flow around the drainage hole

3.1 Characteristics of stress distribution around the borehole

It is assumed that the coal around the borehole is homogeneous, isotropic, linear elastic, non-creep and viscous. The original rock stress of surrounding rock is regarded as isotropic pressure. The cross section of the borehole is round. Using the methods of plane strain interception of a section as a representative of the research object. According to the solution of plane strain problem can get [3]. The radial stress of the drill hole wall is 0, the tangential stress reaches 2 P0 (P0 for surrounding rock stress). If when 2 P0 is greater than the elastic limit strength of coal, coal will occur plastic deformation, the surrounding coal damage will occur making the formation of macroscopic crack. By a single borehole attenuation situation shows that the tangential stress distribution around it has a dramatic impact scope, the limitation is bounded by more than 5% of the surrounding rock stress. Therefore, the largest scope reaches 5 times the radius of drill hole.

3.2 Gas flow law of surrounding rock in borehole

According to the coal seam gas drained gas flow theory and practical experience, the borehole gas flow are mainly the radial steady flow and unsteady flow two. Intense impact drilling within range (5 times the radius of drill hole) due to the development of the permeability of coal seams in the area is large, the borehole gas flow over a period of time can be approximately considered steady flow; The gas flow in the coal seam outside the scope of severe influence of the drilling is an unsteady flow, that is, with the increase of the flow time, the gas emission intensity and gas flow rate of the drilling rapidly decrease[4].

Therefore, cracks appear in the coal body around the drainage borehole, and the development of
cracks provides a channel for the migration of gas around the borehole. In addition, the development of the cracks around the borehole and drilling disturbance, and the continuous expansion of the plastic zone make the coal body around the borehole decompress and make the gas continuously analyzed. Under the action of gas pressure gradient, the gas is continuously expelled. The direction of the main flow vector of gas migration is radial flow along the borehole, and the closer the gas migration is to the borehole, the greater the gas migration velocity will be, and the trend decrease. Finally the gas migration velocity will form an inverted funnel around the borehole.

4. Numerical modeling

According to fengcheng mining coal seam gas occurrence characteristics, using RFPA numerical simulation software to simulate the gas migration regularity in coal body around the borehole [5 ~ 10]. According to the condition of coal seam gas occurrence in mine, the residual gas pressure assumes 1 MPa, the hole diameter is 75 mm, simulating the gas flow characteristics around the drill hole. According to the different contrast experiment was carried out respectively, drill holes space take respectively, to 2 m, 1.5 m, 1 m. Set the time step= 0.5d. The simulation results are shown in figure 1, figure 2 and figure 3.
According to the numerical simulation results, it can be seen that when the residual gas pressure in coal seam is 1 MPa, the situation of drilling for gas migration, around the borehole gas seepage velocity of surrounding area is larger. The farther the surrounding rock of deep drilling, the gas seepage velocity decreases. On the edge of the drilling penetration reach maximum speed. Upon the figure, the gas seepage velocity in the funnel shaped around borehole, namely in the borehole surrounding gas migration velocity is the largest. Influenced by each other of the distance between the drillings, when drilling distance of 2 m, 1.5 m, infiltrative velocity of the horizontally and vertically around the borehole in middle position between the drill hole is zero. It indicates that when the space between boreholes is 2 m and 1.5 m, the gas migration around the borehole is not affected by the disturbance of the borehole and fails to provide a good migration channel for the gas migration. When the borehole gas emission is carried out without negative pressure, the danger of coal and gas outburst cannot be completely eliminated in a short time. When borehole space is 1 m (the effective influence radius of 0.5 m), around the borehole gas seepage velocity increase different between drillings, that is to say, when borehole space is 1 m, in the process of drilling to form, human disturbance and around borehole fissure development, provide a good channel for gas migration, this for the drill hole plays important role in coal and gas outburst danger.

5. Practical application

In fengcheng coal mine, pre-extraction was carried out in the drilling area of floor penetration before tunneling in the transport roadway of 1018 working face. The floor drainage roadway was arranged at a horizontal distance of 20 m from 1018 gateway and a vertical distance of 12 m from the coal seam. After 3 months of regional pre-extraction, the danger outburst of 1018 transport roadway has been eliminated by regional measure effect test, that is, the residual gas content of coal seam in the area measured is less than 8 m³/t. The 5, 9, 18 circulation area verification results show that the coal roadway ahead still has the outburst risk, which takes outburst prevention measures. Using the borehole gas drainage, the hole space is 1m and control tunnel line is 5m, the front distance is 10m, discharge time is 1d. Coal gas desorption indexes before and after partial discharge measure K₁ value contrast see table 1.
Table 1: contrastion of index ($K_1$) of gas desorption

| Cycle number | Working face prediction index ($K_1$) / (mL / (g.min$^{1/2}$)) | Discharge hole spacing /m | Number of drain holes | Results of local measures effect test ($K_1$) / (mL / (g.min$^{1/2}$)) |
|--------------|---------------------------------------------------------------|---------------------------|-----------------------|---------------------------------------------------------------|
| 5            | 0.83                                                          | 1                         | 50                    | 0.32                                                          |
| 9            | 0.97                                                          | 1                         | 50                    | 0.35                                                          |
| 18           | 0.92                                                          | 1                         | 50                    | 0.37                                                          |

As can be seen from table 1, the discharge boreholes are constructed at an interval of 1m. After 1d of discharge, the area has been completely eliminated, and the roadway tunneling has been carried out safely. This shows that the design of the discharge boreholes with an interval of 1m is reasonable and effective.

6. Conclusion

(1) As the main measure to prevent and control coal and gas outburst, gas emission from borehole is not only used to relieve pressure of coal body but also provides a channel for gas release within the radius of borehole emission. The determination of borehole emission radius provides reasonable layout parameters and basis for the implementation of outburst prevention measures in the mine.

(2) Through numerical simulation analysis, set the gas emission in Fengcheng mining as 1d, and the effective influence radius of the borehole is 0.5m, and the rationality and reliability of the effective influence radius are proved by the test.

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