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Exploitation technology of pressure relief coalbed methane in vertical surface wells in the Huainan coal mining area

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Abstract: Exploitation technology of pressure relief coalbed methane in vertical surface wells is a new method for exploration of gas and coalbed methane exploitation in mining areas with high concentrations of gas, where tectonic coal developed. Studies on vertical surface well technology in the Huainan Coal Mining area play a role in demonstration in the use of clean, new energy resources, preventing and reducing coal mine gas accidents and protecting the environment. Based on the practice of gas drainage engineering of pressure relief coalbed methane in vertical surface wells and combined with relative geological and exploration engineering theories, the design principles of design and structure of wells of pressure relief coalbed methane in vertical surface wells are studied. The effects of extraction and their causes are discussed and the impact of geological conditions on gas production of the vertical surface wells are analyzed. The results indicate that in mining areas with high concentrations of gas, where tectonic coal developed, a success rate of pressure relief coalbed methane in surface vertical well is high and single well production usually great. But deformation due to coal exploitation could damage boreholes and cause breaks in the connection between aquifers and boreholes, which could induce a decrease, even a complete halt in gas production of a single well. The design of well site location and wellbore configuration are the key for technology. The development of the geological conditions for coalbed methane have a significant effect on gas production of coalbed methane wells.
Keywords: pressure relief coalbed methane; exploitation; vertical surface well; Huainan coal mining area

1 Introduction

The Huainan coal mining area, one of the largest industrial coal bases in China, has abundant coalbed methane (CBM) resources, estimated up to 640×10^8 m^3 within the area under production and construction and to 3000×10^8 m^3 within the entire mining area[1]. It is a typical, highly gassy mining area where tectonic coal developed and where considerable attention should be paid to ensure safety during coal mining. Aiming mainly at mining safety and considering energy resource utilization, the extraction of underground coal mine gas has made remarkable progress and the amount of methane extracted from the Huainan mining area exceeded 1.5×10^8 m^3 in 2006. Along with increasing coal mining intensity, the risk of coal and gas outbursts substantially increases, as well as exhaust gases and the pressure on the reduction of greenhouse gas emissions. These conditions demand effective ways for coalbed methane development and utilization, as well as high efficiency of gas extraction[2]. Since the tectonic coal stratum has been regarded as the forbidden zone for in-situ coalbed methane surface well development technology, underground CBM extraction technology has become almost a unique project of technological development on CBM extraction, providing a solution for the safe extraction of coalbed methane in the mining areas where tectonic coal developed. But underground CBM extraction technology in coal mines has problems, such as low gas extraction ratios, low methane concentrations and low utilization ratios, restricting CBM development and utilization in the tectonic coal mining area[3]. Studies on pressure relief coalbed methane of vertical surface wells in tectonic coal developed area are very important for developing and utilizing new, clean energy resources, reducing waste of energy resources, preventing coalmine gas explosions, protecting the environment in mining areas with high gas concentrations. They play an important exemplary and compelling role in the technological development for the exploration of coalbed methane in China.

Learning from the experience of American gas

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drainage in coal mines since the 1970s, some engineering experiments have been conducted for pre-pumping gas from adjacent coal seams using vertical surface well technology. More than 10 surface drills are operating in the Liwangmiao coal mine in Hunan, the Longfeng coal mine in northern Fushun, the #4 coal mine in Yangquan, the Dalong coal mine in Tiefa, the #2 coal mine in Daming and the Wudanggou coal mine in Baotou. Engineering tests have made some progress, but gas drainage by drills produced small flows under conditions of poor stability. Engineering operations were restricted by technological conditions at the time and could not be extensively applied in practice. But since then, gas drainage in goafs by vertical surface wells has made great strides and has been extensively applied in practice. From all these attempts, we have accumulated experience in exploitation technology of pressure relief coalbed methane in vertical surface wells and to mine the gas in the Huainan coal mining area.

2 Project situation

The first vertical surface well, used for pressure relief coalbed methane exploitation and referred to as Peg-1, was operated in 1999 in the Huainan Mining Area. Up to now there are a total of 20 vertical surface wells (see Table 1), of which seven wells are in the Panyi mine, one in the Pansan mine, five in the Xieqiao mine, two in the Zhangbei mine, four in the Guqiao mine (including one single horizontal offset well) and one well in Xieyi mine. The CBM wells were successful in the Panyi, Pansan and Xieqiao mines, with a cumulative maximum amount of coal mine methane drainage from single wells of about 400 million m^3. This amount of gas was produced over a period of 300 days. But the CBM wells in the Xieqiao, Zhangbei and Guqiao mines ceased gas production after their working faces advanced about 50 to 150 m away from a drill.

Table 1 Basic information of vertical surface wells for coalbed methane drainage

Mine	Well number	Well depth (m)	Well termination horizon	Depth of bedrock surface (m)	Gas production duration (d)	Cumulative gas production (10^4m^3)
Panyi mine	PEG-1	680.30	11-2 coal seam floor	281.60	820	292
	Extraction No.1	667.00	11-2 coal seam floor	357.50	300	335
	Extraction No.2	660.79	11-2 coal seam floor	357.50	180	149
	Extraction No.3	679.04	11-2 coal seam floor	343.95	Non use	
	2361-1	680.89	11-2 coal seam floor	247.80	60	72
	2361-2	687.50	11-2 coal seam floor	251.45	240	230
	2361-3	687.41	11-2 coal seam floor	256.35	180	120
Pansan mine	14102(1) Working face 1	864.10	11-2 coal seam floor	406.55	150	118
Xieqiao mine	1242(1) Working face 1	635.67	11-2 coal seam floor	330.30	35	71
	1242(1) Working face 2	638.19	11-2 coal seam floor	352.55	20	16
	1242(1) Working face 3	645.72	11-2 coal seam floor	371.85	15	3.3
	1242(1) Working face 4	644.98	11-2 coal seam floor	374.30	46	58
	1242(1) Working face 5	653.06	11-2 coal seam floor	379.45	45	54.11
Xieyi mine	5111(s) Working face well	698.77	C15 coal seam floor	28.10	240	96
Zhangbei mine	11418-1	558.80	5 m from 8 coal seam floor	399.50	8	10
	11418-2	526.41	5 m from 8 coal seam floor	392.95	8	15.3
Guqiao mine	W117-1S	752	11-2 coal seam floor	439.20	420	180
	W117-2	758.37	11-2 coal seam floor	437.15	3	0.1
	W117-3	789.48	11-2 coal seam floor	430.60	10	3.1

3 Design of vertical surface well for pressure relief gas drainage

3.1 Allocation of vertical surface wells for relieved gas drainage

Vertical surface relieved gas drainage wells are located in the area of a prepared mining section, to extract coalbed methane from protected seams (see Fig. 1). Before starting mining at the working face, the construction of the vertical surface wells should be completed, in which the well termination horizon is between a protective seam and a protected seam and the sieve tube should be laid down in the well section about 20 m to 30 m distance from the bottom of the well to the protected seam of the roof as a gas extraction section. The casing over the sieve tube should be sealed permanently. When the working face of a lower protective coal seam advances to about 50 m away from the CBM well, water in the drill leaks to the goaf through deformation cracks. In order for water in the protected coal seam to be drained, huge amounts of methane need to be desorbed from the