Hydraulic Fracturing and Anti-reflection Test in Guizhou Yushe Coal Mine No.11014 Mining Face

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Abstract: In view of the fact that there is a blank belt in the 11014 mining face of Yusha Coal Mine in Guizhou, which is not controlled by pre-drilling, the hydraulic fracturing and anti-pressure technology is used to carry out gas drainage in the 11014 mining face. Field tests were carried out by designing a reasonable hydraulic fracturing borehole and selecting suitable fracturing equipment. After the implementation of this technology, the single-hole extraction concentration of the 11014 mining surface is more than 30%, and the pure flow rate is increased by 17% compared with the fracturing. This effectively solves the difficult problem of eliminating the quasi-reaching standard and it ensures the safe and efficient mining of coal mines.

1. Introduction

China's coal mine geological conditions are complex, high gas coal seams account for more than 70% [1]. With the development of coal seam pressure relief and the application of field application, hydraulic fracturing is an effective technology to achieve the elimination and local outburst of coal mine underground area, and it is a powerful guarantee to improve the pre-extraction gas concentration of coal seam [2,3]. In recent years, coal mine hydraulic fracturing technology has been widely promoted and applied. Li Quangui, et al [4] carried out the hydraulic fracturing technology in the working face of Daxing Coal Mine, and the results showed that the gas drainage capacity increased by 7.2 times, and the coal seam permeability coefficient in the area affected by hydraulic fracturing increased by 79~272 times. Guo Chenye, et al [5] conducted a hydraulic fracturing test on the Donglin Coal Mine 3604E2 working face, resulting in a five-fold increase in single-hole gas extraction. Ma Haifeng, et al [6] proposed the "water-sand-water" hydraulic fracturing enhanced anti-reflection technology, through the field test of the bottom pumping roadway of the 1232 (1) working face of Panyi Mine, and the average of the perforation and the volume of the gas is increased by 1.4, 1.2. Li Qi [7] carried out a sub-segment hydraulic fracturing technology test in Panbei Mine, and the average daily extraction volume increased by 2.94~10.87 times. Luan Yueqi [8] used hydraulic fracturing and anti-pressure technology to test the working surface of Xieqiao Mine 1351(3) working face, which improved the gas permeability of the coal seam and greatly increased the gas drainage concentration. Based on the above analysis, hydraulic fracturing has a significant effect on improving coal seam permeability and increasing gas drainage concentration. Therefore, this paper mainly uses the hydraulic fracturing technology to conduct the anti-reflection gas extraction test on the Guizhou Yushe Coal Mine 11014 mining face.

2. Coal mine situation

The 11014 working face of Guizhou Yushe Coal Mine is K1-B coal seam. The working face has a length of 850 meters and a tendency length of 180 meters. The gas content is 13.88m3/t, the gas

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content gradient is 0.0533m3/m.t, the gas pressure is 1.55MPa, the firmness coefficient f is 0.25, and the coal seam permeability coefficient is low [9]. In the wind alley, a pre-drilling hole with a downward direction is carried out. The longest drilling hole is 120m, most of which is below 100 meters. From the roof of the roadway, the first layer of the drilling and drilling control machine lane is carried out. The control range is 30m upward along the sloping length of the coal seam, and the standby lane is formed into a recovery area along the upper layer. Because the working face is 180 meters long, the dip angle of the coal seam changes greatly, and there is a geological structure in the middle. The upper and lower boreholes cannot be placed in place according to the design, resulting in the pre-drilling hole in the working face along the strike direction of 30~50 meters. Pre-drilling control, in order to improve the permeability of the coal seam and improve the extraction effect, further uncontrolled strips in the middle to ensure the mining and mining of the mine, hydraulic fracturing is carried out on the working face for gas drainage.

3. Hydraulic fracturing drilling arrangement

According to the current production, mining and excavation of the Yushe coal mine, the fracturing site is set as the roof drainage tunnel of the 11014 working face, as shown in Fig. 1.

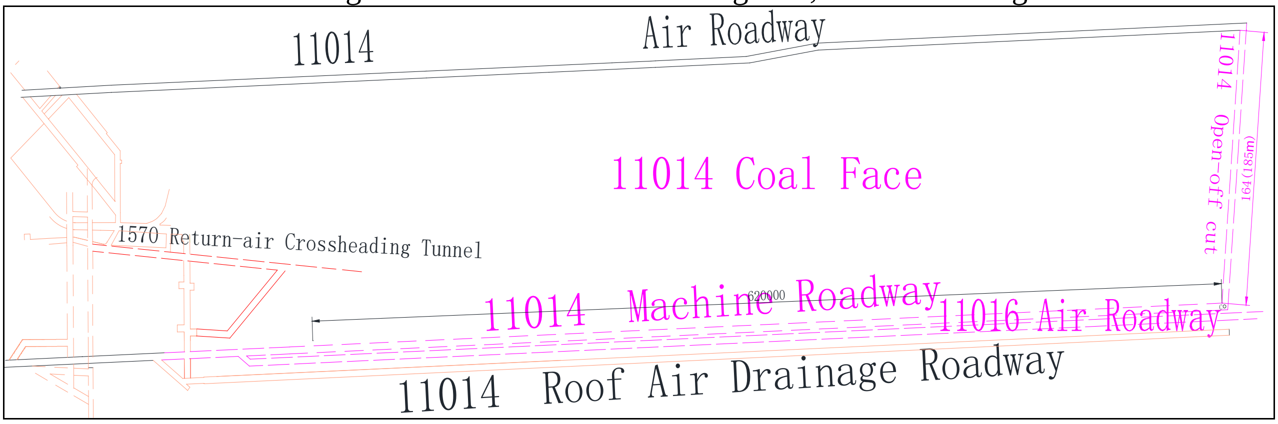

Fig.1 Schematic diagram of hydraulic fracturing in the roof of the working face 11014

According to the site conditions, we chose to wear the laminated cracks. A total of 21 fractured boreholes were designed. The cumulative hole depth was 1765 meters and the cumulative sealing depth was 1309.6 meters. This hydraulic fracturing is mainly carried out by CBYL400 fracturing pump set (as shown in Table 1).

Table 1 CBYL fracturing pump set operating parameter

Gear position	Speed ratio	Pump speedr/min	Matching motor power/kW	Plunger diameterD=100mm		Plunger diameterD=80mm	
				Flow m^3/h	Pressure/MPa	Flow m^3/h	Pressure/MPa
5	1	370	400	70.5	16.5	45.2	25
4	1.35	274	400	52.3	22	33.5	35
3	2.01	184	400	35.1	33	22.5	52
2	2.68	138	400	26.3	44	16.8	69
1	4	92.5	400	17.6	50	11.3	78

The fracturing sequence adopts fracturing from the inside to the outside, and the initial distance of the fracturing hole is about 37~46 meters. At the same time, the borehole in the peripheral area of the fracturing hole which is easy to affect the hydraulic fracturing construction is grouted and sealed to ensure that the hydraulic fracturing can smoothly extend to the "blank zone" of the extraction.

Drilling arrangement after fracturing:

(1) Fracturing Drilling and Drilling: After hydraulic fracturing and completion of drainage in

11014 top pumping, all fracturing boreholes and radius drilling holes are connected to the extraction system for extraction.

(2) Supplementary through-hole drilling and extraction: In order to eliminate the blanking of the working face, after hydraulic fracturing of the 11014 working face, the design is to drill the drilling hole in the 11014 top pumping road. Because there is only 30~50 meters of extraction "blank belt" between the working face and the lower layer of the drilling hole, and the angle between the drilling hole and the coal seam is very small, the through-hole drilling through the coal section is longer. Therefore, it is only necessary to construct 2 drill holes per drill point to completely eliminate the extraction blank belt. In combination with the mining sequence of the working face, the drilling is arranged in a grid of 10m×20m in the range of 300m outside the opening and cutting; the drilling of the drilling outside the 300m is arranged in a grid of 20m×20m, and a total of 92 drilling holes are applied.

From February 26, 2014 to April 23, 2014, all the fracturing boreholes have been completed. A total of 22 fracturing holes have been constructed, with a footage of 1831 meters, on February 26, 2014, March 26, 2014. Fracturing was carried out on April 4, April 7, and April 8. A total of 20 fracturings were carried out, and all the fracturing holes were all connected on April 10th.

4. Analysis of the effect of hydraulic fracturing and anti-reflection

4.1 Analysis of the influence range of fracturing

In the case that many extraction holes affect the fracturing effect, the fracturing radius during construction is as long as 46m, far exceeding the expected radius. [11] On the morning of February 26, 2014, the first five fracture holes were fractured.

Table 2 Statistics on the construction of hydraulic fracturing holes

Hole number	Fracturing pressure		Fracturing displacement			Outlet point location	
	Highest pressure /MPa	Smooth pressure /MPa	Highest displacement /m³.h^{-1}	Smooth displacement /m³.h^{-1}	Cumulative displacement /m³	Outer/m	In/m
1#	25.5	24	33	24	20	22	14
2#	24.2	23．8	35	27	28	46	2
3#	23.7	20.1	39	35	20.4	20	2
4#	22.8	22.3	41	40	17.4	26	9
5#	12.8	12.8	35	35	/	/	/

4.2 Analysis of drainage effect

According to the drilling of the drilling layer and the integrated pumping pipe joint after the fracturing, most of the single hole extraction concentration is above 30%.

Before the fracturing, the drainage concentration of the 11014 roof drainage roadway is 15%~20%, with an average of 18%. The extraction mixing flow rate is 75m^3/min, and the pure flow rate is 13.5 m^3/min. The extraction concentration is 15~20%, with an average of 16% within 12 days after fracturing. The extraction mixing flow rate is 75~125 m^3/min, with an average of 100 m^3/min. By the calculation, the pure flow rate is 16 m^3/min, which is 18.5% higher than that before fracturing.

From March 11 to March 31, 2014, the concentration of extraction is 20% to 25%, with an average of 21%. And the mixed flow rate is 74~100m^3/min, with an average of 75m^3/min. By the calculation, the pure flow rate is 15.75 m^3/min, an increase of 17% compared to before the fracturing.

5. Conclusion

(1) The hydraulic fracturing and anti-pressure gas drainage test was carried out by designing a reasonable hydraulic fracturing drill hole in the Yushe Coal Mine 11014 mining face and selecting suitable fracturing equipment.

(2) After the implementation of this technology, the single-hole extraction concentration after fracturing is above 30%, and the pure flow rate is increased by 17% before the fracture.

(3) Through the implementation of this technology, the gas permeability of the coal seam in Yushe Coal Mine has been improved, and a good drainage effect has been achieved, which has achieved the purpose of ensuring mining and mining, safe and efficient mining.

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