

Study on CO₂ crack anti-reflection technology and extraction radius of investigation combined with the application

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Abstract: In order to improve the gas extraction efficiency and the wear layer drilling gas extraction to amount to mark time, 15th coal seam in a mine using CO₂ crack anti-reflection technology combined with the plum blossom cloth pore radius of the arrangement of extraction. Field test showed that CO₂ crack anti-reflection technology conditions, according to the calculated crack concluded three groups of radius of influence radius of gas extraction in the arrangement, Based on two pieces of test area crack anti-reflection technology of coal seam gas extraction effect is compared before and after, and three groups of different radius of gas extraction extraction effect analysis shows that 1.5m radius of gas extraction from standard can effectively shorten the extraction time and increase the rate of gas extraction.

1. Introduction

Because of CO₂ crack anti-reflection technology has anti-reflection effect and security well, the technology is widely used in recent years^[1]. Wang Zhaofeng^[2-4] and other research in the field of coal seam anti-reflection has obtained certain achievements, such as a single hole way of research of JiuLiShan mine, Pingdingshan 13th Mine studied staggered plum flower holes arrangement way, the study is of significance to the improvement of extraction effect. In order to further shorten the gas extraction from standard time, According to the actual circumstance of mine, the author adopts Wang Zhaofeng, a professor at the research of the plum blossom drilling holes arrangement way combining applied to crossing hole gas extraction in the radius of investigation, the advantage is that clear for presplitting and extraction from borehole spacing and radius of each group of the gas extraction in the amount of gas extraction and radius of gas extraction to investigate the crossing hole is clear and makes the actual extraction process better improve the efficiency of gas extraction.

2. CO₂ crack anti-reflection technology

2.1 Principle of CO₂ crack anti-reflection technology

Principle of CO₂ crack technical is filling the liquid CO₂ in the blasting machine head, quickly stimulate heating with a blasting device, the competent within 40ms CO₂ gasification and volume expansion of more than 600 times more rapidly, pressure relief piece can reach the extreme pressure, pressure relief piece can immediately breaking within 0.5s^[5], high pressure gas produced from the top of the pressure can impact air flow and pressure of coal, thus increasing the permeability of coal strata. Blasting device structure is shown in Fig.1.



1. Inflatable head 2. Heat pipes 3. The main line
4. Gasket 5. Pressure relief piece 6. The top of the pressure

Fig.1 Blasting device structure

2.2 The crack radius of influence

By fracture mechanics and elastic-plastic mechanics theory, the blasting gas blasting stress wave function for rock damage can be divided into regional and blasting gas area of the quasi static field [6].

Stress wave action radius:

$$r_c = r_h \times \left(\frac{P_{\max}}{K_I S_t} \right)^{\frac{1}{\alpha}} \quad (1)$$

Type: r_c is the initial crack length, m; r_h is blast hole diameter, 90mm; K_I is under the dynamic load coefficient of tensile strength increased; S_t is rock tensile strength under the static load, coal general value for 5MPa [7]; α is the attenuation index, average value of 1.5, P_{\max} is blasting gas high pressure peak, 270MPa.

As r place of quasi static stress field area:

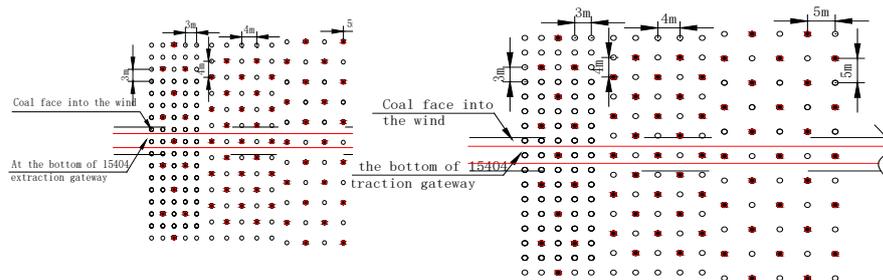
$$\begin{cases} \left(\frac{P_{\max}}{2P} \right)^{1/K} = 1 + \left[\left(\frac{r_c}{r_h} \right)^2 - 1 \right] \frac{P}{K_b} \\ \sigma_r = P \times \left(\frac{r}{r_c} \right)^{-\alpha} \end{cases} \quad (2)$$

Type: r_c is the initial crack length, m; r_h is blast hole diameter, 90mm; K_b is coal bulk modulus, MPa; r hole distance to distance; P_{\max} is blasting gas high pressure peak, 270MPa; P is the initial crack gas pressure in the area, MPa; For σ_r distance r , quasi static stress. After stress wave effect, combined with the formula (1), (2) to calculate the crack influence radius of about 6.6 m.

3. Crossing hole arrangement

To study CO₂ crack anti-reflection technology effects of the effective radius of drainage gas in coal seam can be calculated by the crack fracture radius, at the end of the underground random lane end to select the two pieces of test area, test area 1 and test area 2, respectively, test area 1 without fracturing well location, test area 2 fracturing for the quincunx cloth hole drilling, as shown in Fig.2 (a), as shown in Fig.2 (b).

According to the actual situation of mine in bottom lane test area location of the radius of the gas extraction can be divided into three groups: 1.5m, 2.0m, 2.5m, the gas drainage space between boreholes for 3m, 4m, 5m, inspection hole according to 5 rows layout in each group. Test area 1 is not done in layout, the extraction from drilling arrangement for 3m×3m, 4m×4m, 5m×5m (x row spacing hole spacing). Test area 2 of the second layer drilling arrangement for black hole filling stage, the other for extraction from drilling, three groups in the test area extraction radius of drill hole arrangement for 3m×3m, 4m×4m, 5m×5m (final hole spacing×row spacing), control the roadway on both sides of the contour extraction hole within 15m, In arrangement to adopt the way of zhao-feng wang, the plum flower cloth hole arrangement in three groups of extraction from drilling [8], and extraction radius of 1.5m, 2.0m and 2.5m respectively, the number of three groups in layout to 13, 27, 27.



(a) test area 1 without fracturing well location (b) test area 2 fracturing for the quincunx cloth hole drilling

Fig.2 Field drilling layout diagram

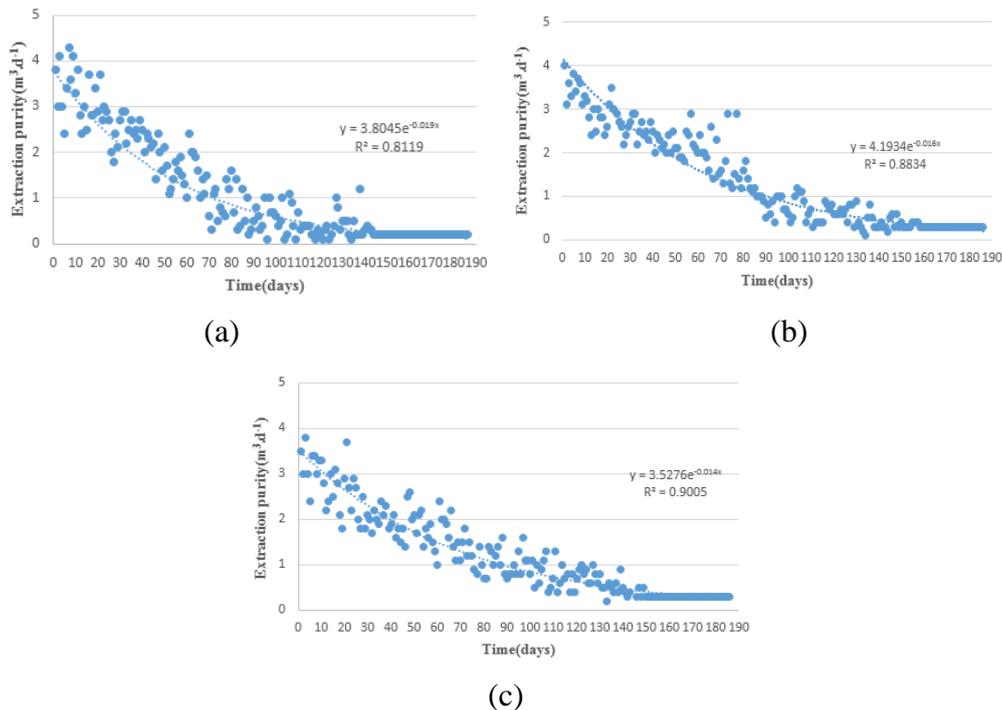
4. Field test results

Test address selects 15th coal seam in a mine drainage, An average of about 5.74m 15th coal seam thickness, 14.71% of the volatile matter of coal seam, the porosity is 5.56%, the gas adsorption constant a is 30.7702, b is 1.3573, coal seam permeability coefficient is $0.008\text{m}^3/(\text{m}^2\cdot\text{d})$. In bottom lane distance opening 340 ~ 460 m position arrange two pieces of test area of test area, they are named test area1, test area 2, and field sampling test of gas content and gas pressure measurement test show that 120 m after primitive gas content in the area of $8.9\sim 11.84\text{m}^3/\text{t}$, original gas pressure is $0.81 \sim 0.96\text{MPa}$.

Within the test area 2, according to the scheme of 15th coal seam crack blasting of CO_2 and completed immediately after blasting crack of hole sealing, and connect extraction pipeline, the extraction effect were investigated finally. To contrast analysis was carried out on the two pieces of test area, test area 1 and test area 2 use comprehensive gas drainage parameters tester on the extraction of gas concentration, flow extraction effect.

4.1 Under the condition of not crack blasting for CO_2 extraction radius effect

For comparison and analysis of CO_2 crack layer anti-reflection technology to crossing hole radius of extraction effect, respectively investigates the 15th coal seam in a mine alley pumping test area a 15404 at the end of the 4th mining extraction radius of 1.5m, 2.0m, 2.5m three groups of extraction from drilling and in not adopt measures to crack under the condition of the original coal gas extraction from scalar relationship curves with time, As shown in Fig.3.



- (a) Under the condition of 13kPa negative pressure stability for 1.5m radius of extraction
- (b) Under the condition of 13kPa negative pressure stability for 2m radius of extraction
- (c) Under the condition of 13kPa negative pressure stability for 2.5m radius of extraction

Fig.3 Test area extraction from scalar curve over time

Can be seen from Fig.3, test area 1 without crack anti-reflection, daily gas extraction scalar curves of scalar have been function form:

$$y = At^{-b} \quad (3)$$

Type: y is extraction concentration and extraction of pure quantity, m^3/d ; A, b is constant; t is time, d .

Fig.3 was measured and the average extraction from scalar, Can be seen from Fig.3 extraction

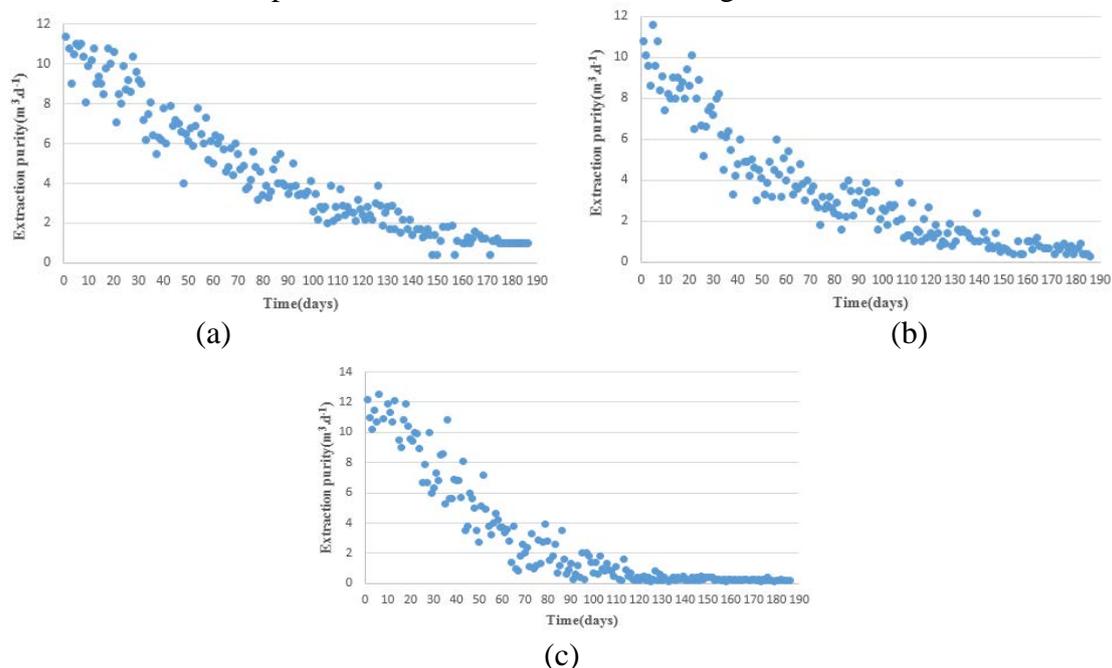
radius of 1.5 m after the extraction of borehole in pore forming extraction from scalar attenuation to $2\text{m}^3/\text{d}$ on 25th day, when the extraction to the 80th day extraction from scalar approximately $1\text{m}^3/\text{d}$, 140 days after extraction from scalar at $0.15\text{m}^3/\text{d}$; Extraction from 2 m radius of extraction in drilling hole after extraction from scalar attenuation to $2.1\text{m}^3/\text{d}$ in the 30th day, when the extraction to the 90th day extraction from scalar approximately $1\text{m}^3/\text{d}$, 160 days after extraction from scalar at $0.2\text{m}^3/\text{d}$; Extraction of the radius of 2.5m extraction in drilling hole after extraction from scalar attenuation in the 20~40 days in stable fluctuations around $2\text{m}^3/\text{d}$, 150 days after extraction from scalar at $0.3\text{m}^3/\text{d}$, the mine 15th coal seam permeability coefficient is $0.008\text{m}^3/(\text{m}^2\cdot\text{d})$.

Can be seen from fig.2, Extraction radius of 1.5m crack after the extraction of scalar curve of average single-hole extraction from scalar 10d accumulative total of 35m^3 , 20d accumulative total of 65.1m^3 , 30d accumulative total of 91.1m^3 , 40d accumulative total of 116.7m^3 ; After extraction of radius 2 m crack extraction from scalar curve of cumulative average single-hole extraction from scalar 10d 34.9m^3 , 20d accumulative total of 62.4m^3 , 30d accumulative total of 90.1m^3 , 40d accumulative total of 115.7m^3 ; Extraction radius of 2.5m crack after the extraction of scalar curve of cumulative average single-hole extraction from scalar 10d accumulative total of 32.1m^3 , 20d accumulative total of 57.7m^3 , 30d accumulative total of 82.1m^3 , 40d accumulative total of 102.4m^3 .

According to the test area, a coal seam primitive gas extraction from scalar decay curve and extraction of three groups of extraction radius, respectively, the cumulative scalar calculation can be obtained, without taking crack blasting radius of 1.5m extraction under the condition of extraction from standard need to 235days, 2m radius of extraction from extraction to amount to mark need to 270days, radius of 2.5m extraction extraction standard need to 300 days.

4.2 Radius of CO₂ extraction crack blasting effect

Test area 2 examined three groups after extraction radius and adopt measures to crack gas coal extraction scalar relationship curves with time, As shown in Fig.4.



- (a) Under the condition of 13kPa negative pressure stability crack after 1.5m radius of extraction
- (b) Under the condition of 13kPa negative pressure stability crack after 2m radius of extraction
- (c) Under the condition of 13kPa negative pressure stability crack after 2.5m radius of extraction

Fig.4 Crack blasting experiment area CO₂ extraction from scalar curve over time

According to Fig.4 shows that test area 2 arrange in the three groups of extraction to radius of 1.5m, 2m, 2.5m crack after blasting anti-reflection, extraction from borehole in 35~135 days average daily extraction from scalar has been at the level of higher than before the crack, and three groups of extraction from average daily drilling extraction from scalar is before the crack of 1~4

times, according to above analysis, the crack anti-reflection technology can effectively increase the air permeability of coal seam and improve extraction from scalar, and implementation of crack after preliminary effect is very obvious. Extraction radius of 1.5m crack after the extraction of scalar curve of average single-hole extraction from scalar 10d as 103m^3 , 20d accumulative total is 201m^3 , 30d accumulative total of 290.3m^3 , 40d accumulative total is 360m^3 , extraction amount to mark only about 150days; After extraction of radius 2m crack extraction from scalar curve of average single-hole extraction from scalar 10d to 96m^3 , 20d accumulative total of 172.9m^3 ,30d accumulative total of 248.5m^3 ,40d accumulative total of 308.1m^3 ,extraction amount to mark only about 190 days; Extraction radius of 2.5m crack after the extraction of scalar curve of average single-hole extraction from scalar 10d as 100m^3 , 20d accumulative total is 186m^3 , 30d accumulative total is 268m^3 , 40d accumulative total is 340m^3 , extraction amount to mark only about 240 days.

5. Test area crack effect analysis

5.1 Test area crack effect comparison

Contrast of through two pieces of test area crack anti-reflection after the extraction effect, crack anti-reflection measures after extraction concentration increased significantly, drilling extraction purity is similar to crack measures before attenuation trend.

According to the time node,10d,20d,30d,40d cumulative average extraction of a single extraction of pure quantity, gas extraction from three groups of different radius of crack after the extraction of scalar curve of single span the average extraction from scalar increased compared with before the crack of 3 times. At the same time a series of measures to crack the permeability coefficient of coal seam after $2\text{m}^3/(\text{m}^2\cdot\text{d})$, permeability coefficient is approximately 250 times before crack anti-reflection, thus the standard time of extraction significantly shortened.

5.2 Contrastive analysis of the different extraction radius

According to the Fig.3 shows that before crack measures 1.5m radius of extraction of single hole daily extraction of pure quantity is the largest, Standard time of extraction shortest time is 235 days; According to fig.3 Crack measures after radius of 1.5m extraction, extraction effect of a single hole daily extraction of pure quantity is best, And according to the calculation in influence radius of 6.6m to decorate in 13, the shortest time for standard time of extraction is 150 days, and radius of 1.5m extraction of single hole daily extraction scalar is three times before the crack.

6. Conclusion

(1) 15th coal seam in a mine CO_2 crack blasting experiment, based on fracture mechanics and elastic-plastic mechanics calculated CO_2 crack blasting influence radius of 6.6m, and according to the arrangement of radius of influence radius of extraction from 1.5m in 13.

(2) 15th coal seam in crossing hole extraction radius on 1.5m standard optimal extraction time was 235 days, after crack anti-reflection Standard time of extraction was 150 days, the Standard time of extraction is shorten 85 days, the extraction efficiency increased by 36.17%.

Acknowledgments

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