Research on the incremental changes of moisture content in natural soaking of coal particles of different scales

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ABSTRACT

This article uses laboratory testing methods to analyze the moisture increment of coal particles of different scales and under different soaking time conditions and obtains the variation law of moisture increment of coal particles of different scales and soaking time. Tests have shown that the moisture increment of coal samples with different scales of coal particles increases with the increase of soaking time. In the early stage of soaking, the moisture increases rapidly, and the smaller the coal particle size, the greater the moisture increment; After soaking for 2 hours, the increase in moisture content of coal particles at five scales gradually slows down; After soaking for 32 hours, the moisture increment of the five coal particle coal samples gradually stabilized; Within the same soaking time, as the size of coal particles increases, the moisture increment decreases. The moisture increment of coal samples with a 10 mm scale is the largest, followed by coal particles with a 20 mm scale, and coal particles with a 50 mm scale are the smallest; Through experimental analysis, it was found that the size of coal particles is directly related to the increase in coal moisture content. When the size of coal particles is small, the larger the void volume between particles, which is equivalent to improving the porosity of coal and making it easier for water to enter the coal body. The experimental data in this paper can be used as the basic data for the preliminary exploration of coal seam water injection engineering application, and provide support for the development of coal seam water dust removal technology.

Keywords: Coal particle size, soaking time, experimental testing, moisture increment, change pattern

1. INTRODUCTION

In recent years, China's coal production has been getting higher and higher, coal production has maintained a growth rate of about 3%, and the total coal has exceeded 4 billion tons[1-3]. At the same time, the number of coal mines in China has been decreasing year by year, resulting in the increase of the output of a single mine, and the mining intensity has increased to varying degrees, resulting in the increase of dust generation in the coal production process, which has a very serious impact on the occupational health of operators[4,5]. In the past 10 years, the Chinese government has also begun to pay attention to the hazards of coal mine dust. Universities and scientific research institutes are actively working to reduce dust concentration, formulate a lot of regulations and standards for dust control and management, and the government has also formulated corresponding laws and regulations[6-8]. However, there are still a lot of new pneumoconiosis patients in China every year, according to statistics, tens of thousands of patients. The degree of occupational disease hazard is very serious, the situation is not optimistic, and it is urgent to carry out research on dust control. After medical diagnosis, it was found that the cause of pneumoconiosis was that the operators inhaled a large number of fine dust particles with a particle size less than 7.07μm[9-11]. These respirable dust mainly came from the coal production process. The most effective active dust removal measure for this part of dust management was the coal seam water injection technology, which can wet the dust at the source of coal production to make it lose its floating ability[12-14]. It is the most effective dust prevention measure. At the same time, in China's 13th Five-Year Plan, higher requirements are put forward for the intelligent construction of coal mines, more and more applications of medium and senior intelligent working faces, more and more applications of electronic components and sensors on production equipment, spray dust removal methods adapted to similar working face equipment will bring adverse effects, so coal seam water injection will be a good solution. However, the dust removal effect of coal seam water injection is related to the wettability and water absorption capacity of coal body[15,16]. At the same time, the coal particle size has a direct impact on the water increment of coal body water injection. Therefore, in order to achieve the ideal dust removal effect of coal

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seam water injection, it is necessary to understand the relationship between the coal particle size and water absorption rate. The research results of this paper can supplement the basic theory of coal seam water injection dust removal, and the experimental data can provide predictive support for the dust removal effect of coal seam water injection [17-19].

2. SAMPLE PRODUCTION

During the crushing process of coal, coal particles of different sizes are produced, which affects the ability of water to adhere to its surface. In order to study the water absorption rate of coal particles under different scale conditions, this paper takes the coal seam mining in Caojiatan Coal Mine, Yulin City, Shaanxi Province, China as the background. Through on-site sampling, laboratory crushing, and screening methods, experimental samples are prepared. The sample preparation process is as follows:

Samples of coal blocks with side lengths greater than 300 mm were obtained on-site. The coal blocks were crushed using a hand hammer in the laboratory, and coal particles of five scales, 10 mm, 20 mm, 30 mm, 40 mm, and 50 mm, were screened using sample sieves with different pore sizes. The production process is shown in Figure 1.

Figure 1. Sample production process.

3. TESTING PROCESS

This experiment mainly uses the soaking method and weighing method to test the water absorption rate of coal particles of different scales. The testing steps and process are as follows:

Firstly, in the laboratory, we took 100 g of coal particles of five different scales and placed them in different sample containers. Then, we dried them in an oven for 30 minutes to remove moisture from the raw coal;

Secondly, after the drying is completed, we immediately place it on a one-thousandth scale to weigh the original weight of coal particles;

Then, we fill the containers containing coal particles of different scales with water and soak them;

Finally, the soaked coal particles are weighed at intervals to obtain the weight of coal particles at different soaking times. Figure 2 shows the process of this experiment.

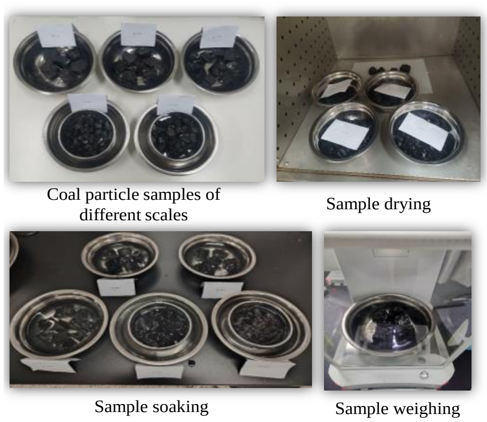


Figure 2. The process of this experiment.

In the above experimental processes, the weight of five different scales of coal particles after repeated soaking can be measured. Through statistical calculation, the variation law of moisture content of coal particles with different soaking times and scales can be obtained.

4. ANALYSIS OF TEST RESULTS

By conducting a one week test on the moisture content of five different scale coal particles after soaking, equation (1) was used to calculate the changes in moisture content of coal particles at different times and scales. The test results are shown in Table 1.

$$\rho = \frac{m_1 - m}{m} \cdot 100\% \tag{1}$$

In the equation: m is the mass of coal particle drying, g; m_1 is the mass of coal particles after soaking, g.

Table 1. Statistical data on changes in moisture increment.

Time/h	**Coal particle size/mm**					**Notes**
	10	**20**	**30**	**40**	**50**	
0	0.00%	0.00%	0.00%	0.00%	0.00%	
0.5	6.51%	5.63%	2.32%	2.55%	1.57%	
2	7.50%	4.65%	3.05%	3.69%	2.24%	
5	6.25%	4.10%	3.45%	4.13%	2.68%	
7	5.70%	3.31%	4.27%	4.27%	2.87%	
9	5.77%	5.61%	3.81%	4.17%	2.89%	
12	8.53%	5.94%	3.98%	4.43%	2.95%	
24	6.94%	4.34%	5.09%	4.90%	3.40%	
32	7.87%	5.44%	4.85%	5.28%	3.70%	
48	8.76%	5.77%	5.02%	5.36%	3.77%	

Based on the obtained data on moisture increment changes, we analyzed the water absorption patterns of coal particles at different scales using cumulative soaking for 12 hours, 24 hours, and 48 hours. The moisture increment change curves of coal particles at different scales under different soaking times are shown in Figure 3.

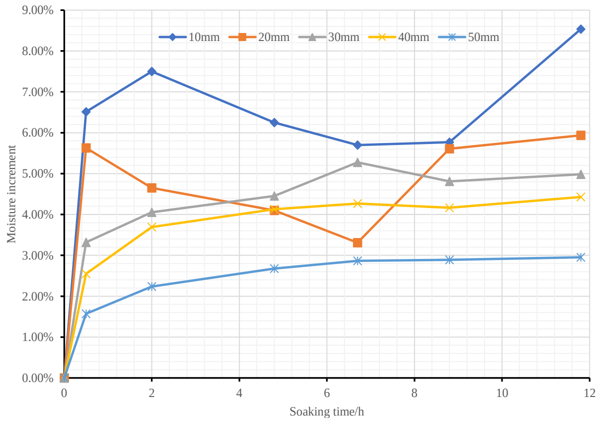
Through laboratory soaking tests, it was found that the moisture increment change curves of coal samples with different scales of coal particles increased with the increase of soaking time, as shown in Figure 3 for three soaking times of 12 hours, 24 hours, and 48 hours. In the early stage of soaking, the moisture increased rapidly. After reaching 2 hours of soaking time, the increase in moisture increment of coal samples with five types of coal particles gradually slowed down; After the soaking time reached 32 hours, the moisture increment of the five coal particle coal samples gradually stabilized.

From the perspective of coal particle size at different scales, within the same soaking time, as the coal particle size increases, the moisture increment decreases. The moisture increment of coal samples with 10 mm scale coal particles is the largest, followed by 20 mm scale coal particles, and 50 mm scale coal particles are the smallest.

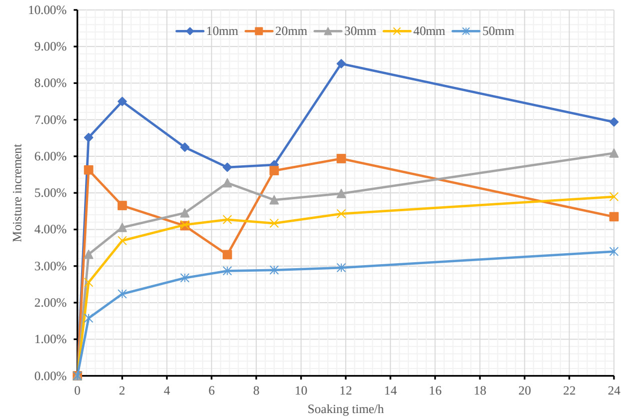
From the perspective of moisture increment, in the early stage of the soaking experiment, the water absorption increment of coal particle samples at five scales increased rapidly. In the first 0.5 hours, the moisture increment of coal particles a t the 10 mm scale was the highest, reaching 6.51%, and the moisture increment of coal particles at the 20 mm scale reached 5.63%; The moisture increment of coal particles at 30 mm, 40 mm, and 50 mm scales ranges from 1.5% to 2.5%. Compared with coal particles at 10 mm and 20 mm scales, the moisture increment of coal particles at 40 mm and 50 mm scales is significantly lower, indicating that coal particle size has a significant impact on coal water absorption.

After soaking for 32 hours, the moisture increment of 10 mm scale coal particles was basically maintained at 7.87%, 20 mm scale coal particles was basically maintained at 5.44%, 30 mm scale coal particles were basically maintained at 4.85%, 40 mm scale coal particles were basically maintained at 5.28%, and 50 mm scale coal particles were basically maintained at 3.70%, showing a trend of smaller moisture increment as the coal particle size increases.

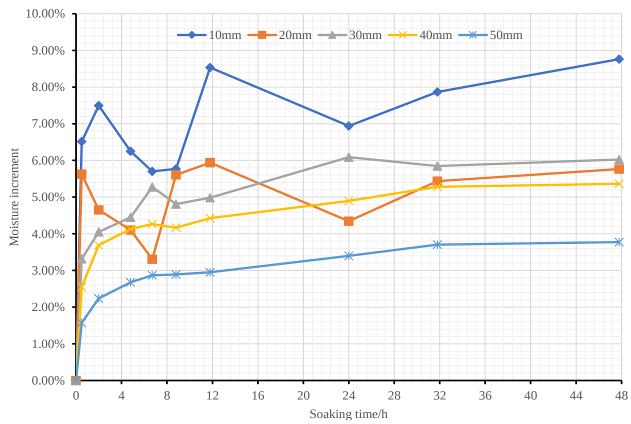
Through the above experiments, it can be analyzed that the size of coal particles is directly related to the increase in coal moisture content. When the size of coal particles is small, the larger the volume of voids between particles, which is equivalent to increasing the porosity of coal, making it easier for moisture to enter the coal body.



(a) Soak for 12 h



(b) Soak for 24 h



(c) Soak for 48 h

Figure 3. Changes in moisture content of coal particles at different scales under different soaking times.

5. CONCLUSIONS

The soaking method and weighing method were used to test the moisture increment of coal particles with different scales. It was found that the moisture increment of coal samples with different scales increased with the increase of soaking time. In the early stage of soaking, the moisture increased rapidly, and the smaller the coal particle size, the greater the moisture increment.

In the early stage of soaking, the water content increases rapidly. After the soaking time reaches 2 hours, the increase in water content of the five coal particle coal samples gradually slows down; After the soaking time reached 32 hours, the moisture increment of the five coal particle coal samples gradually stabilized.

Within the same soaking time, as the size of coal particles increases, the moisture increment decreases. The coal sample with a 10 mm scale has the highest moisture increment, followed by coal particles with a 20 mm scale, and coal particles with a 50 mm scale have the smallest.

Through experiments, it has been shown that the size of coal particles is directly related to the increase in coal moisture content. When the coal particle size is small, the volume of voids between particles increases, which is equivalent to increasing the porosity of coal and making it easier for moisture to enter the coal body.

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