

# Research and Application of High Pressure Water Jet Pressure Relief Gas Control Technology

Zhanjin Lu<sup>1,2</sup>&Zunyu Xu<sup>1,2</sup>&Siqian Li<sup>1,2</sup>

<sup>1</sup> National Key Laboratory of Gas Disaster Detecting, Preventing and Emergency Controlling

<sup>2</sup> Chongqing Institute of Coal Science Research Institute, Chongqing, china

**Keyword:** High pressure water jet; Pressure Relief Effect of Coal Seam

**ABSTRACT:** In order to improve the concentration and pumping volume of gas control drilling hole in the cross-cut uncovering area, reduce the pre-pumping time of outburst coal seam, principle of broken coal based on high pressure water jet, the mechanism of high pressure water jet punching to relieve pressure and increase permeability is studied, through theoretical analysis and practical application, the effect of high pressure water jet punching on gas control is expounded, the results show, Coal seam after the implementation of hydraulic punching measures, the elastic potential of the coal has been released, effectively eliminate the stress to stimulate the protruding, with better relief effect of pressure relief, effectively improve the extraction of gas concentration and pumping volume, to achieve a safe and rapid regional out of conflict. In this paper, the research and application of high pressure water jet pressure relief and gas permeable control technology in 700m central pedestrian oblique well in Xinji No.1 Mine are introduced.

## INTRODUCTION

Cross-measure exposed to highlight the danger of coal seam when the general has a greater outstanding risk, and the protrusion intensity is high; Relevant information shows, the average outburst intensity of coal seam is 7~14 times of that of coal seam. More than a thousand tons of large prominent 90% occurred in the cross-cutting coal, prominent gas emission is relatively large. The coal seam gas pressure and stress are in the original state, when exposed to coal, the working face suddenly enters a softer coal seam from a hard rock, all of these factors provide favorable conditions for the occurrence of prominent events. Simultaneously, particularity of construction technology for uncovering coal in crosscut, the whole process of exposing coal seam is dangerous, and may occur continuously outstanding, prominent extension and self-opened highlights, than the general type of prominent more dangerous to personal safety; on the other hand, new mines, new levels or the preparation of new mining areas can not avoid cross-cut coal. Therefore, formulate a reasonable and effective special outburst prevention technology before uncovering, it is of great significance to the safety and high efficiency coal uncovering.

In recent years, with the development of mechanized mining, mining depth gradually increased, coal and gas outburst increasingly serious harm, especially the high stress, large deep mining of soft low permeability coal seam, need to spend a lot of time and engineering volume drainage, easily lead to the production of replacement tension. Therefore, how to improve gas drainage rate in loose low permeability outburst coal seam, reduce coal seam gas content and gas pressure, which is a key problem to be solved urgently in mine gas disaster prevention.

## PROJECT OVERVIEW

Xinji Mine-700 central pedestrian dark inclined well The current roadway is located at 7.6m north

of H103, continue to move forward construction 5.6m, 12.5m, 29.6m, 55.4m, 69m will be exposed from the roadway roof 4 coal, 5-1 coal, 5-2 coal, uncovering coal elevation are -701.351m. The 4 coal and 5 coal sections of the roadway are located north of the F10 fault, geological exploration line between 6 to 7 lines, uncovering the elevation of -701.3m, the 4 coal seam, 5 coal seam is not identified for the outburst of dangerous coal layer, 6 Coal is not classified outburst coal seam area, the exposing coal seam is the new level for the first time, 4,5 The basic parameters of coal seam gas in Table 1. At present, the use of perforated borehole pre-pumping or the permeability of the original coal in the drainage of gas in the mine, single hole pumping volume is small, pre-pumping a long time, drainage effect is not very good. The mine for the mine three levels to develop key projects, exposing coal deadline is essential, to speed up the development of new levels of progress, mine and scientific research units, take the enhanced pressure relief measures.

Table 1 -700 central pedestrian dark inclined shaft expose 4,5 coal gas parameters test results

Coal seam	Gas content (m <sup>3</sup> /t)	Initial velocity of gas emission ΔP	Solid coefficient of coal f
4	0.9972	9	0.86
5	5.4912	6	0.5

## MECHANISM ANALYSIS OF HIGH PRESSURE WATER JET

High-pressure water jet drilling and integrated equipment out of a large number of coal, for the expansion and deformation of the media to provide sufficient space, the surrounding coal body under the action of the stress in the expansion and deformation, so that the stress to move around, play a role in local pressure relief; Not only a large number of gas emissions during the punching period, but also due to the expansion of the media deformation, increased the permeability of the coal seam, expanding the gas extraction radius, improve the pumping efficiency, effectively reduce the coal seam gas content; Wetting of coal during reaming, so that the reduction of brittle coal, increased the plasticity of coal, reduce the elastic energy of coal, in addition, wet coal after, the desorption rate of residual gas in the medium can be reduced, reduce the gas expansion energy.

## APPLICATION OF HIGH PRESSURE WATER JET

### Construction situation

September 8, 2013 to October 17, 2013, 68 wells were constructed during the opening of a coal mine in Xinji No.700 central pedestrian dark inclined coal mine, Of which 5 punching, Punching record in Table 2. Measures completed as shown in Figure 1.

Table 2 -700 central pedestrian dark inclined hole to expose 5 coal punching record table

date	Starting time	stop the time	Drilling number	Hole deep	Length of coal hole	Azimuth Angle(°)	inclination (°)	The amount of discharged cinder(m <sup>3</sup> )
2013-9-26	18:00	19:10	J523-5	35.3	4	7	+6	2.5
2013-9-28	16:59	21:20	J526-2	56	3.5	355	-5	1.5
2013-9-29	15:30	18:35	J524-2	44.8	3	354	+1	2
2013-9-30	15:40	18:20	J522-2	37	3	352	+12	1
2013-10-13	16:30	19:50	J522-4	28.6	1	5	+14	0.63

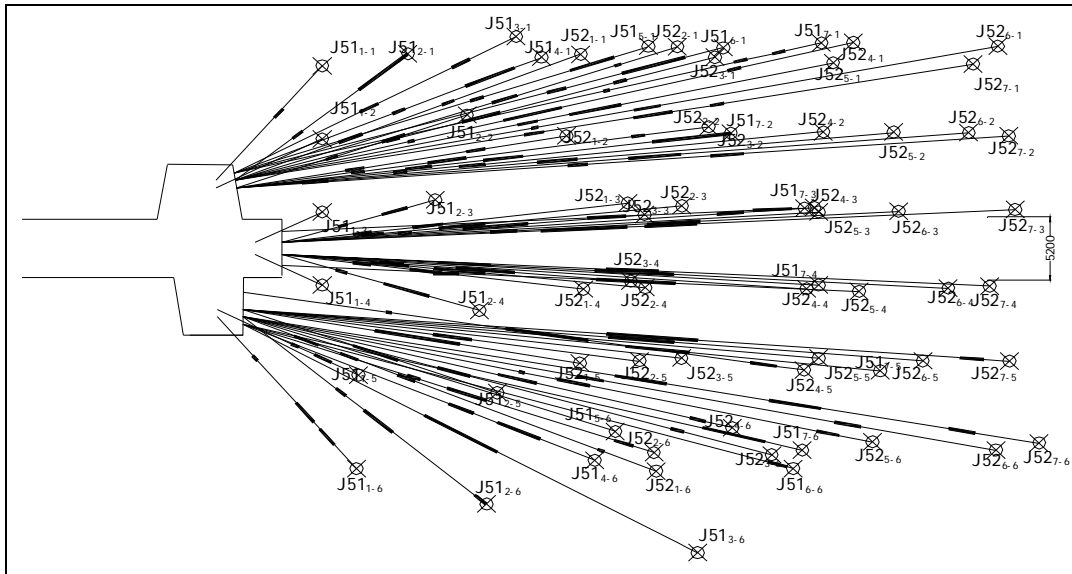


Figure 1 -700 central pedestrian oblique shaft to expose the 5 coal seam area outburst prevention measures drilling completion map

Uncovering the area of a total of five high-pressure water jet drill design and expansion of the integrated hole reaming test drilling, according to formula (1) to calculate a single hole discharge cinder rate  $\eta_{cinder}$ , Table 3 shows the chip removal rate of expanded coal.

$$\eta_{cinder} = T_{cinder} / T_{Single\ hole} \quad (1)$$

Table 3 Chip removal rate of expanded coal.

Hole number	5-1 coal length of coal expansion (m)	Expand the amount of coal (m3)	Expansion of coal quality (kg)	Single hole chip removal rate
J523-5	3	2.5	3000	0.027
J526-2	2	1.5	1800	0.020
J524-2	3	2	2400	0.022
J522-2	2	1	1200	0.016
J522-4	1	0.63	7600	0.020

As can be seen from Table 3, the discharge cinder rate of the test hole was 1.6% ~ 2.7%, the experimental application of high-pressure water jet drilling and integration technology to achieve the desired purpose.

**Effectiveness analysis**

As can be seen from Figure 2, Figure 3, Figure 4, According to the actual monitoring of the hydraulic punching period, Roadway head gas concentration of 0.1% -0.12%, the return air concentration of 0.08% -0.1%, which is the same as the ordinary drainage hole during tunnel construction.

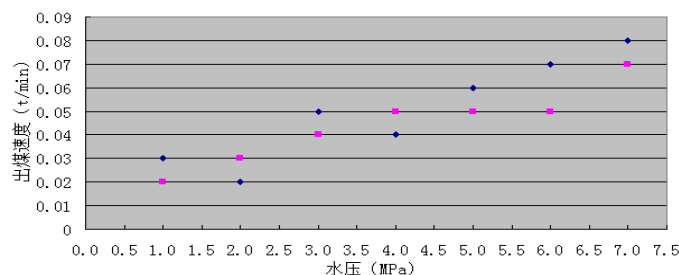


Figure 2 The relationship between coal velocity and water pressure

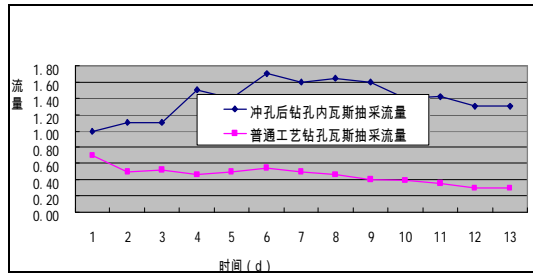


Figure 3 Change of Punching Gas Concentration

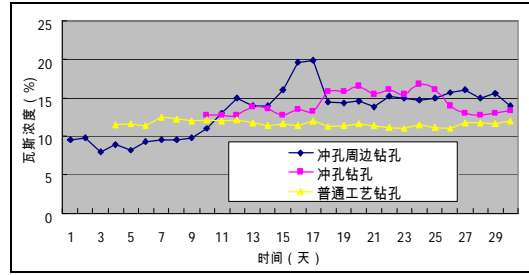


Figure 4 Punching gas flow chart

Through the high-pressure water jet drilling and its surrounding ordinary borehole gas concentration analysis, the concentration of gas in the pre-hole is larger, and the gas concentration in the surrounding drilling hole is more obvious. Such as J526-2 using high-pressure water jet after 10 days before the extraction of gas concentration in the hole 7.4% -19%, in the later period, the concentration of the gas in the hole is between 1% and 5%, while the J526-3 hole on the left of the drill hole in the J526-2 hole before drilling hole gas concentration of 1% -2.5%, J526-2 hole after the hole gas concentration increased by 3% -8.8%. J522-5 borehole in its adjacent J522-4 hole before the hole is not punching the gas concentration of 3% -5.2%, J522-4 borehole after drilling hole J522-5 gas rose to 6.8% -22.8%.

After the punching of the extraction of gas concentration and extraction flow is not taken more than 1 times the punching measures drilling; After the hole near the hole pumping gas concentration has increased significantly, the amount of increase in more than 10%; The attenuation coefficient of the pumping flow after punching is obviously reduced, 1/4 of the borehole without punching.

### Evaluation

-700 central pedestrian oblique well after the implementation of regional outburst measures, Within a month a total of about 15000m<sup>3</sup> of gas drainage, the extraction rate was 65.7%; The maximum residual gas content is 2.6098m<sup>3</sup>/t, the maximum value of the gas desorption index  $\Delta h_2$  is 70Pa, evaluation -700 central pedestrian dark inclined prevention measures effective. Principle of Broken Coal Based on High Pressure Water Jet, through theoretical analysis and practical application, the results show, coal seam after the implementation of hydraulic punching measures, The elastic potential of the coal has been released, effectively eliminate the stress to stimulate the protruding, with better relief effect of pressure relief, effectively improve the extraction of gas concentration and pumping volume, to achieve a safe and rapid regional out of conflict.

### Conclusion

Through the above data show, in the use of enhanced pressure relief after penetration measures, pumping flow can be increased more than 1 times, drilling extraction concentration increased by 10% or more, reducing the bore attenuation flow, improve the concentration of gas extraction and pumping volume, increasing the permeability coefficient of coal seam, drainage radius is enlarged, reducing the pre-pumping time, to achieve regional rapid elimination of coal and gas outburst disaster impact, to ensure that the protective layer in the extraction of coal mining succession.

### References

- [1] Zengzhao Feng, Jian Kang, Kanglian Duan. Experimental Study and Mechanism Study on Gas Outburst in Hydraulic Cutting of Coal Body [J]. Journal of Liaoning Technical University, 2001, 20(4):443-445

- [2] Jianxin Tang and so on. Design and test of high - pressure water jet device for medium cutting in drilling [J]. *Rock and Soil Mechanics*, 2007, 28(7):1501-1504
- [3] Qing Ye, Baoyu Li, Boqaun Lin. High Pressure Abrasive Hydraulic Slotting Technology [J]. *Safety In Coal Mines*, 2005, 36(12):11-14
- [4] Zhonghua Li and so on. Pressure Releasing Mechanism of High Pressure Water Jet Cutting Coal Seam [J]. *Journal of Liaoning Technical University*, 2009, 28(1):43-45