The 6th International Conference on Mining Science & Technology

Gas control technology of working face in single, high-gas and medium-thick coal seam

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Abstract

Aiming at solving the problems of large gas emission and difficult control of working face in single, high-gas and medium-thick coal seam, the author prefers the drainage way of head-on along layer drill hole by comparing several kinds of drainage ways. Based on analyzing all kinds of factors affecting drainage result, such as the arrangement of drill hole, the span of drill hole, the depth of sealing hole, drainage negative pressure and drainage duration, The author designs gas drainage at working face in single, high-gas and medium-thick coal seams. According to the author’s gas drainage parameters in the design, it is summarized as follows: the rate is as high as 62.71% at working face; the great hidden danger to safety is reduced and it is great significant to control gas disasters in single, high-gas and medium-thick coal seam.

Keyworks: single, high-gas and medium-thick coal seam; gas drainage; head-on along layer drill hole

The coal mine accidents result There are 4746 deaths in 2006, and fatality rate per million tons is as high as 2.041, which is 4 times higher than that in developing country such as India, South Africa and Poland etc; it was 40~50 times compared with developed countries including America and Australia. According to a statistics, gas accidents take great proportion in coal mine in China, reaching more than 80%, which causee casualties up to 90% in extraordinarily big accidents. It can be seen that gas accidents influence seriously on the safety production of coal mine.

As an partial measure, it has been indicated that gas drainage from coal seam is effective in preventing and controlling coal and gas outburst. Along with the guideline “gas drainage after extraction, daily output determination matching with the actual fan ability, monitoring and controlling”, gas drainage in coal seam is establishes an important position in high gas mine or coal and gas outburst mine. Through several years experiment and research, our country has made greater advance in theory and technology of gas drainage, and greater accomplishment in practical production.

For the working faces in multiple coal seams, gas drainage crossing hole will get better effect after improving gas permeability coefficient of coal seam; in single-thin coal seams, one row gas drainage holes can solve the problems in working face; but in the single, high-gas and medium-thick coal seam, one row gas drainage holes can’t reach good drainage effect and can’t solve the problem of gas concentration over limit during production, therefore, it has
greater realistic meaning to study on gas drainage at return working face in the single, high-gas and medium-thick coal seam.

1. General introduction of the experimental site

The experimental site is selected in 3102 working face at Yongan coal mine. 3102 working face, which is 850 m long and 160 m long in incline, locates in the south of orbit laneway, and is around with original coal. The strata containing coal are the Carboniferous of Taiyuan and Permian of Shanxi. The total thickness of coal strata is about 138.11-163.52 m, including 13 layers of all kinds of coal seams. The group of Taiyuan included 7-11 layers coal, the 9th and 15th coal seams can be mined, and others belong to coal line. The group of Shanxi includes 3 layers coal, only 3th coal seam can be adopted, 1th and 2th coal seams are coal line. The mine is exploiting the coal seam 3th at present, there is a length of 80 m between 3th coal seam and 9th; 3th coal, 5.46 m thickness on average, is divided into two layers. Before mining the nether seam, The upper seam, which is 2.5 m thick, is to mine firstly. The mining and sheet downthrown method for managing roof will be used.

Buried depth of 3102 upper working face is 286~360 m, and the average buried depth is 323 m. According to the survey supplied by Henan Polytechnic University, the gas content is 15.80m³/t.

2. Selecting gas drainage methods

Through long-term study and practice on gas drainage from mining seams, adjacent seams, and goafs, there are significant progress in the technical system and equipment development. Relatively mature methods contain gas drainage from mining seams with high permeability, gas drainage with pressure relief from adjacent seams, high-located drainage roadway gas drainage, gas drainage from crossing layers, hydraulic crack in coal holes, hydraulic cutting, high-middle pressure affusion, griddig holes, cross holes forced gas drainage in poor gas permeability of coal seams, gas drainage with horizontal long-holes in upper adjacent seams of tip rock, gas drainage with horizontal long-holes in seams and from fully mechanized working faces without virgin coal etc.

Gas drainage from virgin coal seams with hole drilled in seams is a main stream of developing technique, which will ensure the continuity of coal mining production under low gas concentration and create safe environment of coal mining. Besides, the cost of gas drainage is also relatively lower, so it is the best option to adopt gas drainage from virgin coal seams with hole drilled along seams. Hole drilled in seams contains two ways: horizontal long-holes and incline long-holes. Only achieving gas drainage from virgin coal seams before mining, gas drainage from virgin coal seam with hole drilled along seams can neither handle high-gas coal seams in advance nor actualize gas drainage before forming the production system of coal mining.

The purpose of gas drainage from goaf is to solve the problem of over limit in working face, especially at the up corner, another purpose is to decrease gas quality from goaf, and alleviate the pressure of mine ventilation. Now the technology of gas drainage from goaf includes borehole, low-position drilling of tunnel roof, and horizontal hole on rock roof and so on. The methods, such as burying pipe in goaf and gas drainage from closed goaf, are also widely utilized.

Referring to the working face in single, high-gas and medium-thick coal seams, however, for crossing holes, it is necessary to drive a rock tunnel construction which would cause cost increase, and the delay of operation. Because head-on hole not only keeps the equilibrium of gas drainage from virgin coal seams, but also fully makes use of the pressure relief over working face to raise drainage efficiency from mining seams, therefore, the drainage way of head-on along layers to drill holes is chosen as a gas drainage method in single, high-gas and medium-thick coal seam.

3. Selecting gas drainage parameters

The major factors affecting efficiency of gas drainage are arranging way of drill holes, drill holes interval, the depth of sealing holes, drainage negative pressure and drainage duration etc. According to local experiment and study, choosing following parameters of gas drainage are advantageous to efficiency of gas drainage of working face in single, high-gas and medium-thick coal seams:
3.1 Layout way of drill holes

Arranging head-on parallel drill holes in cut eye direction from return airways to working face, the way of drill hole is two rows Sanhuayan, and parameters of drill holes are shown in Table 1.

Table 1 Layout parameters of drill hole in working face

<table>
<thead>
<tr>
<th>Items</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layout way of drill holes</td>
<td>two row Sanhuayan</td>
</tr>
<tr>
<td>Rows interval</td>
<td>0.5~0.6m</td>
</tr>
<tr>
<td>The distance from row bottom holes to base plate</td>
<td>0.6~1.0m(deciding according to the situation)</td>
</tr>
<tr>
<td>The length of drill hole</td>
<td>150m</td>
</tr>
<tr>
<td>The diameter of drill hole</td>
<td>Starting 89 mm, end hole 75 mm</td>
</tr>
<tr>
<td>The angle of drill hole and tunnel</td>
<td>84°~85°</td>
</tr>
<tr>
<td>Hole in the inclination</td>
<td>The same as coal seam inclination</td>
</tr>
<tr>
<td>The way of sealing hole</td>
<td>Assemble amine ester sealing of hole</td>
</tr>
</tbody>
</table>

3.2 Drill holes interval

The drill holes interval is determined by drainage radius which will be gotten through surveying the pressure curve of drill hole. According to the measurement, the drill hole drainage radius is 2.5 m; that means the drill holes interval is 5 m.

3.3 The depth of sealing hole

The quality of sealing hole directly influences the drainage effect. Since the start of hole drilled along seam is located in released pressure section, where there are many crannies. if the sealing hole effect is poor, the flow will leak out easily, which causes the negative pressure of drainage decrease and influences drainage effect, therefore, the depth of sealing hole should be deeper than released pressure boundary. Based on the result of the measurement, the released pressure boundary of the mine is 4 m, thus the depth of sealing hole is 5 m.

3.4 Drainage negative pressure

If the mine belongs to coal and gas outburst mine, based on Regulation of Prevention and Control of Coal and Gas Outburst, negative pressure of gas drainage from virgin coal seam must not be lower than 13 kpa. To be sure of the success, in the experiment drainage negative pressure is more than 15 kPa.

3.5 Drainage duration

According to the gas emission initial intensity per hole and the damping factor of gas flow-rate per hole, draining longer than 500 days has little meaning, therefore, it is right to the drain for 500 days.

4. Gas drainage efficiency calculations

Gas drainage efficiency is the percentage of gas drainage quantity to gas reserves at working face. It is calculated by the following formula.

\[ \eta = \frac{Q_1}{Q_2} \times 100\% \]  

Where \( \eta \) is gas drainage efficiency, \( Q_1 \) is gas drainage quantity of a working face, \( Q_2 \) is gas reserves of a working face.
Before the mining, 324 drill holes are constructed in the intake and return airway of 3102. The total length is 24,093 m, and gas drainage quantity reaches 10,801,800 m³ during 475 days.

The gas drainage quantity of upper of 3102 comes from 3⁶ coal seam, therefore, we will calculate gas reserves at working face, the author takes the whole coal seam thickness into consideration. That means \( Q_2 = \text{the average incline length of working face} \times \text{the average trend length of working face} \times \text{average coal seam thickness} \times \text{average coal seam density} \times \text{average gas content} = 162 \times 850 \times 5.46 \times 1.45 \times 15.80 = 17,224,700 \text{ m}^3 \).

Gas drainage quantity and gas reserves at one working face are taken into the formula above, then: \( \eta = \frac{100 \times 10,801,800}{17,224,700} = 62.71\% \).

5. Conclusions

(1) In view of the problems of big gas emission and difficult control at working face in single, high-gas and medium-thick coal seam, the paper selects the drainage way of head-on along layer drill hole after compared with several other kinds of drainage ways.

(2) The author designs gas drainage at working face in single, high-gas and medium-thick coal seam from arranging way of drill hole, the span of drill hole, the depth of sealing hole, negative pressure of drainage and drainage duration based on analyzing all kinds of factors which affect the drainage effect. According to designed parameters, it is find that gas drainage rate is as high as 62.71% at working face; thus the design of drainage is fit for single, high-gas and medium-thick coal seam, and it has an important guidance to working face in single, high-gas and medium-thick Coal Seam.

(3) In order to get the high efficiency of gas drainage, each mine should be designed based on its actual condition and the reasonable arrangement of drainage parameters.

Acknowledgements

This article is supported by the followings: National Natural Science Foundation of China (50474011), Creation Foundation for Extraordinary Scholars in Henan Province of China (0421000400), Key Project of Chinese National Programs for Fundamental Research and Development(973 program2006CB202204), Major Project of Science and Technology Tackle Key Problem in Henan Province of China(0421000400), etc.

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