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Experimental research on settlement and migration law of pulverized coal in vertical well of coalbed methane

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ABSTRACT

In view of the serious problem of pulverized coal production in the process of coalbed methane development, the experimental conditions were set up by using the production characteristics of coalbed gas wells, and the static sedimentation experiments and dynamic sedimentation and migration experiments of pulverized coal particles in the wellbore of coalbed methane wells were carried out. The static settling velocities of pulverized coal particles with different sizes were obtained in the static settling experiment of pulverized coal. Discovery by dynamic transport experiments, when the drainage speed is greater than 0.035m/s, 40-400 mesh pulverized coal will be carried and transported. The research results have important guiding significance for optimizing on-site drainage and mining parameters.

KEYWORDS

Pulverized coal; Coal seam gas wellbore; Static settlement final velocity; Dynamic migration; Drainage speed.

1. INTRODUCTION

In the process of coalbed methane emission and production, there is a common problem of pulverized coal output0. As a green energy, the efficient development and utilization of coalbed methane is of great significance to ensure the safe production of coal mines, reduce the greenhouse effect, and optimize the energy structure. However, in the process of coalbed methane emission and production, there is a common problem of pulverized coal output[2]; The other part is moved to the wellbore and gathers and settles or enters the drainage and production equipment, resulting in mechanical wear, buried pumps, stuck pumps and other accidents, which destroys the continuity of coalbed methane production[3]-[4]. It is more conducive to the formulation of measures for coalbed methane production to find out the migration and settlement law of pulverized coal particles in the wellbore.

The previous research on the migration law of pulverized coal particles mainly obtained the settlement law of pulverized coal and its migration law in the fractures of coal reservoir by establishing models and numerical simulations, and using static sedimentation and powder-carrying migration experiments, and finally obtained the final velocity of pulverized coal settlement and the minimum pulverized pulverized coal carrying velocity. There are few studies on the dynamic migration and settlement law of pulverized coal in the process of single-phase flow of drainage and pressure reduction. In this paper, the sedimentation and migration law of pulverized coal is explored through the sedimentation experiment of pulverized coal.

2. PULVERIZED COAL SEDIMENTATION EXPERIMENT

The final velocity of pulverized coal particles is an important parameter to study the flow rate carried by particles.

2.1. Static sedimentation test of pulverized coal particles

Before the experiment, five particle size ranges of 40-60 mesh, 60-80 mesh, 80-100 mesh, 100-200 mesh, and 200-400 mesh were prepared. In the experiment, a trace amount of pulverized coal particles of a certain particle size is selected and placed in a vertical sedimentation cylinder filled with water, waiting for the pulverized coal particles to begin to descend, and the time and distance of the pulverized coal particles sinking to the bottom of the wellbore are recorded, and the final sedimentation velocity corresponding to the pulverized coal particles of the particle size can be calculated, and the experimental results are shown in Table 1.

Table 1. Static sedimentation velocity of pulverized coal particles with different particle sizes

Particle size(mesh)	40-60	60-80	80-100	100-200	200-400
Velocity(m/s)	0.029	0.018	0.009	0.006	0.004

In the course of the experiment, it was found that when the particle size of pulverized coal is smaller, the less likely it is to settle in the water. The results show that with the decrease of pulverized coal particle size, the final velocity of static sedimentation decreases, and the less likely the pulverized coal particles are to settle.

2.2. Dynamic settlement experiment of pulverized coal

2.2.1. Experimental sample preparation

According to the pulverized coal suspension samples collected in Panhe and Persimmon Zhuangnan in the early stage, the concentration measurement and particle size analysis were carried out, and the two wells with the highest pulverized coal concentration were selected as reference standards. The particle size produced by the two wells is mainly small particle size. According to the results of this experiment, the coal is crushed and developed into powder by using a high-speed pulverizer in the laboratory, the particle size range is 40-400 mesh, and the standard sieve is used for manual screening, which is mainly divided into three particle size ranges of 40-100 mesh, 100-200 mesh, and 200-400 mesh, and then mixed with a mixing ratio of 40-100 mesh: 100-200 mesh: 200-400 mesh = 1:2:7.

2.2.2. Experimental equipment

This study is mainly based on the self-built dynamic settlement test system of pulverized coal in coalbed methane wells, and the experimental test system platform is shown in Figure 1. The experimental equipment is mainly composed of three parts: data acquisition system, power system and simulated wellbore. The equipment can inject gas and liquid into the simulated wellbore through screw pump and air compressor to simulate the dynamic migration process of pulverized coal in the process of coalbed methane production.

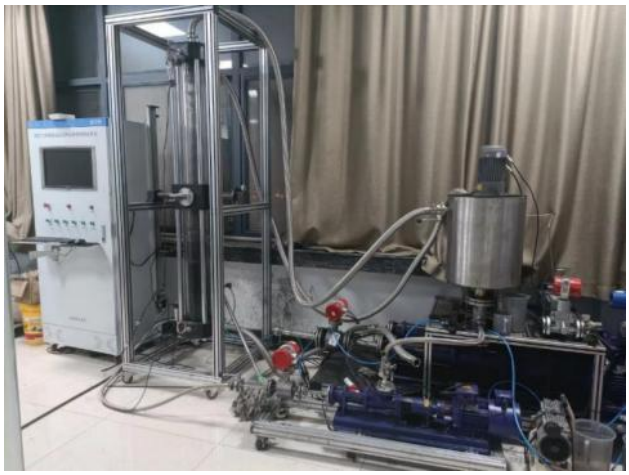

Fig.1 Visualization device for dynamic migration of pulverized coal in coalbed methane wells

2.2.3. Experimental scheme for dynamic migration of pulverized coal

In the experiment, different drainage velocities in the range of 0.006m/s to 0.062m/s were designed. In the experiment, pulverized coal suspension of different mass concentrations was added to the stirring tank and stirred to prevent precipitation, and the pulverized coal suspension was injected into the simulated wellbore by adjusting the drainage speed, and the density of pulverized coal suspension under different drainage velocities was measured by the tuning fork density meter. The experimental protocol is shown in Table 2.

Table 2. Dynamic migration test scheme of mixed particle size pulverized coal

Particlesize(mesh)	Experimental conditions							
40-400	concentration	10	15	20	25	30		
	velocitym/s	0.006	0.015	0.025	0.035	0.045	0.055	0.062

3. EXPERIMENTAL CONDITIONS

3.1. Dynamic sedimentation law of pulverized coal suspension under different drainage flow rates

The concentration curve of pulverized coal particles in mixed particle size is shown in Figure 2.

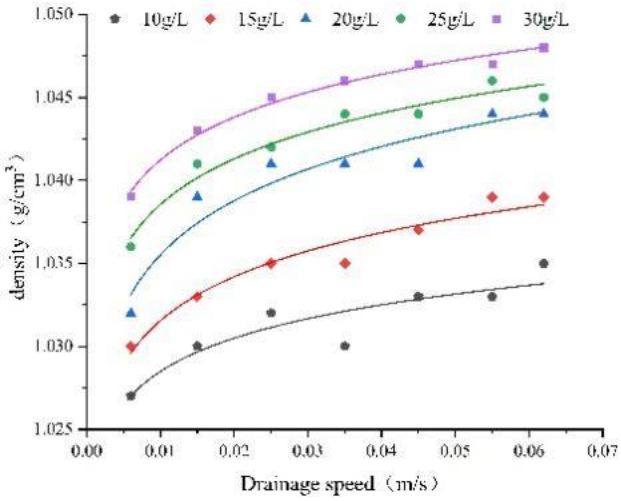

Fig.2 Variation curves of pulverized coal concentration under different drainage rates of mixed particle size

In the actual production process of coalbed methane, the underground production of pulverized coal particles is often complex, so it is more in line with the actual situation to select mixed particle size pulverized coal particles to participate in the experiment. The experimental results were fitted, and it was found that there was a strong correlation between the measured value of the tuning fork density meter and the drainage velocity for different pulverized coal concentrations. At the beginning of the experiment, it can be clearly seen that the pulverized coal particles are slowly rising with the water flow, and after a period of time, the pulverized coal fills the whole tubing; from the experimental results, it is not difficult to see that with the continuous increase of the drainage velocity, the measured value of the tuning fork density meter does not increase, that is, the concentration of pulverized coal in the tubing in the wellbore is also increasing, and with the continuous increase of the drainage velocity, the pulverized coal at the bottom of the well continues to enter the tubing with the fluid through the sieve hole, indicating that the increased drainage velocity can effectively carry and transport the pulverized coal;

In the experiment, it is also found that when the drainage velocity is below 0.035m/s, a large amount of pulverized coal settles at the bottom of the well, and only a small amount of pulverized coal is carried to the wellhead with the water flow, and the probability of accidents such as buried pump stuck pump in coalbed methane well increases, when the drainage velocity reaches 0.035m/s and above, the measured value of the tuning fork density meter has a large increase fluctuation, and the pulverized coal at the bottom of the well also shakes, that is, the drainage velocity at this time can better carry the pulverized coal settled at the bottom of the well to the wellhead to reduce the occurrence of accidents such as buried pump jamming; The longitudinal comparison of the density curves of the tuning fork sensor at different drainage speeds shows that when the concentration of pulverized coal changes under the same drainage speed, the tuning fork sensor can reflect in time, so as to make timely adjustments to the on-site drainage and mining conditions.

Ideally, only the fluid velocity needs to reach the static sedimentation velocity of pulverized coal, so that pulverized coal can be better carried and transported. In actual production, the actual critical carrying flow velocity is greater than the actual final settlement velocity. Based on the previous static settlement experiments and dynamic settlement experiments, the critical current-carrying velocity of pulverized coal is greater than the corresponding final velocity of static sedimentation of pulverized coal. This is because in the actual production process, the migration of pulverized coal will be affected by temperature, pressure difference, well diameter, particle size, shape and the interaction between its particles, which will lead to changes in the critical carrying velocity.

4. CONCLUSION

Through the static sedimentation experiment and the dynamic sedimentation and migration experiment of pulverized coal particles, it is found that the migration and settlement of pulverized coal in the coalbed methane wellbore under the conditions of different pulverized coal particle sizes, different pulverized coal concentrations and different drainage flow velocities are found:

1) The static pulverized coal sedimentation experiment showed that the final velocity of static sedimentation of pulverized coal particles with different particle sizes was 0.029m/s for 40-60 mesh, 0.018m/s for 60-80 mesh, 0.009 m/s for 80-100 mesh, 0.004 m/s for 100-200 mesh, and 0.004 m/s for 200-400 mesh.

2) Through the particle size analysis of pulverized coal solution in on-site coalbed methane wells, a 40-400 mesh mixed particle size pulverized coal solution was prepared, and it was found that when the fluid velocity was 0.035m/s, the pulverized coal could be better carried and transported.

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