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The Safety Guarantee Technology of Extra-thick Coal Seam Mining in Tashan Coal Mine

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Abstract

In recent years, a series of gas and spontaneous fire prevention technologies are summarized by Tashan coal mine of Datong Coal Mine Group CO., LTD, which are suitable for extra-thick coal seam mining of carboniferous period through collaborative investigation of industry-university-institute and engineering practice. These technologies provide safety guarantee for the high efficient mining of extra-thick coal seam of permo-carboniferous in Tashan coal mine.

Keywords: Tashan coal mine, extra-thick coal seam mining, safety guarantee, comprehensive technology;

1. Introduction

Tashan coal mine is an oversize underground tunnel mine with designed productive capacity of 15 Mt per year, and is also the first coal mine of Datong Coal Mine Group CO., LTD to mining the coal seam of permo-carboniferous. In the mine, geological structure is complex, and the thickness of its mainly coal seam 3~5# is 11.1~31.7 meters (average 18.44 meters). Some areas are invaded by igneous rocks and the upper Jurassic coal seam mining formed large goaf. The gas in upper corner of coal face is usually exceeded due to large relative gas emission rate and production by using the top coal caving mining. In

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addition, each coal seam has coal dust explosion risk and explosion index is about 37%. It is very important to study the safety guarantee technologies of gas and spontaneous combustion prevention and monitoring.

2. Gas prevention of fully-mechanized sublevel caving mining in extra-thick coal seam

The maximum relative gas emission capacity of the coal seam in Tashan coal mine is 3.83 m³/ t•d, but the gas in upper corner of coal face is usually exceeded due to large relative gas emission rate and production by using the top coal caving mining, which has serious influence on the safety production of mine[1-3]. Through the determination and analysis of gas basic parameters of coal seam 3~5# in underground and laboratory, and the sources of gas of working face combined with the actual situation of mine, then the problems of gas exceeded has been solved by using the comprehensive treatment methods of air volume adjustment, pumping gas with exhaust fan, coal drainage, lead wind with facilities, bury tube in the upper corner for drainage, high level gas drainage gateway, and bury tube in airtight for drainage.

2.1. Analysis of gas emission law of full-mechanized working face

The gas emission of fully-mechanized working face in Tashan mine is unbalanced because of high strength mining and roof pressure in coal face. Take 8208 work face as an example. Figure 1 is the relationship between the production of work face and absolute volume of feeder gas in February 2011. Figure 2 is the relationship between the roof pressure in coal face and absolute volume of feeder gas in February 2011.

From the changing trend shown in the figures, the curve of absolute outflow of gas, production curve and the pressure changing curve of work face have roughly the same trend. Therefore, production and pressure of working face and absolute outflow of gas of working face is proportional relation. The larger the production, the larger the gas emission quantity of work face. As well, in the period of roof pressure in coal face, the trend of absolute outflow of gas is increasing.

![Fig. 1. the relationship between production and absolute outflow of gas of 8208 work face in the first half of February](image-url)
Fig. 2. the relationship between pressure and absolute outflow of gas of 8208 work face in the first half of February

2.2. Borehole gas drainage from coal seam being worked

In the return airway of the work face, facing the direction of face advance, drainage boreholes have been dilled to the roof of coal seam. Three boreholes is a group, and the spacing of each group is 15 meters. The borehole parameters are divided into A type and B type. They have been arranged alternatively and adjusted according to the extraction effect. The borehole arrangement is shown in figure 3 and figure 4, and the borehole parameters are shown in table 1.

Fig. 3. the borehole arrangement of A type

2.3. Roof high roadway drainage

Roof high drainage roadway is arranged in the stable rocks along the 3-5# coal seam roof within inner interlocked 30 meters of the return airway. It is 20 meters between the roof high drainage roadway and the return airway roof in the vertical distance, and inner interlocked 20 meters of the return airway in the horizontal direction. The shape of cross-section is rectangular, whose net width is 3.5 meters and net height is 3.0 meters.

After the transfixion between roof high drainage roadway and work face, the airtight has been built in the roof high drainage roadway, and each two DN500, DN600 gas drainage pipe have been pre-buried,
then the drainage pump of gas extraction pumping station has been connected and formed the roof high drainage roadway system. Each work face is equipped with two large and two small pumps (drainage capacity of large pump is 560m³/min, drainage capacity of Small pump is 350m³/min). Normally, one large and two small pumps are opened to drainage. The average drainage capacity is 1100 m³/min. When pressure or gob gas emission is large, the spare pump is opened temporarily to increase drainage capacity. The arrangement of the gas drainage system of high roof roadway is shown in figure 5.

Fig. 4. the borehole arrangement of B type

Table 1. The parameters of drainage borehole

<table>
<thead>
<tr>
<th>Name of work face</th>
<th>Drill field numbers</th>
<th>Borehole numbers</th>
<th>The horizontal Projection distance between end hole point and ventilation roadway (m)</th>
<th>Angle to the roadway (°)</th>
<th>The distance between end hole point and the roof of coal seam (m)</th>
<th>The length of borehole (m)</th>
<th>Dip angle of borehole (°)</th>
<th>Borehole diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1#</td>
<td>20</td>
<td>28.5</td>
<td>-10</td>
<td>45.1</td>
<td>8.5</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2#</td>
<td>25</td>
<td>35.3</td>
<td>-2.5</td>
<td>49.01</td>
<td>13</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3#</td>
<td>30</td>
<td>42.4</td>
<td>5</td>
<td>54.15</td>
<td>21.8</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1#</td>
<td>50</td>
<td>25</td>
<td>0</td>
<td>48.5</td>
<td>19.8</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>2#</td>
<td>55</td>
<td>39.5</td>
<td>5</td>
<td>51.6</td>
<td>25</td>
<td>94</td>
<td></td>
</tr>
<tr>
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<td>3#</td>
<td>60</td>
<td>44.8</td>
<td>10</td>
<td>56.36</td>
<td>28.4</td>
<td>94</td>
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</tr>
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</table>
After the transfixion between roof high drainage roadway and work face, the ventilation type of work face changes from U shape to U+1 shape. Meanwhile, Leakage flow field in the goaf is also changing, and the width of three zones becomes narrow. The gas of the leakage flow field in the original goaf is drained under the function of drainage negative pressure. At the same time, high drainage roadway will effectively intercept the gas coming from the goaf to reduce the gas emission of upper corner.

After using the technology of high drainage roadway, the problem of gas exceeding the limit of fully-mechanized work face in Tashan mine has been solved. Take 8208 work face as example, after stable operation of the roof high drainage roadway drainage system, gas density in the upper corner of work face is maintained at about 0.5%, about 0.5% at scraper-trough conveyer, about 0.25% at ventilation flows, about 2.4% at high roof roadway.

3. Comprehensive fire preventing and extinguishing of fully mechanized sublevel caving mining in the extra-thick coal seam

For fully mechanized face of TaShan mine, the thickness of coal seam is big, as well as the length of work face and air volume. The width of oxidation zone in spontaneous combustion three zones in goaf is big, and the coal quantity is large. So, it is very important to prevent spontaneous combustion and guarantee safety mining. It guarantees the safety mining of extra-thick coal seam by using nitrogen injection, grouting, airtight and other technologies[3-5].

3.1. Nitrogen injection for fire extinguishing

Currently, nitrogen injection quantity of each top-coal caving face of Tashan mine is more than 3000 m³/h. To solve the problem of low efficiency for long distance transmission, cooperated with the Shenyang Institute, the underground mobile nitrogen making machine with the largest capacity (2000 m³/h) in our country (Fig. 6) has been developed, whose length is 35 m. The process of nitrogen injection is buried pipe to inject nitrogen in goaf.
3.2. Yellow mud grouting for fire prevention

TaShan mine has the fixed ground grouting system which can implement grouting fire prevention engineering anytime and anywhere.

3.3. Airtight and plugging

After the face stop mining, the goaf airtight changes from the alley airtight to chamber airtight. Through targeted grouting and goaf pre-grouting, the rigor of the airtight has been strengthened. By blocking small cracks on the ground and abandoned wellhead, the oxygen condition of external leakage channel of the goaf has been eliminated.

4. The forecast of spontaneous fire of the face with fully mechanized mining caving method

In order to predict and forecast harmful gas in closed fire zone, goaf, high caving area and other locations, mine fire bundle tube monitoring system has been chosen. Through computer-controlled, automatic sampling, 24-hour cycle monitoring or artificial setting a few key ways monitoring, each way of the CO, CH₄, CO₂, O₂, N₂, H₂ and so on have been analyzed. It can forecast for natural fire and judge risk of fire timely and accurate, and automatically alarm when any gas detection concentration exceeds definition concentration. Monitoring data can be presented or printed with daily, monthly report and trend curve. Mine fire bundle tube monitoring system connects mine integrated automation system, and shares with data information. Figure 7 shows the arrangement of measured points of strap tube.

5. Conclusions

In recent years, through collaborative investigation of industry-university-institute and engineering practice, the unique technologies of safety guarantee has been initially formed of extra-thick coal seam mining of Datong carboniferous, which has solved the problem of safety mining the extra-thick coal seam, and realized the high yield, high efficient and high recovery safety mining. Mine production in 2010 has reached 20.8 million tons. The production of work face breaks through 10 million tons, and the highest monthly production is 1,312 million tons, the maximum daily production is 58000 tons, and there is no serious injury accident for continuous production of 60 million tons. But it is just the beginning to mining the extra-thick coal seam of permo-Carboniferous for Datong Coal Mine Group CO.,LTD, some
technology problems such as the arrangement of high roof road of extra-thick coal seam of permo-Carboniferous and pre-drainage technology from coal seam being worked need to be studied and solved.

Fig. 7. the arrangement of measured points of strap tube

References


