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Technologies of open the fired zone of 1504 working surface in Jiaxin Coalmine safely

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Abstract

This paper introduces the case of firing of 1504 working surface with high content of gas and facile spontaneous combustion of coal seam of No.15 in Jiaxin Coalmine. By a large number of investigation and theoretical analysis on the fire field, all factors causing the fire in 1504 working surface were found out and the position of fired area of the goaf was determined. The gas inside fired area were monitored by a series of means. Based on the truth that the fire have been extinguished, a reasonable plan for fire zone opening is proposed, according to the fire position and factors causing the fire, to ensure the safe opening of the fired area of 1504 working surface.

Keywords: coalmine; easily spontaneous combustion; opening the fired zone safely

1. Introduction

Jiaxin Coalmine is about 20km far from Zuoquan county of Shanxi province, in the southern of Qinghe mining area. The coal field has a simple structure and a single inclination of structure overall. The main coal seam for mining is No.15. This coalmine integrated the resources of several small ones. At present, it has only one working surface, the 1504, which is fully-mechanized. The 1502 preparative working face, which is also fully-mechanized, is now tunnelling the gateway up and down it.

The 1504 working face is in the south of the coal field. To the north of it is the protective coal pillar for Shi-hang Coalmine. To the east of it is the original goaf. To the west of it is the virgin area. The 1504 working face is in the No.15 coal seam, the coal bed is stable, the total ply of this coal is 5.4-7m and the average is 6.2m, the unit weight is 1.4 m$^3$/t, the industrial reserves is about 812 thousand tons, the mining rate is 93%, the recoverable reserves is 755 thousand tons, and the coal seam pitch is 7°. It is a high gas concentration coal seam with an absolutely gas flow-volume of 20-60m$^3$/min and relative gas flow-volume of 9.77m$^3$/t on its working surface. The No.14 coal seam is above the roof of No.15 coal seam, the interlamellar spacing of the two coal seam is only 7m. The 15th coal and 14th coal seam are all easy spontaneous combustion seam with high content of phosphorus and sulfur.

2. An overview of the fire and closing process

The 1504 fully mechanized top-coal caving face was formed in the end of October, 2009, and testing exploited in January 1, 2010. The return air tunnel appeared CO overrun at 10:00pm in February 3, and reached 1125ppm in February 4.

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There was much smoke pouring out of the 1504 working surface and its upper corner, a massive of smoke emerged in the return air lane. Then the coal established the emergency rescue and disaster relief headquarters immediately. In consideration of the CO and CH₄ concentration in the main return air tunnel increased dramatically in the 1504 face, and there is plenty of smog inside the tunnel, it is much more dangerous to seal off the fire area in this coalmine with high content of gas. The emergency rescue and disaster relief headquarters make the decision of withdrawal all the workers first, and then injecting water into the coalmine shafts to extinguish the firing area in 1504 working face. Finally, the coalmine had been closed. The main shaft and the auxiliary shaft simultaneously closed at 18:20 in February 4, 2010. The Jiaxin Coalmine was closed temporarily for the fire. The 1504 fully mechanized caving face caught fire after it worked only one 33 days, with a mining distance of 27m.

3. An analysis on the cause of fire

(1) The No.14 coal seam is only 7 meters away from the No.15 coal seams in height. Both of them are easily spontaneous combustible, which have a very short spontaneous combustion period[1].

(2) Secondly, Taking samples from No.14 and No.15 coal seam for component tests, the results show that the content of phosphorus and sulfur in both coal seam are very high, as shown in Table 1. The phosphorus and sulfur are combustion-supporting substances, the high content of them is one important reason for spontaneous ignition on the goaf[2].

<table>
<thead>
<tr>
<th>Serial number</th>
<th>Sample name</th>
<th>Full sulfur $S_{ad}$ (%)</th>
<th>Full Phosphorus $P_{ad}$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jiaxin mining 14#coal</td>
<td>2.25</td>
<td>0.0012</td>
</tr>
<tr>
<td>2</td>
<td>Jiaxin mining 15#coal</td>
<td>1.59</td>
<td>0.0155</td>
</tr>
</tbody>
</table>

(3) The 1504 working surface was mined with the fully mechanized top coal caving method, so the recovery rate is relatively low. Especially the top-coal near the open eyes is hard to put down, meanwhile the slot and the stents in near six meters not mining top-coal, which creates too much residual coal left in the goaf. When the loose coal in the goaf piling up to achieve a certain thickness, it provides enough material bases for spontaneous ignition. In addition, the distance between No.15 and No.14 coal seam is short (about 7 meters). Along the working surface work forward and the broken roof fall down, the 1m thick coal seam of No.14 is also thrown into the goaf of 1504 working surface. It not only increases the amount of residence coal in goaf, but also increases pore ratio and leakage air volume in goaf. All of above create the conditions for the spontaneous ignition in goaf.

(4) The advancing speed of 1504 working surface is too slow (33 days, with a mining distance of 27m). Because the gas content of No.15 coal seam is high (9.77 m³/t), and the 1504 working surface were mined in the fully mechanized top coal caving method which caused the gas emission was high and not uniform. The gas concentration in the return air on the working surface often exceeded the gas limit, during the mining process. According to the gas concentration record, during 1 month before the coalmine caught fire, the gas exceeded the gas limit many times (The highest gas concentration is 1.5% in return air groove, with the return corner topped by 5%). It lead the gas alarm and power failed and affects the speed of mining (1 months only promote 23m), the oxidation zone in goaf can not quickly move into choking zone in goaf, but stay in oxidation zone. It caused the coal on the goaf stay longer within the oxidation zone than the coal seam's spontaneous combustion period finally and caused the legacy of coal in goaf spontaneous combustion[3].

(5) The fragmentations of coal collapsed from the goaf are mostly big and coal release rate is low, leading to low course aggregates in goaf. Sufficient Oxygen supply to legacy of coal on the goaf accelerates its oxidation, which is also one of the important reasons caused fire in goaf.

4. The preparations for opening the fired zone

(1) Injecting chemical slurry to the goaf where above and downward 10m of No.95 stent in order to closing and blocking the fire in it[4].

(2) Preparing the construction of the additional air supply tunnel for the 1504 working face.

(3) Drilling boreholes for grouting to the goaf of the working surface from the upper near-horizontal hole drilling field.

(4) Completing the preparation for the opening of fired zone, including connect the pipes suppling water and air to the working surface.
5. The Scheme of opening fire zone

(1) Preventing the content of gas in the return air from overrun, especially prevent the phenomenon of uneven emission of gas, withdraw workers from the return air area, interrupt the power supply, and set the security line. Strictly according to the coalmine safety rules to carry out the related regulation[5].

(2) Making sure that the pips supplied water and wind were connected to the working surface as quickly as we can. In the process of upholding in the working face, overhauling and building the walls, water should be used to scour the mud and coal-dust at the surface of support continuously, and at the same time, through the aperture of the support to scour the worked-out section, keep it have enough humidity and the roof of the coal seam is damp, prevent roof take fall sparks[6-7].

(3) Accelerate the construction of the additional air supply tunnel (as shown in Fig.1), strive to get through the air providing tunnel and working face in 20 days-30 days, forming a negative pressure ventilation situation, in order to effectively eliminate the gas which lies to the support near the worked-out section, when the negative pressure ventilation system formed in the working surface, it needs to ventilate two to three days in negative pressure ventilation conditions, eliminate the gas which lies to the support near the worked-out section, and before the working face be moved forward, it require the gas checking members to make use of rubber pipes to determine the concentration of gas for each support, then the measure about adopting pressure blast line to blow away the gas should be used in the place where the gas concentration is high, in order to prevent high-concentration methane accumulation.

(4) After the completion of the gas emissions on the working surface, injecting chemical slurry to the goaf where above and downward 10m of No.95 stent in order to closing and blocking it. Then move the working surface near.

Closing and blocking requirements: Constructs a temporary wooden fence from No.95 stent upward 2m and constructs a 0.6m wall with clay or the powdered coal packed in bags from No.96 stent, the width between the temporary wooden fence and the sandbag wall is 2m. From 10m downward the No.95 stent, the depth of chemical slurry for blocking is also requested to reach 2m into the goaf.

(5) Under the premise of blocking the air returning tunnel, hits the high auger field in the air returning tunnel first. Using the upper near-horizontal hole drilling field along the 14# coal seam to drill 18 injecting boreholes in 30m×20m scope of the top area of the working surface (as shown in Table 2).Inject chemical slurry to the isolated and blocked area where might return burning, the mixing proportion of mud and water is 1:4 in the slurry.

(6) Grouting design.

First, choose yellow mud for the main grouting materials, and mixed with proper quantities of MgCl\(_2\). Digging a groove for confecting the mixed slurry in high drilling field. The slurry matching: the mixing proportion of mud and water is 1:4, the mixing proportion of MgCl\(_2\) and water is about 1:15.

Second, design 11 grouting holes in the high drilling field, the opening holes layout mode for 0.4m x 0.3m, the horizontal spacing is 0.4m and vertical spacing is 0.2m between two of them. The beginning of 1st, 4th, 7th, 13th and 16th holes are about 1m above drilling yard floor and the ending of them are about 6.5m above the roof of No.15 coal seam. The beginning
of 3rd, 6th, 8th, 11th, 12th, 18th holes are about 0.8m above drilling yard floor, and the ending of 8th and 11th holes are about 4.7m above the roof of No.15 coal seam, the ending of 3rd, 6th, 12th, 18th holes are about 2.7m above the roof of No.15 coal seam.(as shown in Fig.2).

Table 2. Grouting drilling parameters settings list

<table>
<thead>
<tr>
<th>Hole No.</th>
<th>Vertical height(m)</th>
<th>Drilling height(m)</th>
<th>Dip angle(°)</th>
<th>Direction Angle(°)</th>
<th>Design depth(m)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>4.6</td>
<td>1</td>
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<td>182</td>
<td>45</td>
</tr>
<tr>
<td>3</td>
<td>8.3</td>
<td>0.8</td>
<td>-8°</td>
<td>186</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>4.6</td>
<td>1</td>
<td>-6°</td>
<td>189</td>
<td>44</td>
</tr>
<tr>
<td>6</td>
<td>8.3</td>
<td>0.8</td>
<td>-8°</td>
<td>191</td>
<td>59</td>
</tr>
<tr>
<td>7</td>
<td>4.6</td>
<td>1</td>
<td>-6°</td>
<td>195</td>
<td>44</td>
</tr>
<tr>
<td>8</td>
<td>6.3</td>
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<td>-7°</td>
<td>196</td>
<td>54</td>
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<tr>
<td>11</td>
<td>6.3</td>
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<td>202</td>
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<td>13</td>
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<td>45</td>
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<td>46</td>
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<tr>
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<td>0.8</td>
<td>-8°</td>
<td>224</td>
<td>61</td>
</tr>
</tbody>
</table>

Fig.2. The fire zone open and grouting bored layout.

6. Conclusions

(1) The actual spontaneous combustion period of the No.15 coal seam is only about 20d. It is easy spontaneous combustion coal seam with an absolute gas emission volume of 20-60m³/min. The mining risk of it is big, so it can not work before reasonable gas extraction and fire prevention measures were proposed.

(2) When the upper corner of the 1504 working surface appears high concentration of CO, we need to withdraw people immediately and take the extinguishing measures by injecting water to flood the working surface, in order to avoid the casualties in accidents.

(3) The cause of the fire is analyzed correctly, and a pointed fire zone open plan is made out.

(4) The fire zone in 1504 working face of Jiaxin Coalmine have opened successfully due to the scientific plan.
References