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Ex perimental study on water absorption of coal under different pressure source conditions

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Abstract

In order to study the effect of pressure on the water absorption capability of coal, the water injection experiments of two coal samples were done under different pressure source conditions and room temperature by using self-designed pressurized water device. The experimental results show that pressure has a positive effect on water absorbability; water absorbability gets large as the pressure increases; the earlier water absorbability of coal is rapid, and the water absorbability of coal displays a similar Langmuir-isothermal adsorption curve with the changes of time, and it has saturated water absorbability. The water injection pressure is higher, which not only strengthened the ability of expanding seepage space, but also developed the transporting water and storage water space. The later water absorption curve of coal becomes weaker, and water adsorption process is mainly influenced by capillary force. The pressure water only supplies provisions and time is the main influential factor.

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Keywords: pressure; water absorbability; seepage space; capillary force

1. Introduction

Water injection into coal seam is a main industrial measure in coal mine, and it has been extensively used for prevention of dust, rockburst, coal and gas outburst and softening hard coal [1]. Coal is porous medium which contains high amounts of fracture and porosity. Water injection into coal seam is seepage

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in fracture, diffusion in porosity and coal surface wetting process. Problems concerning water injection into coal seam have been given a detailed study by many scholars on, such as micro-mechanism of coal absorption water [2], water seepage law [3-4], wetting coal by surfactant [5-7], application of magnetized water [8], phenomenon of water vaporization [9], etc. Due to the water injection conditions limit, medium and low pressure water injection were used commonly in domestic coal mine, and it had seriously affected the water injection effect. Some scholars [10-11] studied the atmosphere (0.1MPa) and low pressure (2.5MPa) water absorption capability of coal, but the high pressure (>6MPa) water absorption capability of coal has not been reported. In this paper, based on laboratory experiments, the water absorption of coal under different pressure source conditions are analyzed and it has something referential value for practical water injection into coal seam project.

2. Experiments

2.1. Coal samples

Taking two coal samples of representative as research and experiment object, and the coal samples are numbered by WTZ-2 and XJ-15 respectively. The basic parameters of two coal samples are shown in Table 1. The lump coals were collected from different coal seams with wax sealing rapidly, the 100mm×100mm×100mm coal samples which were used for water injection experiments under different pressure were processed in laboratory. Before the experiments, the coal samples were put into ZK-2020 vacuum drying oven under 105℃ for 24-30h, to ensure complete moisture evaporation of coal.

Table 1. The basic parameters of coal samples

Coal samples	Moisture (%)	Ash (%)	Volatility (%)	True density (cm^3/g)	Apparent density (cm^3/g)	Porosity (%)
WTZ-2	0.92	19.17	22.03	1.414	1.355	4.17
XJ-15	1.23	10.01	8.63	1.506	1.422	5.58

2.2. Experimental device and process

The self-designed pressurized water device is used for experiment tests under different pressure source conditions, the principle and outline of experimental apparatus are show in Fig.1. The experimental device consists of pressure barrel, manual high-press pump, water sink, etc. Compressive strength of designed pressure barrel is 12MPa; it can meet the experiment requirements.

The experiment procedure is described as follows:

- The drying coal samples are weighed and the initial mass is recorded. The coal samples were put into the netted barricade of pressure barrel according to certain order, then the sealing head is sealed and all blots were locked down.
- When entering water in pressure barrel from inlet hole, the drainage hole is closed and the gas vent is opened. When the pressure barrel is full of water, the inlet hole and gas vent are closed .
- The water pressure added to 2.5MPa by manual high-press pump, and closes the pressure hole. The coal samples absorb water under pressure and record the water absorption coal mass on different time. The water absorbability of coal is calculated by Eq.(1).

$$\delta = \frac{W_t - W_0}{W_0} \times 100\% \quad (1)$$

- Where δ is the water absorbability, W_t is water absorption coal mass, W_0 is drying coal mass.
- After the experiment is over, open the drainage hole and gas vent, the water in pressure barrel flow into the water sink.
- The coal samples are to renew drying, and the experiments of 6MPa and 10MPa are done respectively.

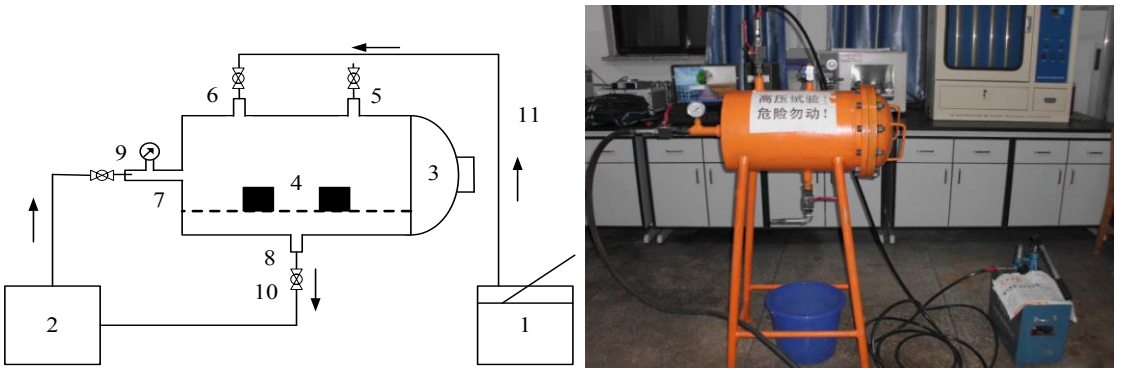

Fig. 1. (a) Principle of experimental device; (1-manual high-press pump; 2-water sink; 3- pressure barrel; 4-coal samples; 5- gas vent; 6- pressure hole; 7-inlet hole; 8-drainage hole;9-pressuremeter; 10-ball valve; 11-high pressure pipelines); (b) Outline of experimental device

3. Results and analysis

The water absorption of 2 coal samples under different pressure experimental results is shown in Fig.2. Form Fig.2, pressure has a positive effect on water absorbability; water absorbability gets large as the pressure increases. In the water absorption process, the earlier water absorbability of coal is rapid, after a certain time, the Water absorption curves become weaker. The water absorbability of coal display a similar Langmuir-isothermal adsorption curve with the changes of time, and it has saturated water absorbability.

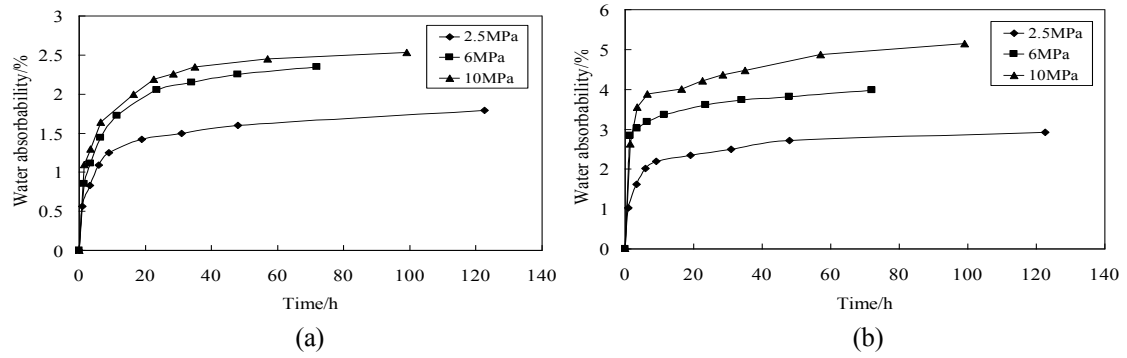

Fig. 2. Water absorption curves of coal samples under different pressure (a) WTZ-2; (b) XJ-15

In the practical water injection into coal process, the pressure water seepage in big fracture under differential pressure in the earlier period, and the fracture is filled with water. The water injection pressure is higher, which not only strengthened the ability of expanding seepage space, but also developed the transporting water and storage water space. While the water seepage, different kinds of

slight porosity absorb the water under capillary force, and time is the main influential factor. The water injection pressure has almost no influence on adsorption water process, it only supply provisions for adsorption. If the surfactant is put into water injection, it can reduce surface tension of water and improve wettability of coal, the water adsorption time can be shortened.

4. Conclusions

Water injection pressure has a positive effect on water absorbability and the water absorbability gets large as the pressure increases. The earlier water absorbability of coal is rapid, and then the Water absorption curves become weaker. The water absorbability of coal display a similar Langmuir-isothermal adsorption curve with the changes of time, and it has saturated water absorbability. From the angle of experiment, it is proved that water injection into coal seam process consists of water seepage and water adsorption. If the surfactant is put into water injection, the effect of water injection into coal seam can be improved.

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