International Journal of Latest Engineering and Management Research (IJLEMR)
ISSN: 2455-4847
www.ijlemr.com || Volume 10 – Issue 02 || February 2025 || PP. 35-38

High Pressure Hydraulic Flushing used in Rock Cross-Cut Coal Uncovering Technology Research and Application

Jingtao Xie[1], Xiaowa Wu[2], Lei Wang[2], Xie Jiawei[3], Shuai Shuai Xi[2], Yi Guo[2]
[1]*Henan Longyu Energy Co., LTD. Juji coal mine, Shangqiu, 476600, Henan, China*
[2]*Shanxi Daping Coal Industry Co., LTD., Changzhi 047100, Shanxi, China*
[3]*School of Energy Science and Engineering, Henan Polytechnic University, Jiaozuo 454003, Henan, China*

Abstract: In order to improve the security and efficiency of rock cross-cut coal uncovering, the author launched a high-pressure water jet theory broken coal based on hydraulic flushing rock cross-cut coal uncovering technology, and optimized the high-pressure water jet nozzles. In 27021 return air extraction roadway of Zhongmacun coal mine applications show that, after high pressure hydraulic punching ,each index of drilling cutting lower than the critical value, the tunneling rate was greatly improved, and ensure d the rock cross-cut coal uncovering safely and efficiently. Keywords: High-pressure water jet; hydraulic flushing; outburst coal; rock cross-cut coal uncovering; removing outburst.

I. Introduction

In Chinese 645 state-owned key coal mines, high gas and coal and gas outburst mines account for 46%[1]. In order to ensure the safety of the coal uncovering work in the coal seam, the prevention and control of coal and gas outburst points out that the measures of the coal uncovering working face include pre-pumping gas extraction, discharge drilling, hydraulic punching, metal skeleton, coal curing and other measures. Among them, hydraulic punching technology is widely used in Shimen coal uncovering because of its simple operation and short process elimination cycle[2-5].

In this paper, on the basis of the principle of hydraulic punching, on the hydraulic continuous punching coal mechanism research, and optimize the high pressure water jet nozzle, selection, through the independent research and development of "gas extraction drilling hydraulic machine" in coking coal group horse village mine 27021 back to the bottom of stone plate jie coal field application shows that the continuous hydraulic punching can achieve rapid elimination, punching after drilling index are lower than the critical value, ensure the safety of stone jie coal work.

II. Principle of Hydraulic Punching Action

Hydraulic punching using the impact of high pressure water jet, damage, stripping within the scope of coal, formed around drilling holes, holes around the coal to hole, coal expansion deformation, coal fully pressure, coal seam permeability increased, promote gas desorption and emissions, greatly release the elastic potential in coal seam and surrounding rock and gas expansion energy[6-7]. The hydraulic punch hole moistens the coal body and increases the plasticity and humidity of the coal. Therefore, the hydraulic punching not only eliminates the power of coal and gas outburst, but also changes the properties of the outburst coal seam, and plays a role of comprehensive outburst prevention[8].

III. High-Pressure Water Jet Nozzle Optimization

III.1 Nozzle mechanical parameters

According to the theory of hydraulic punching coal breaking, the water jet pressure must be greater than the compressive strength of coal. Therefore, the optimization of high-pressure water jet nozzle becomes an important factor affecting the effect of hydraulic punching. The nozzle parameters are mainly the jet power PW, and the jet pressure[9-10].

$$P_w = 16.67pq = 13.09p_1\mu d^2\sqrt{\frac{2(p_1-p_2)+\rho v_1^2}{\rho}} \quad (1)$$

$$P = P_0 - P_1 - P_2 \quad (2)$$

Among: P0 is pump outlet pressure, P1 is the pipeline loss pressure, P2 is the nozzle loss pressure.

For calculating the hydraulic parameters of multiple nozzle, the equivalent diameter is used.

$$d_e = \sqrt{d_1^2 + d_2^2 + d_3^2 + \cdots + d_n^2} \quad (3)$$

III.2 Line Friction Resistance

The hydraulic punching adopts 12mm inner diameter of continuous oil pipe, which greatly increases the borehole ring area and reduces the plugging accident when the hydraulic punching occurs. At the same time, compared with the large diameter drill pipe, the small diameter coiled oil pipe pipeline friction resistance is greatly increased[11].The friction of winding oil pipeline is divided into straight pipe friction fST and bending friction fCT, and the difference between the two increases.

$$\Delta P = f\frac{2\rho v^2 L}{d} \quad (4)$$

$$f_{ST} = [\frac{1}{2}\log_{10}(\frac{2.51}{\mathrm{Re}\sqrt{f_{ST}}} + \frac{\varepsilon / d_T}{3.715})]^2 \quad (5)$$

$$f_{CT} = f_{ST} + 0.03\sqrt{\frac{d_t}{D_{reel}}} \quad (6)$$

IV. Field Test of Water Jet Punching

IV.1 Overview of the Test Area

Zhongma Village Mine of Coking Coal Group is located 8km in the northeast of Jiaozuo City, Henan Province, in the middle of Jiaozuo coal field. It belongs to the coal and gas outburst mine. On September 11,1969, the first coal and gas outburst occurred in DongReturn Lane. The working face of 27021 is located in the upper part of the west wing of 27 mining area, the east lane in the north, the goaf of 27041 working face in the south, the 25 mining area in the west, and the parking yard of 27 track in the east. The coal seam is powdered and massive, black, 0.5~6.3m thick, and the gas content of the coal seam is 13.32 m3/t. The geological structure of this area is simple, the overall monooblique structure.

Three rows of A, B and C are arranged in the drainage lane of the return air bottom, each with 8 rows, A total of 24 boreholes. The control range of drilling is: 45.5 m 15 m through the coal seam to the coal seam roof 2m. Drilling numbers and arrangements are shown in Fig.1

IV.2 Water-Jet Punching Equipment

The punching equipment uses independently developed "WSZ 16/45-200 gas extraction hole hydraulic operation machine": the maximum working pressure is 45MPa, the maximum flow rate is 200 L/min; the diameter is 16mm continuous oil pipe to deliver high-pressure water to ensure that the coal powder of the closed borehole can be discharged; the length can be adjusted to 150m; without manual takeover, it can continuously penetrate into any position in the borehole; adjust the position, jet pressure, and the underground or control room.

Figure 1. High-pressure hydraulic punching equipment

Figure 2. High-pressure spray nozzle

According to equation 1-6 and optimized by Table fluent software, the nozzle parameters are shown in Tab.1 below.

Table 1 Mechanical parameters of different nozzle combinations

Spray mouth combination	equivalent diameter (mm)	Jet model	Jet pressure (MPa)	Jet power (kW)
Φ3+4×Φ1.5	4.24	Φ1.5	24.93	9.85
		Φ3	26.50	43.18
8×Φ1.5	4.24	Φ1.5	24.93	9.85
4×Φ1.5+2×Φ2	4.12	Φ1.5	28.18	11.84
		Φ2	29.19	22.19
3×Φ2+4×Φ1	4	Φ2	33.12	26.81
		Φ1	32.03	6.38

IV.3 Hydraulic Punching Test

From July 20 to 31, 2012, there were 9 shifts and 24 drilling high-pressure hydraulic punching operations, totaling 21.2 t. The drilling coal output is shown in Tab.2.

Table 2 Statistical table of coal output of hydraulic punch hole

Drilling number	A1	A2	A3	A4	A5	A6	A7	A8
coal output (t)	0.5	2	0.2	0.1	1.5	2	3	0.2
Drilling number	B1	B2	B3	B4	B5	B6	B7	B8
coal output (t)	0.2	2	0.4	0.1	0.5	0.6	2.5	0.5
Drilling number	C1	C2	C3	C4	C5	C6	C7	C8
coal output (t)	0.2	0.2	0.1	0.2	1	0.2	1	2

The average thickness of the coal seam in this range is 0.6 m, and the coal reserves in the drilling control area are 45.5 m 15 m×0.6m 1.5 tm3=614.25 t。 The percentage of washed-out coal reserves in the region was 21.2 t 614.25 t=3.26%. The gas content of the coal seam is 13.32 m3 t, the gas reserve in the borehole control area is 8181.81 m3. The total amount of air exhaust gas discharged during punching is 0.083m per seconds punching time 41760 s=3466.08 m3, the percentage of the gas content of coal seam is 42.4%. After the punching, the residual content of coal seam gas within the control range of drilling is 7.69m³/ t.

IV.4 Analysis of Outburst Prevention Effect

After the hydraulic punching, the coal uncovering was done on August 26,2012 to predict and test the outburst danger of the working face and test, including △ h2 .The maximum value is 137.2 Pa, the maximum value of drilling S is 2.4 kg / m, and the maximum speed of drilling gas emission q is 3.48 L/min. According to the requirements of the regulations for the control of coal and gas outburst of coal, it indicates that the method.

V. Conclusion

(1) Under the average coal thickness of 0.6 m, 20 t coal is produced, accounting for 3.26% of he coal volume in the control area; the total amount of wind gas discharged during punching is 3466.08 m3; After the early hydraulic punching operation, the gas content of the coal seam is 13.32 mAnd 3 / t decreased to 7.69 m3 / t, indicating that high pressure hydraulic punching can increase the amount of drilling and accelerate gas discharge.

(2) The inspection of the uncovered coal sensitive index shows that △h2 The maximum value is 137.2 Pa, the maximum value of drilling dust amount S is 2.4 kg / m, the maximum value of drilling initial gas emission velocity q is 3.48 L/min, and the above indicators are lower than the reference critical value of outburst risk.

(3) It is proved that the hydraulic punching operation has eliminated the outburst danger of the coal seam in this place, and the second area was successfully completed later. The coal uncovering work of the next group of coal.

Reference

[1]. The State Administration of Work Safety. The annual statistical analysis [EB / OL]. (2008-01-12) [2009-08-02]. http://www. Chinasa-fety. g ov.cn/newpage/aqfx/aqfx_ndtjfx. htm.
[2]. Liu Mingju, Guo Xianlin, Li Bo, et al. Hydraulic penetration and penetration prevention technology in the bottom plate lane [J]. Coal Science and Technology, 2011,39 (2): 33-35.
[3]. Liu Yingzhi, Liu Yanwei, Hao Tianxuan. Research and application of hydraulic punching cover coal roadway tunneling technology [J]. Coal Science and Technology, 2013,41 (11): 82-85.
[4]. Liu Mingju, Ren Peiliang, Liu Yanwei, et al. Theoretical analysis of coal breaking measures [J]. Henan Polytechnic University (Natural Science Edition), 2009, 28 (2): 142-145.
[5]. Baiguoji, Zhang Junru, Jiang Xugang, et al. Analysis of the effect of hydraulic punching and sudden process elimination and its main influencing factors [J]. Henan Polytechnic University (Natural Science Edition), 2010,29 (4): 440-443.
[6]. Xu Xin, Li Baoyu. Research on the application of hydraulic punching discharge pressure increasing penetration technology in coal mine gas drainage [J]. Mining Machinery, 2011,39 (4): 8-10.
[7]. Fan Yingchun, Wang Zhaofeng. Analysis of the effect of soft and low penetrating coal seam [J]. Safety of coal mine, 2012, 43 (6): 137-140.
[8]. Liu Mingju, Kong Liuan, Hao Fuchang, et al. Application of hydraulic punching technology in seriously protruding coal seam [J]. Journal of Coal Science, 2005, 30 (4): 451-454.
[9]. Xue Shengxiong, et al. High Pressure Water Jet Technology Engineering [M], Hefei: Hefei University of Technology Press, 2006.
[10]. Xu Xianliang, Wang Kasong, Meng Limin. Fluid mechanics [M], Beijing: National Defense Industry Press, 2011.
[11]. Sas-Jaworsky II,A,and Reed,T.D:"Predicting Friction Pressure Losses in Coiled Tubing Operations," World Oil (Sept.,1997), 141-161.