

Application Idea of Hydraulic Cutting in the Development of Horizontal Well of Coalbed Methane

Shiliu Cao*

Shaan Xi Provincial Land Engineering Construction Group Co, Ltd China
Institute of Land Engineering and Technology Shaanxi Provincial Land Engineering Construction Group Co, Ltd Chian
Key Laboratory of Degraded and Unused Land Consolidation Engineering, the Ministry of Land and Resources of China
Shaan Xi Provincial Land Engineering Consolidation Engineering Technology Research Center, Xi'an 710075 China

*Corresponding author e-mail: caoshilium@126.com

Abstract. From vertical well to horizontal well drilling in coalbed methane, coalbed methane extraction drilling footage in the seam have increased by several times and even hundreds. And horizontal wells in gas production is only 3-10 times to vertical wells, which have not increased accordingly. Among all the reasons, not only vertical well fracturing improved the coal seam permeability, but also horizontal well section seepage area far less than vertical well seepage area. In order to improve the horizontal well section seepage area, based on the analysis of matures application in hydraulic cutting technology, consider using it, after the completion of construction in CBM horizontal well, then cut a line through the coal seam fissure, so that horizontal well can be consider as countless vertical well arrangement in horizontal direction, which played a big advantage in section seepage area of vertical well. Its effect of gas will also be greatly improved compared to common horizontal well.

1. Introduction

The development of coalbed methane in China has been in the history of more than 20 years. After experiencing the development of trial and business development, it has not yet entered the rapid development stage. Hydraulic cutting is becoming more and more widely used in industry, machine processing, medicine, food processing and other fields [1]. In the field of oil drilling and production, hydraulic cutting technology is used for casing fenestration, hydraulic injection horizontal drilling is precisely entered into production layer and other special processes, effectively improving the oil production of low permeability and ultra-low permeability reservoirs [2]. The coal industry is the earlier industry which use the hydraulic cutting technology, hydraulic coal mining has been gained the mature experience in unstable coal seam angle, steep coal seam and side seam permeability[3], and has been improved the test effect of gas drainage in the success of gas drilling slotting award [4-5].

At present, after introducing multi-branch horizontal well technology, coal seam fracturing and increasing production technology and gas injection and production increasing technology, the low output of coalbed methane well is still a major problem that perplexes the development of coalbed



methane industry in China [6]. The success of hydraulic cutting technology in increasing production and low permeability coal seam gas extraction of low permeability reservoirs provides a reference for the development of ground coal bed gas [3]. The use of hydraulic cutting technology in coal seam cutting, could make coal seam hole drainage area to a higher level, and the coal gas production will also be greatly improved.

2. The principle and application of hydraulic cutting technology

Hydraulic cutting technology is the purpose of using ultra high pressure and highly speed water to impact the cut object then to break it. The flow pressure can reach tens to hundreds of MPA, the nozzle diameter is less than 20mm, and the flow rate can reach 600-1000m/s.

Different industries require different technical requirements for hydraulic cutting pressure. At present, the manual water gun is usually used in the hydraulic coal mining well in China. The general working parameters are: pressure 12-20Mpa, effective range 15-20m, nozzle diameter 20-25mm and flow rate 180-300m³/h [3]. In the field of mechanical processing, the diameter of the nozzle is 0.15-0.35mm, the pressure could reach 40-400MPa, and the velocity of water could reach in 800-1000m/s[1] . The hydraulic cutting technology parameters used in perforation and horizontal perforation of oil well are equivalent to those of hydraulic coal mining technology, and the pressure is relatively lower than that of mechanical processing. According to the construction practice of Wang Zaiqiang reflects the level of perforation, under normal circumstances, jet footage of the highest speed can reach 25~30 m/min, the average speed of more than 5 m/min[2].

Application of hydraulic cutting construction in gas drilling in vertical joint is still in the test phase of the promotion, the main technology and construction requirements are: first using ordinary drilling method, then using the hydraulic cutting of borehole; drilling depth is generally 150-200m, cutting range 700-1000mm, the water pressure is maintained at 25-40MPa[4]. Figure 1(according to Fang Qiancheng, et al, 2007), which is the schematic for pumping hole slotting in gas mining.

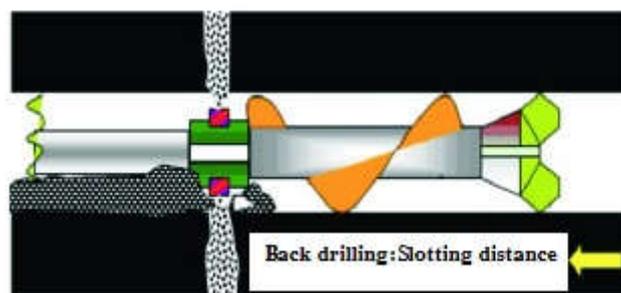


Figure 1. Diagram in the gas drainage hole cutting diagram

3. The application of hydraulic cutting seam gas in horizontal wells

3.1. Construction of hydraulic cutting seam to increase the percolation area

CBM horizontal wells' high yield is mainly due to its greatly increasing in the coal seam footage, communicating the crack in the coal seam, thereby expanding the gas production area[7]. However, from the horizontal well cross section, its drainage area is only one borehole size, plus the coal seam direct roof and floor is mostly the water resisting layer, and the roof and floor have less gas content. Therefore, the horizontal well drainage area is not as good as the vertical well on the shaft cross section. However, from the horizontal well cross section, its drainage area is only one borehole size, the coal seam direct roof and floor is mostly the water resisting layer, and the roof and floor have less gas content. Therefore, the horizontal well drainage area is not as good as the vertical well on the shaft cross section. This may partly explain why horizontal well in coal seam drilling increased exponentially than vertical well in coal seam footage, but gas production did not[8].

Due to the horizontal wells are not suitable for fracturing, which limited the horizontal wells in the cross section of the drainage area, in order to solve this problem, could use gas pumping experience reference that use of hydraulic slotting drilling hole to increase permeability of the. The author believe that hydraulic cutting technology can be used in the construction of surface CBM wells, hydraulic cutting joints are constructed in the coal seam to communicate vertical or horizontal cracks on the coal seam, and further expand the drainage area of the coal seam and increase the output.

3.2. Plan for construction

After the completion of horizontal well, we could considered the difference of the main seepage direction of coal seam, if the direction of seepage is horizontal, the vertical seam will be constructed along the direction of horizontal well and cut through the coal seam. If the direction of the seepage is mainly in the vertical direction (which may occur in the steep inclined coal seam), the construction of the horizontal seam in the coal seam is cut through the coal seam. As shown in Figure 2, the vertical seams near the level of the coal seam are illustrated by the horizontal direction of the fluid seepage direction.

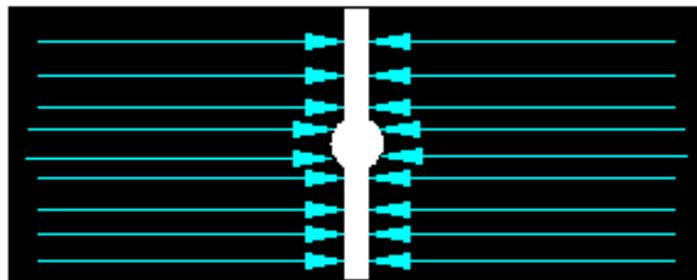


Figure 2. Schematic diagram of vertical seam construction in horizontal coal seam

The construction technology of the horizontal well is complicated and the orientation method is tedious, so the main purpose of using orientation in coal seam is to ensure the drilling in the coal seam. After the hydraulic cutting technology, because of the shear force in water flow can be adjusted by hydraulic pressure and velocity, the compressive strength of coal seam is obviously lower than rock stratum. There is no possibility of excessive drilling, which leads to drilling into rock stratum. The use of three nozzle case, also can be adjusted by different nozzle pressure, to achieve control of the drilling direction [9]. Therefore, it is conceivable that the hydraulic cutting technology can be used to drill into the coal seam without prior construction of directional horizontal well.

3.3. Advantages and disadvantages of hydraulic cutting in coal seam

Advantages:

- (1) In the cross section of the original horizontal well, the discharge area of the coal seam is greatly improved, and the productivity in horizontal wells will be improved by the effective.
- (2) Improve the flow condition and the control area of horizontal well, prolong the service life of a single well.
- (3) Without the guidance of directional instruments, the boreholes in the coal seam will not easily enter the rock strata, that have a strong adaptability to the geological conditions.
- (4) Construct horizontal and vertical seams in minge could improve the development effect of soft coal seam.

3.4. Disadvantages

- (1) Due to the lack of construction experience, it is not clear that the power consumption and water consumption in hydraulic cutting and ordinary drilling.

(2) Because the nozzle of hydraulic cutting (equivalent to the drilling bit) and the drill rod are smaller than the original aperture, there may be a problem of the small annular pressure and the difficulty in the reverse row of pulverized coal.

(3) The nozzle is the key equipment for the formation of ultra-high pressure flow [10]. Due to the lack of construction experience, it is not clear that the service life of the nozzle.

4. Conclusion

Hydraulic cutting is a widely applied and mature technology in oil extraction, coal mining and gas drainage, which fully demonstrated its wide prospect in the surface drilling of CBM. The geological conditions of coal bed gas in our country is poor, especially in the low permeability, coal forming period experienced multi-stage tectonic movements, and the tectonic soft coal development, not only affects the coal seam pressure range, also the fracturing effect[11]. If the fracturing method could not improve the permeability in the coal seam effectively, then the hydraulic cutting will be the method which can be relied on. Without the guidance of directional instruments, the boreholes in the coal seam will not easily enter the rock strata. The using of hydraulic cutting, on the one hand, the flow condition and the discharge area of the coal seam is greatly improved, on the other hand, improve the development effect of soft coal seam, the productivity in horizontal wells will be improved by the effective.

Acknowledgments

This work was financially supported by Project of Key Scientific and Technological Innovation Team in Shaanxi (2016KCT-23) fund.

References

- [1] Zhang Lin, Pei Yi, Li Ming. Water Jet Cutting Application Research and Development [J]. Hunan Agricultural Machinery. 2011, 38 (1):95-97.
- [2] Application of Horizontal Borehole Technology by Hydraulic Jetting in Changqing Longdong Oilfield [J]. Oil Field Equipment. 2009, 38 (8):66-69.
- [3] Ke Zhixuan. Application of the Hydraulic Coal Mining in Steep Seam [J]. Coal, 2015(2):25-27.
- [4] Fang Qiancheng, Wang Zhaofeng, Yang Liping. Study on Utilizing of Hydraulic Cutting Seam Technology to Improve the Low Gas Permeability Coal Seam and Gas Drainage [J].
- [5] Li Yongqiang, Yu Jian, Chen Huasen. Discussion on the Construction Technology of Hydraulic Cutting to Increase the Permeability of the Outburst Coal Seam. Mining Safety & Environmental Protection, 2012, 39 (s1):13-16.
- [6] Zhou Jiajia. Development and utilization status and technical progress of coalbed methane in China [J]. Petrochemical Industry Application, 2017, 36 (5):1-4.
- [7] Zhang Yongping, Yang Yanhui, Zhao Guoliang, et al. Problems in the development of high-rank CBM horizontal wells in the Fanzhuang-Zhengzhuang Block in the Qinshui Basin and countermeasures[J]. Natural Gas Industry, 2017, 37 (6).
- [8] Liu Yinan, Zhang He. Analysis on the CBM Recovery Technology for Horizontal Well in Liulin Block [J]. China Coalbed Methane, 2013, 10 (6):13-17.
- [9] Gao Chuanchang, Wang Haofeng, Huang Xiaoliang, et al. Experimental Study on Pressure Variation of Self Excited Aspirated Jet Nozzle with Different Structural Parameters under Submerged Conditions [J]. Chinese Journal of Applied Mechanics, 2012, 29 (3):330-334.
- [10] Li Qiang. Study on the Structure of Ultra-high Pressure Abrasive Water Jet Cutting Nozzle [D]. Lanzhou University of Technology, 2011.
- [11] Wang Liangang, Li Lianjun. Discussion on the Development Mode and Technology of CBM in China [J]. China Chemical Trade, 2010, 38 (4):104-107.