

Dynamic migration and settlement law of pulverized coal in vertical wellbore of coalbed methane well

Qiang Zou*

School of resources and environment, Henan polytechnic university, Jiaozuo, Henan, China

* Corresponding author

Abstract: Through the dynamic settlement and migration simulation test system of coal powder in coalbed methane wells, the liquid flow rate and gas flow rate are changed to simulate and test the settlement and migration state of coal powder in the wellbore at different production stages in the actual production process of coalbed methane wells. The concentration of coal powder in the whole experiment process is obtained by the concentration meter of the wellbore device, so as to obtain the critical carrying flow rate of different coal powder particles. The conclusions are as follows: For 40-60 mesh pulverized coal, it is easier to be carried and transported at a drainage speed of about 0.025 m / s. For 60-80 mesh pulverized coal, it will be carried and transported at a speed of about 0.015 m / s. For 100-200 mesh pulverized coal, it will be carried and transported at a speed of about 0.006 m / s.

Keywords: Coal-bed gas well; Pulverized coal particles; Critical entrainment velocity.

1. Introduction

At present, domestic and foreign scholars have studied the start-up-migration law of pulverized coal under different drainage stages (single-phase water flow, gas-water two-phase flow), different regions (formation or wellbore) or the same region but different research objects (supporting cracks or coal seam primary cracks), mainly from experimental research, simulation research and numerical simulation. Three aspects have accumulated certain results. The following mainly expounds and summarizes the research of scholars from three aspects: theoretical research, experimental research and numerical simulation.

Firstly, from the aspect of theoretical research, Bai Jianmei et al [1] analyzed the influence of fluid flow rate, fracture width and particle size on fracture permeability in the process of single-phase fluid carrying pulverized coal migration, and measured the variation law of pulverized coal production, which provided guidance and suggestions for the actual production process. Qing et al. [2] carried out experiments on the settlement and migration of pulverized coal. Based on the theoretical basis of particle settlement, the minimum carrying speed and the final settlement speed of pulverized coal were obtained, and the functional relationship between the two was derived. Finally, the drainage system of coalbed methane was optimized to obtain the minimum daily drainage volume that can effectively carry out pulverized coal particles.

Secondly, in terms of experimental simulation research, it can be divided into three types according to the different simulation materials [3-5]. The first type is to directly use pulverized coal to simulate the migration and output characteristics of pulverized coal in horizontal wells or vertical wells[6]. This paper focuses on the sedimentation velocity and stratification characteristics of pulverized coal, the critical flow velocity of pulverized coal start-up migration, the relationship between pulverized coal migration and pulverized coal particle size, water flow velocity, the influence of pulverized coal concentration on pulverized coal output, the influence of active agent on pulverized coal migration, the migration and output of pulverized coal in

proppant and the variation characteristics of fracture conductivity[7-9].

China is rich in coalbed methane resources [10]. As a clean energy, the efficient development and utilization of coalbed methane is of great significance to ensure the safe production of coal mines, alleviate the greenhouse effect and optimize the energy structure [11]. The problem of pulverized coal output is common in the process of coalbed methane drainage. In order to explore the dynamic settlement law of pulverized coal in the vertical wellbore of coalbed methane in the single-phase flow stage of drainage and depressurization, based on the self-developed dynamic migration and settlement test system of pulverized coal, combined with the actual production on site and the characteristics of pulverized coal output, an experimental scheme of pulverized coal migration in line with the real working conditions was designed. By carrying out simulation experiments under different coal particle sizes and drainage speeds, the influence of various factors on the settlement law of coal powder is systematically revealed. The research results can provide theoretical guidance for the formulation of production strategies for on-site coalbed methane wells.

2. Experimental parameters

(1) laboratory equipment

The device is mainly composed of data acquisition system, simulated wellbore and power system. The device can inject gas and liquid into the simulated wellbore through the screw pump and air compressor in the power system, and realize the dynamic settlement and migration process of pulverized coal in the simulated wellbore. The screw pump can realize stepless speed change and control the flow rate of the pump. The air compressor can adjust the flow rate of the injected gas by the flowmeter to simulate the water and gas production in the actual production process. The data acquisition system can collect and save the data in real time during the experiment.

(2) sample preparation

Pulverized coal samples with different mesh numbers were

prepared.

Table 1. Coal particle size table

Numbering	1	2	3	4
Pulverized coal particle size (mesh)	40-60	60-80	80-100	100-200

(3) experimental principles

In view of the most prominent problem of pulverized coal output in the single-phase flow stage of drainage and pressure reduction in coalbed methane drainage, this experiment characterizes the change of pulverized coal concentration in actual production by adjusting the concentration of pulverized coal in the mixing tank, and simulates different drainage intensities by controlling the pumping speed of the screw pump. The purpose of this experiment is to monitor and explore the dynamic settlement law of pulverized coal in the vertical wellbore of coalbed methane at this stage in real time with the help of a tuning fork density meter.

3. Dynamic migration settlement steps

The preparation of the experimental samples, through the mill and the standard sieve to grind the coal into powder and through the standard sieve to divide the different particle size range; before the formal experiment, in order to test the stability of the system, a blank experiment was carried out to obtain the relationship between the pump speed and the liquid

flow rate, and the pump speed was set to increase by 10 turns. Add 50 L water and 1 jin of pulverized coal to the storage tank, and mix to obtain a 10g / L pulverized coal concentrate ; open the cabinet to open the computer, link software and high-speed camera ; wait for the software interface to appear data and data stability can start to collect experimental data ; adjust the camera parameters, take pictures of the dynamic migration of pulverized coal during the whole experiment, and can also record the experimental process. Open the stirring motor, small speed can be, the pulverized coal solution is stirred evenly, to prevent the occurrence of stuck pump and reduce the wear of pulverized coal on the pump during the experiment ; the pump is opened to set the experimental discharge flow to pump the pulverized coal solution into the wellbore at a certain flow rate, and the B pump valve is properly adjusted to stabilize the annular liquid level in the wellbore before the experiment is started. After the experiment is completed, the injection pump and the stirring motor are closed first, then the software and the computer are closed, and finally the equipment is closed. Unplug the power.

4. Experimental design

(1) The experimental scheme is designed for the dynamic settlement experiment of different pulverized coal particle sizes. The main parameters of the experiment are pulverized coal mass concentration, drainage speed and pulverized coal particle size. The experimental scheme is shown in table 2.

Table 2. Design table of particle size and flow rate

Pulverized coal particle size	Experimental flow rate(m/s)	Pulverized coal particle size	Experimental flow rate(m/s)	Pulverized coal particle size	Experimental flow rate(m/s)
40-60	0.006	60-80	0.006	100-200	0.006
	0.015		0.015		0.015
	0.025		0.025		0.025
	0.035		0.035		0.035
	0.045		0.045		0.045
	0.055		0.055		0.055
	0.062		0.062		0.062

(2) Experimental data display

The dynamic experimental data of pulverized coal are shown in Table 3, Table 4 and Table 5.

Table 3. 40-60 mesh flow velocity density relationship table

Flow velocity(m/s)	0.006	0.015	0.025	0.035	0.045	0.055	0.062
Density(g/cm3)	1.0409	1.0448	1.0462	1.0451	1.0447	1.046	1.0467

Table 4. 60-80 mesh flow velocity density relationship table

Flow velocity(m/s)	0.006	0.015	0.025	0.035	0.045	0.055	0.062
Density(g/cm3)	1.0399	1.0472	1.0409	1.0396	1.04	1.0412	1.0408

Table 5. 100-200 mesh flow velocity density relationship table

Flow velocity(m/s)	0.006	0.015	0.025	0.035	0.045	0.055	0.062
Density(g/cm3)	1.0382	1.0383	1.039	1.039	1.0396	1.04	1.04

(3) analysis of effect

The experimental data are further processed, and the drainage speed corresponding to the corresponding drainage volume is calculated to obtain the change of pulverized coal density under different drainage speed conditions. The change of pulverized coal density under different mesh conditions is shown in Figures 1,2,3,4.

It is found that the density of pulverized coal increases with the increase of drainage speed. In the process of dynamic

sedimentation experiment of pulverized coal, it is found that when the flow rate of 40-60 mesh is lower than 0.025 m / s, a large amount of pulverized coal is deposited at the bottom of the wellbore, the channel is blocked, and the amount of pulverized coal entering the tubing is small. At this time, the measurement value of the tuning fork is small, which indicates that the concentration value of the pulverized coal is low at this time. At this time, the drainage speed is not easy to carry the pulverized coal. However, when the drainage flow

rate is greater than 0.025 m / s, it is found that the tuning fork measurement data at this time has a great change. As the liquid flow rate increases, the pulverized coal deposited at the bottom of the wellbore is carried and transported into the tubing. The concentration of pulverized coal increases rapidly and fluctuates greatly, indicating that a large amount of pulverized coal is carried and transported at this time. When the flow rate of 60-80 mesh is less than 0.015m / s, the concentration of pulverized coal is low, and the drainage speed is not easy to carry the pulverized coal. However, when the drainage flow rate is greater than 0.015 m / s, the tuning fork measurement data has a large change. As the liquid flow rate increases, the pulverized coal deposited at the bottom of the wellbore is carried and transported into the tubing, and the pulverized coal concentration value rises rapidly to the maximum value, indicating that a large amount of pulverized coal is carried and transported at this time. When the flow rate of 100-200 mesh is greater than 0.006 m / s, the liquid density gradually increases, indicating that a large amount of pulverized coal is carried and transported at this time.

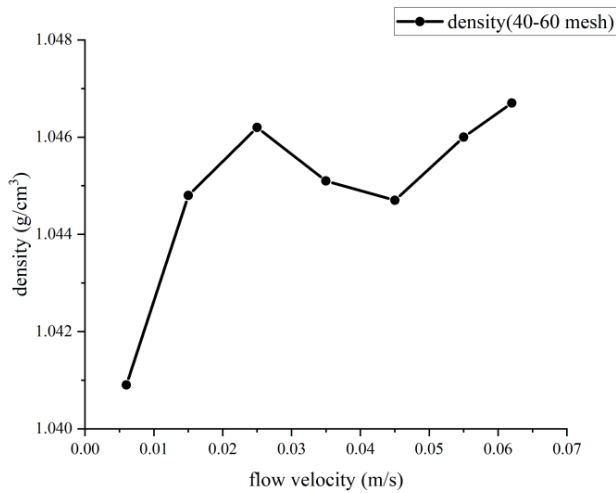


Fig. 1 Density variation curve of 40-60 mesh pulverized coal

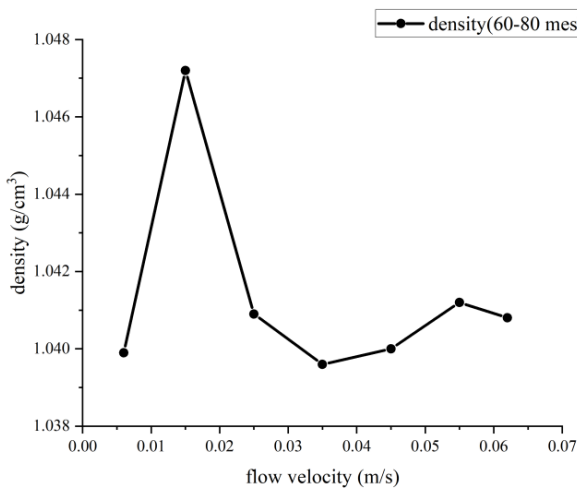


Fig.2 60-80 mesh pulverized coal density variation curve

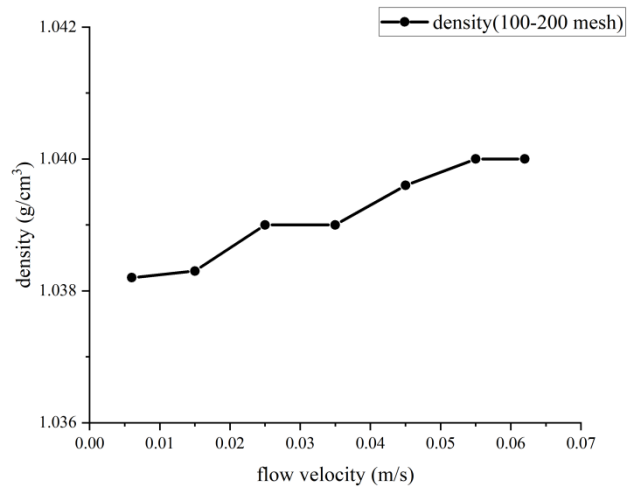


Fig.3 100-200 mesh pulverized coal density variation curve

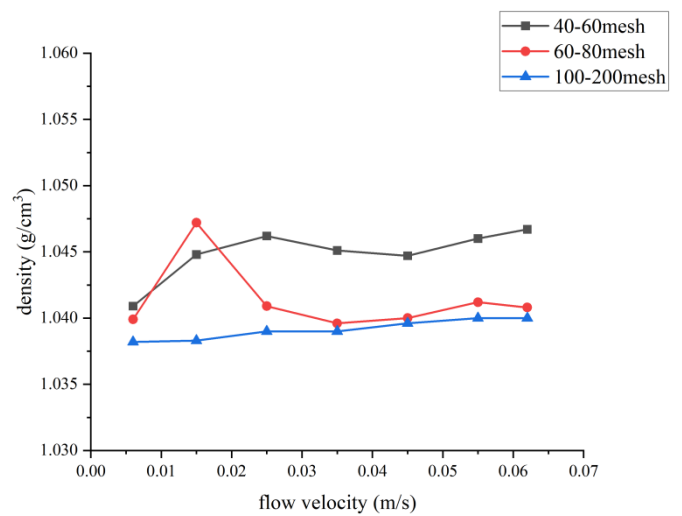


Fig.4 The density variation curves of different particle sizes of pulverized coal

5. Conclusion

In view of the common problem of pulverized coal production in coalbed methane drainage, this study focuses on the single-phase flow stage of drainage and depressurization, and systematically explores the influence of pulverized coal particle size and drainage speed on the dynamic settlement and migration law of pulverized coal in vertical wellbore. The experimental results show that there is a critical velocity for the start-up and migration of pulverized coal, and the threshold decreases significantly with the decrease of particle size. For 40-60 mesh coarse pulverized coal, the drainage velocity needs to reach more than 0.025 m / s to effectively carry it. When the flow rate is lower than this velocity, a large amount of pulverized coal is deposited at the bottom of the well, resulting in a small amount of pulverized coal entering the tubing, and the tuning fork density meter shows a low concentration value. When the flow rate exceeds the threshold, the pulverized coal is carried in large quantities, and the concentration value rises rapidly. For 60-80 mesh medium-fine pulverized coal, the starting critical flow velocity is about 0.015 m / s ; the fine pulverized coal of 100-200 mesh is carried in large quantities when the flow rate exceeds 0.006 m / s, and the density value increases. In summary, the effective coal carrying critical drainage speeds of pulverized coal with different particle sizes are : 40-60

mesh about 0.025 m / s, 60-80 mesh about 0.015 m / s, 100-200 mesh about 0.006 m / s. This conclusion provides a key parameter basis for the site to formulate a reasonable drainage strategy and prevent wellbore blockage according to the particle size of the produced pulverized coal.

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