First International Symposium on Mine Safety Science and Engineering

Intensified extracting gas and rapidly diminishing outburst risk using deep-hole presplitting blast technology before opening coal seam in shaft influenced by fault

Cai Feng, Liu Zegong *

School of energy and safety, Anhui University of Science and Technology, Huainan 232001, China

Abstract

Deep-hole presplitting blast technology is an effective method to intensively increase the permeability of coal seam and high-efficiency extract gas. Aimed at the drivage shaft working place of opening No. 13-1 Coal seam influenced by fault in Panyi Coal Mine, this paper comprehensively took advantage of the technology of deep-hole presplitting blast and intensified increasing permeability, the technology of reinforcing coal body using metal skeleton, as well as the technology damming and extracting gas of outside of metal skeleton, diminished the outburst risk only after 18 days, and got the purpose of rapidly diminishing outburst risk. And this provided an effective solution of rapidly diminishing outburst risk and safety opening coal seam for similar conditions.

Keywords: open coal seam in shaft; deep-hole presplitting blast; metal skeleton; rapidly diminishing outburst risk

1. Introduction

Deep-hole presplitting blast technology used blasting energy to form a pressure-relief circle zone with broken and cracked coal surrounding blasting hole. And then the coal’s permeability increased greatly, and gas in coal released and went out. So gas pressure and gas content decreased, and coal’s rigidity increased, and concentrated stress zone and high-gas zone moved to deep part[2]. This contributed to
diminish concentrated stress caused by geological structure or inhomogeneous distribution of hard and soft coal, and decreased gradient of gas pressure and stress\cite{3, 4}. This contributed to prevent the occurrence and development of coal-gas outburst, and provide a large protected safe zone for drivage shaft or roadway \cite{5}. And at last this could greatly increase extracting-gas rate, and rapidly diminish the risk of coal-gas outburst.

2. General situation of experiment working place

The designed net diameter of east ventilating shaft of Panyi Coal Mine is 8.0m, and designed depth is 872.3m. Absolute altitude of No.13-1 coal-seam’s roof is -784.3m, and the thickness is 4.9m, and the distance between No.13-2 and No.13-1 coal seam is 8m. Physical properties of No.13-1 coal seam is: black, schistose or block, most are dull coal. And coal dust has the risk of blast, and blast index is 35–40%, and the spontaneous combustion period is 3–6 months. The gas content is about 6.64m$^3$/t. This ventilation shaft has opened Fault F32 at altitude of -771m as shown in fig. 1, and the distance between Fault F32 (in the position of center of the ventilation shaft) and the roof of No. 13-1 coal seam is 6-7m, and Fault F32 is 150-200m long in strike, and 190-210m in dip, and the head drop of this fault is 20m, and there is a fracture zone with width of about 6m.

3. Forward probing gas pressure and making sure the risk of outburst

3.1. Arrangement of pressure hole

To reduce the influence on measurement of gas pressure caused by Fault F32 and preliminary injecting cement-water, pressure hole is arranged north-east side and north-west side where far away from the shaft, and termination of pressure hole is located at the outside of the circle where injecting cement-water, and the circle is 15m away from the centre of the shaft.

![Fig. 1. The place of ventilation shaft and Fault F32](image-url)
3.2. Measuring gas pressure technology

Firstly drill the hole of measuring gas pressure for 5m, the diameter of this section of the hole is 133mm, and all this section is installed by pipe of diameter 127mm. And then, use the drill bit of diameter 91mm and drill to the position where distance to the coal seam’s roof is 1m, then draw out the drill bit and inject high-pressure (up to 8 MPa) cement water. After cement water freezes, use the drill bit of diameter 91mm and drill to the coal seam’s floor. Then draw out the drill bit and install measuring gas pipes, and use kelp with cement water to fill the drilled-hole. And at last inject high-pressure N2 to shorten the time. The measured result of gas pressure of No.13-1 coal seam is 1.5MPa.

3.3. Determine the risk of outburst

During the process of drilling detecting hole, get the coal samples from the coal seam and send them to lab and analyze, the results show that: f=0.93, a=18.213m³/t, b=0.8376MPa⁻¹, Δp=15.5, Wf=5.35%, Aσ=55.36%, and calculate the D and K index result is: D=2.5, K=16.67.

4. Technology for preventing outburst

4.1. Arrangement of extracting gas holes

When the distance between No.13-1 coal seam’s roof and shaft is 6.5m, the extracting gas drilling-holes begin to be drilled, and there are 7 circles and sum of 161 extracting gas drilling-holes, and extreme outward 2 circles extracting gas drilling-holes are arranged outside of shaft’s outline, so this can realize continually extracting gas. The extracting gas drilling-holes’ interval is less than 400mm, and the extracting gas drilling-holes’ diameter is 108mm. The termination of the extracting gas drilling-holes must enter into coal seam’s floor for more than 0.5m. All this extracting gas drilling-holes must control the range of 15m outside of shaft’s outline (control the whole footwall of fault F32 in southern shaft). The effective radius of extracting gas drilling-holes is 1.5m. All these extracting gas drilling-holes are arranged homogeneously. As shown in Fig. 2.

---

Fig. 2. The arrangement of extracting gas drilling-holes
4.2. Deep-hole presplitting blast

To increase the permeability of the coal seam and increase the extracting gas rate, take advantage of 8 drilling-holes (73#, 75#, 78#, 81#, 84#, 93#, 96#, 99#) of No.6 circle (excluding the drilling-holes influenced by fault F32) to carry out deep-hole presplitting blast. The explosive load for one time is 69Kg, and this greatly increases the permeability of the coal seam, and the concentration of extracting gas increases from 7% to 10%, and pure gas flow increases to 30%. And this greatly increases the effect. The arrangement of blasting drilling-holes are shown in fig. 3.

Table 1. The comparison of extracting data before and after blasting

<table>
<thead>
<tr>
<th>Type</th>
<th>Gas concentration (%)</th>
<th>Mixed gas flow (m³/min)</th>
<th>Pure gas flow (m³/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>maximum</td>
<td>average</td>
<td>maximum</td>
</tr>
<tr>
<td>Before blasting</td>
<td>7.5</td>
<td>7</td>
<td>8.54</td>
</tr>
<tr>
<td>After blasting</td>
<td>9.6</td>
<td>8.03</td>
<td>9.68</td>
</tr>
</tbody>
</table>

4.3. Extracting gas

Through extracting gas for 18 days, the sum of extracted gas is 24264.06m³, average is 1277.06m³, maximum extracted gas in one day is 4331.46m³, and extracting gas rate is 77.27%. So this diminishes
the risk of coal-gas outburst. The change of extracting data before and after blasting is shown in Table 1 and Fig. 4.

Fig. 4. The change of extracting data before and after blasting

Fig. 5. Extracting gas result during opening coal seam
4.4. Metal skeleton

After drainage gas from coal seam, install diameter of 2 inch steel pipe in No.4 circle (sum of 27 drilling-holes), in which, the steel pipe in coal seam section is punched holes in the shell of pipe. So these drilling holes can use as extracting gas hole, and use as metal skeleton after inject cement water in later period. Metal skeleton can increase the resistance strength of coal body around shaft.

5. Extracting gas effect during opening coal seam

During opening coal seam, extracting gas drilling-holes belonging to the extremely outward 2 circles continue to extract gas uninterruptedly. Because of influence of blast, extracting gas result is very good: the gas concentration is more than 70%, pure gas flow is more than 3.58m³/min. This provides safeguard for opening coal seam. After opened coal seam, the sum of extracting gas is 36428.31m³, average 1277.06m³/day, and maximum is 4331.46m³/day. As shown in fig. 5.

6. Conclusion

Through taking advantage of the technology of deep-hole presplitting blast and intensified increasing permeability, the technology of reinforcing coal body using metal skeleton, as well as the technology damming and extracting gas of outside of metal skeleton, effectively extract gas from coal seam, and get the purpose of diminishing the outburst risk. This provide a effective solution for opening coal seam in shaft influenced by fault.

Acknowledgements

Parts of the research were performed under grant of National Science Support Plan Project (2007BAK28B01) and Key project education department of Anhui Province (KJ2011A075).

References