Experiment study on extraction technology of coalbed methane surface well in Jincheng mining area

Wang Ran[1, 2, a, *]

[1]Gas Research Branch, China Coal Technology Engineering Group Chongqing Research Institute, Chongqing 400037, China

[2]State Key Laboratory of the Gas Disaster Detecting Preventing and Emergency Controlling, Chongqing 400037, China

[a] 411233957@qq.com

Keywords: Ground well, Coal bed methane extraction, Mining-affected area

Abstract: In order to verify the applicability of surface well optimization design and safe extraction technology in Jincheng mining area, the extraction test of CBM surface well in mining area was carried out in W2301 working face of Sihe coal mine, Jincheng city. According to the geological characteristics of Sihe Coal Mine, the shaft structure of the test well was optimized and 70-day extraction test was carried out, the maximum extraction capacity can reach 9 m^3 /min. This experiment also analyzed the influence of surface well extraction on the ventilation concentration of working face and the change of extraction concentration with the advance of working face.

1. Introduction

Coalbed methane is a kind of high quality energy, the calorific value of coal bed methane combustion is twice that of ordinary gas, and the pollution is only 1/800 of that of coal. The research of exploration, exploitation and utilization technology of coal bed methane has always been paid attention to by many countries all over the world[1]. China began to introduce this technology in the 1990s, because China's coal reservoirs generally have the characteristics of "low pressure, low permeability, low saturation", strong adsorption of coal bed methane, difficult to desorption, so can not directly copy the foreign experience[2],.Therefore, combined with the geological characteristics of the mining area, it is necessary to develop surface CBM extraction technology suitable for different regions and conditions. At present, in Huainan, Huaibei and Tiefa mining areas, a large number of field tests have been carried out and some application experiences have been obtained, while in Jincheng mining area, great success has been achieved in the application of pre-mining drainage technology[3-5]. In order to further develop coalbed methane resources in coal mining area and enrich the technical means of coalbed methane resources development, surface well extraction test of coalbed methane in mining area was carried out in Sihe Coal Mine, Jincheng Mining Area, in order to investigate the applicability and technical requirements of surface well extraction technology of coalbed methane in mining area in Jincheng Mining Area. Through the surface well extraction test of coalbed methane in mining area in Sihe Coal Mine of Jincheng Mining Area, the coalbed methane resources in coal mining area have been further developed, and the technical means of coalbed methane resources development have been enriched.

2. Working face overview

The elevation of W2301 working face of Sihe Coal Mine is +1019.11m, the maximum relative height difference is 610.4 m, and the general relative height difference is 200-400 M. The strike length of W2301 face is about 2,000 meters. Because of the complicated geological conditions, it is divided into two mining periods. The first mining is about 1,250 m long, the inclination length is about 221.5 m, the average thickness of coal seam is 6 m, the inclination angle of coal seam is 0 ~7°

  DOI: 10.25236/epcimms.2019.01

and the average inclination angle of coal seam is 2°. The average mining depth of working face is about 420m. The bulk density of coal is 1.46t/m^3, the hardness f of coal is 1-2, the thickness of cap mountain is 320 ~ 440m, and the ground pressure is 9.00 ~ 13.00Mpa. There are 5 # seams with thickness of 0.75 m at 13m below No. 3 coal seam and 7 # coal seam with thickness of 0.4 m at 26m below No. 3 coal seam. The absolute gas emission is estimated to be about 43 m^3/min at the working face, and there is no spontaneous combustion tendency and no explosion of coal dust in the coal seam.

3. Construction Design of Surface Well

3.1 Shape Structure of Surface Wells

It is found that the location of surface wells in the middle of the stope midline and the air return roadway can greatly reduce the damage caused by strata movement to the wellbore casing, and achieve better CBM extraction efficiency [6-7].

According to the working face condition, the position of the test well is 1100 m away from the open hole and 70 m away from the return air roadway.

Based on the study of the damage law of surface wells in mining area and the characteristics of CBM surface development in mining area. The shaft structure of the surface well is divided into three stages. The final hole of the surface well is located 5 m above the top of 3# coal seam, and the whole depth of the well is 389 M.

(1) The first section is drilled by a bit with a diameter of 444.5mm. After drilling into the stabilized rock layer of 10m, the casing is put into it. The diameter of the casing is 406.4mm. The cementing depth of the casing in the first section is about 30m, and the cementing cement returns to the surface.

(2) Secondary section is constructed with 347.6 mm diameter bit. When the bit is drilled at 85m on the roof of 3_coal seam, 309 m long casing is put in. The diameter of casing is 298.4 mm. The whole section is cemented and the cement slurry returns to the surface.

(3) The third-class section is drilled with a bit of 269.9 mm in diameter, and the final hole is 5 m above the roof of 3# coal seam. After completion of drilling, 85m-long casing is put in. The diameter of casing is 177.8 mm. The third-class casing is overlapped with the second-class casing by 5 m. The surface well bore structure is shown in Fig.1.

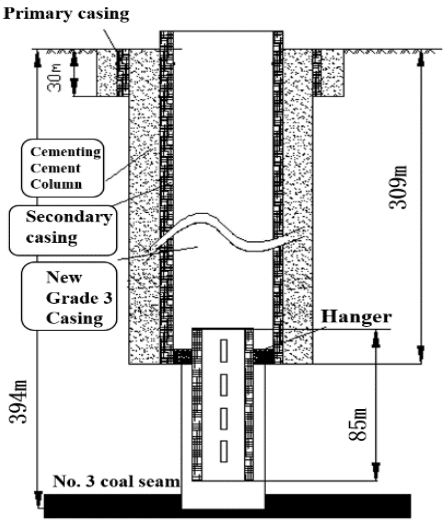

Fig.1 Shaft structure diagram of surface well

3.2 Design of Ground Extraction System

3.2.1 Surface Drainage Pipeline System

(1)Assuming the average mixed flow rate of a single well is 25 m^3/min, the seamless steel pipe

with a diameter of 219 mm is selected for surface well pumping pipeline.

(2) Surface coalbed methane extraction equipment: Water ring vacuum pump, water seal explosion vent, anti-backfire device, gas-water separator, vent, circulating water tank, circulating water pump and diversion pipeline system, etc.

3.2.2 Ground Drainage Safety Monitoring System

In order to record the concentration of coalbed methane produced and prevent spontaneous combustion of underground coal, the parameters monitored during the test include: Methane concentration, oxygen concentration, extraction negative pressure, extraction flow rate, extraction gas composition, etc. The monitoring system equipment includes: GD4 gas drainage multi-parameter sensor, oxygen sensor, U-type differential pressure gauge and light interference methane detector. Among them, GD4 multi-parameter gas drainage sensor and oxygen sensor are used to monitor the relevant parameters of daily automatic monitoring system. U-type differential pressure gauge and light interference methane detector are used to measure the gas flow and concentration of coal seam in pipeline manually when the monitoring system fails.

4. Data analysis of surface well extraction

4.1 Drainage Effect of Surface Wells

The surface well extraction system began to operate on August 5, 2013. The test observation lasted 70 days, and the cumulative CBM extraction purity was about 337,000 m^3. The variation curve of some operation data of surface wells is shown in Fig. 2.

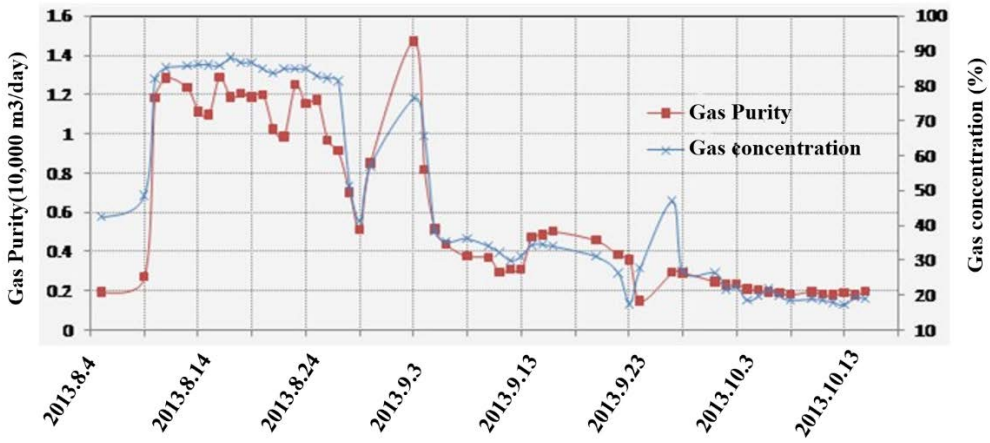

Fig. 2 The relationship between gas purity, gas concentration and time

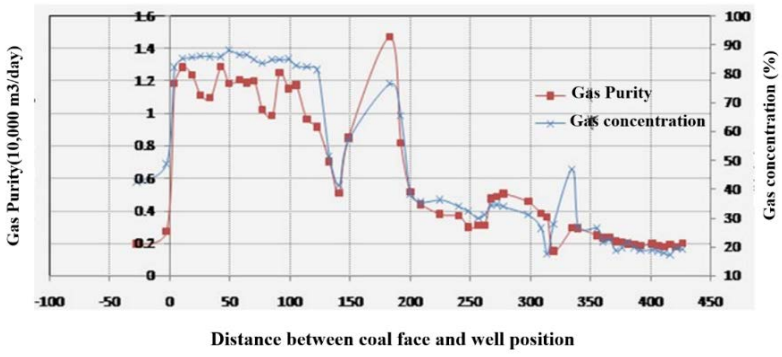

Fig. 3 Relationship between gas purity, gas concentration and distance from coal mining face to well location

The purity and concentration of gas extracted from the surface well tend to be stable gradually

when the working face exceeds the surface well location by 3m. The maximum pure quantity of gas is 12,000 m^3/d, and the gas concentration is about 85%. As shown in FIG. 3, when the working face is approaching the well location, the negative pressure of pumping in a short time increases rapidly due to the effect of the leading support pressure. At this time, the concentration and purity of gas are low. After the working face passes the well location, the negative pressure of extraction is reduced to about 27kPa, the gas purity is maintained at about 50,000m^3 /d, and the gas concentration is maintained at about 40%.

4.2 Effect of surface well drainage on gas control in working face

Figure 4 shows the effect of surface well drainage on gas concentration in working face. When the surface well has not been pumped out, the average gas concentration in the working face is higher, and the maximum gas concentration in the working face is 0.76%. When the distance between the working face and the well is 60 m, the surface wells begin to extract gas, and the maximum gas concentration in the working face is reduced to less than 0.41%, with an average of 0.27%. The average gas concentration in the working face is reduced by 26.5%, and the average air-drainage gas volume in the working face is reduced to less than 16.4 m^3/min. The situation of gas exceeding the limit in working face has been well alleviated.

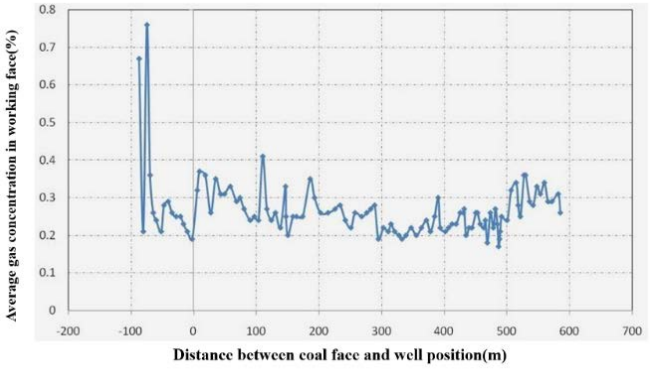

Fig.4 The influence of surface well drainage on gas concentration and ventilation gas discharge in working face

When the surface well has not been extracted, the maximum gas concentration of the total return air lane on the working face reaches 0.92%. After the coal mining working face pushes over the well position of 8m, the gas concentration and gas emission amount of the total return air lane on the working face both drop significantly, and the gas concentration decreases by 39.1%.

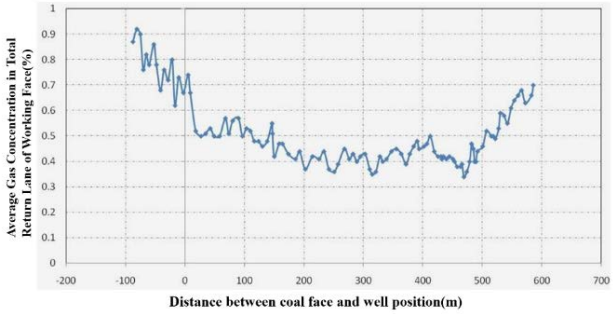

Fig. 5 Effect of surface well drainage on gas in total return air roadway of working face

5. Conclusion

(1) During the operation of surface wells, the maximum net pumping flow can reach 9 m^3/min. Surface wells have great potential in the development of coalbed methane in coal mining area, but how to ensure the stability of wellbore casing is also the key problem to be solved before surface well extraction technology is popularized in Jincheng mining area.

(2) During the period of surface well extraction, the gas concentration in working face is reduced by 26.5% on average, and the average air-drainage gas volume in working face is reduced to less than 16.4 m^3/min. The situation of gas exceeding the limit in working face is well alleviated. The gas concentration and the amount of gas discharged by sight in the total return air lane of the working face are significantly decreased, and the amount of gas discharged by the total return air lane of the working face is reduced by about 39%. This shows that the effect of surface well drainage on gas control in the working face is remarkable.

Acknowledgments

The study was supported by the National Science and Technology Major Project of the Ministry of Science and Technology of China (No.2016ZX05045001-006).

References

[1]JiaChengzao.Evaluation method of coalbed methane resources reserve[M].Beijing: Petroleum Industry Press, 2007.

[2]YangLuwu, Sun Maoyuan, Hu Aimei etal.Development technology suitable for the characteristics of CBM reservoirs in China [J]. Journal of Petroleum, 2002, 23 (4): 46-50.

[3]Huainan Mining (Group) Co., Ltd., Chongqing Branch of the General Academy of Coal Science Research, Australia Federal Industrial Science Park. Study on gas drainage technology in miningarea by ground drilling [R]. Huainan: Huainan Mining (Group) Co., Ltd., 2006.

[4]HuQianting, Liang Yunpei, Lin Fujin. Experimental study on surface borehole gas extraction technology in goaf [J]. Coalbed methane, China, 2006, 3 (2): 3-6.

[5]WangChangming. Study on Gas Migration and distribution in semi-enclosed goafundergroundborehole drainage conditions [D]. Chongqing: Chongqing Branch of the General Institute of Coal Science, 2007.

[6] Liu H, Li X. Research on Long-term Incentive Effect of Local Government Environmental Protection [J][J]. Journal of Applied Science and Engineering Innovation, 2018, 5(2): 42-46.

[7]Yuzhou, Lu Tingkan, Yu Haiyong. Gas drainage from goaf by surface boreholes and its stability analysis [J]. Journal of Rock Mechanics and Engineering, 2005, 24 (Increase 1): 4982-4987.

[8]Hao Longyun, Wang Rui, Zhao Yuetai, Fang Kuanjun, CaiYuqing. The enzymatic actions of cellulase on periodate oxidized cotton fabrics[J]. Cellulose, 2018, 25(11): 6759-6769.

[9] Wang Rui, Yang Chao, Fang Kuanjun, Cai Yuqing, Hao Longyun. Removing the residual cellulase by graphene oxide to recycle the bio-polishing effluent for dyeing cotton fabrics [J]. Journal of Environmental Management, 2018, 207: 423-431.