Original Research Article

Research on the Influence of Gas on Coal Pores based on NMR Technology

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Abstract: In order to study the change characteristics of the pore structure of coal under different CH4 pressure conditions, nuclear magnetic resonance (NMR) technology was used to test the degree of influence on porosity and pore size distribution of coal after the adsorption of CH4 under different pressures. The test results show that under the action of gas pressure, the NMR signal amplitude of the NMR T2 spectrum changes significantly. From the distribution area of the T2 spectrum of the coal sample, it can be known that the peak peak area of small holes>the peak peak area of medium and large holes>the peak peak area of cracks indicates that the coal sample The micropores in the coal body are the most developed, and the connectivity is not strong, and it is difficult to circulate; in the range of gas pressure P=0.5~2.0MPa, as the gas pressure increases, new pores will be generated in the coal body, and the micropores are interconnected to form micropores or medium Pores and mesopores are interconnected to form cracks, thereby increasing the porosity and permeability of the coal sample.
Keywords: Gas pressure; NMR; T2 spectrum; Porosity; Pore size distribution

1. Introduction

With the increase of coal mining depth, the coal gas content continues to increase, and its physical and mechanical properties change, which makes it more difficult to control coal mine gas and roadway surrounding rock [1], triggering disasters and accidents, in order to prevent and prevent disasters and accidents. A large number of scholars have studied the physical and mechanical properties of coal and rock mass. Li Xiangchun[2] and other studies found that coal samples swell and deform after adsorbing gas, which weakens the strength of the coal body and increases the brittleness of the coal body. The more adsorbable gas in the gas absorbed by the coal body, the greater the proportion of gas. The greater the expansion and deformation of the coal body will be. Lin Baiquan[3]used adsorption and desorption experiments and found that the pore size distribution of coal has an important influence on gas adsorption, and the ultimate adsorption capacity of coal is affected by both micropores and mesopores. Zhou Dong [4] et al., through the application of high-precision micro-CT experiments, found the mesoscopic characteristics of coal adsorption gas. Gao Baobin[5]analyzed the mechanical properties and acoustic emission characteristics of coal under different gas pressure conditions, and discovered the meso-mechanism of coal and rock failure, which provided a basis for finding the prediction and prediction methods and indicators of coal and rock failure and instability. Based on the analysis of a large number of scholars, this paper uses NMR technology to test the degree of gas adsorption of coal under different pressures, and then studies the microscopic deformation laws of coals affected by different gas pressures, with a view to controlling coal mine gas and high gas coal seams.

2. NMR experiment principle and experiment scheme

According to the relaxation mechanism of nuclear magnetic resonance, the T2 relaxation time of the fluid in the pores of the medium has three types of transverse relaxation times: surface relaxation T_2^S, diffusion relaxation T_2^D, and free relaxation T_2^B[6-7]. However, in the physical test of coal samples, the fluid T2 relaxation time mainly depends on the surface relaxation. That can be expressed as:

$$\frac{1}{T_2^S} = \rho_2 \frac{S}{V} \quad (1)$$

false

ρ_2 represents the surface lateral relaxation rate, m/s; s/v represents the ratio of the surface area to volume of the pores of the coal and rock samples, m^{-1}.

Pass CH4 gas of different pressures (0.5MPa, 1.0MPa, 1.5MPa, 2.0MPa) into the coal sample, keep the methane gas pressure for 5h, test the T2 spectrum and T2 spectrum of the coal sample with the Numer analysis and testing software After that, use Numai core nuclear magnetic resonance analysis and testing software to test porosity and pore size distribution. The specific experimental process is shown in Fig 1.

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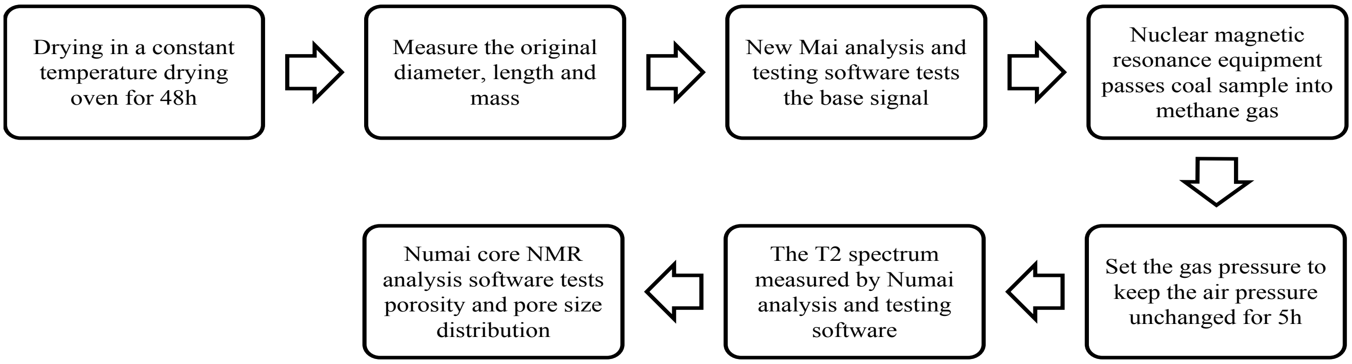

Fig.1 NMR experiment flow

3. T2 spectrum changes under different pressures

Figure 2 shows the T2 spectra under different pressures. The abscissa represents the relaxation time, which is related to the pore radius; the ordinate represents the amplitude value, which is proportional to the number of hydrogen atoms in methane[8]. From Figure 2 and Table 1, it can be seen that the T2 spectrum curves of these three coal samples show three peaks, respectively, T2=0.1~1ms corresponding to micro-pore peaks, and T2=10~50ms corresponding to medium-large pore peaks. T2>100ms is the crack peak. From the T2 spectrum distribution area of the coal sample in Table 1, it can be seen that when P=0.5MPa in the coal sample of WDD3, WDD8, and WDD9, the peak area of micropores accounts for 91.779%, 87.459%, and 98.835% of the total pore peak area; P= At 1.0MPa, the micropore peaks accounted for 92.976%, 87.236%, and 98.842% of the total pore peaks; when P=1.5MPa, the micropore peaks accounted for 91.477%, 92.938%, and 98.804% of the total pore peaks; when P=2.0MPa, Micro-pore peaks accounted for 89.074%, 87.772%, 98.771% of the total pore peaks; according to the NMR experimental principle, the larger the T2 value, the larger the pores, and the smaller the T2, the smaller the pores; the experimental results show that the micro-pores of the coal sample account for the main In part, the medium and large pores and cracks are relatively small. There are two zero points in these three areas, indicating that the connectivity is not good and the overall permeability of the coal sample is not high; from the overall law, with the gas pressure (P=0.5~2.0MPa) Increases, the T2 spectrum distribution area of the small pore peaks in the coal body gradually decreases with the increase of gas pressure, while the T2 spectrum distribution areas of the medium and large pore peaks and crack peaks gradually increase with the increase of gas pressure.

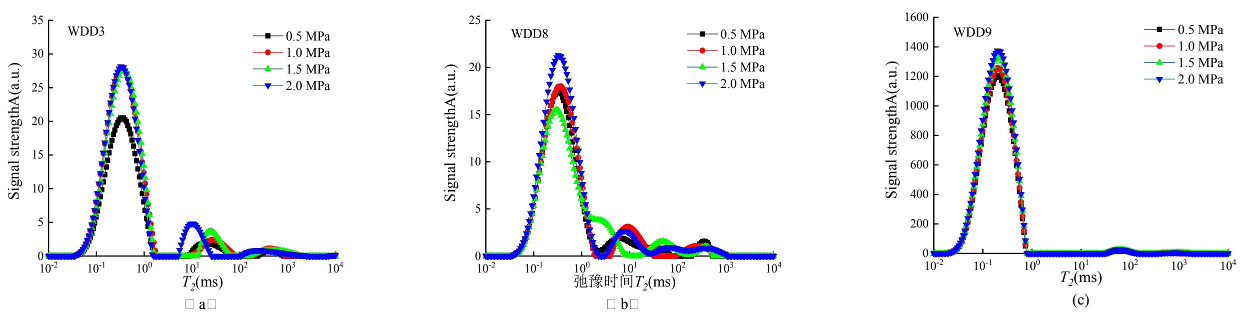

Fig.2 The variation of T_2 spectrum under different pressures

Table 1 T_2 spectral distribution area of coal samples under different gas pressures

Gas pressure（MPa）	WDD3 T2 spectrum distribution area of coal sample			WDD8 T2 spectrum distribution area of coal sample			WDD9 T2 spectrum distribution area of coal sample		
	Tiny hole peak	Cuhk Kongfeng	Crack peak	Tiny hole peak	Cuhk Kongfeng	Crack peak	Tiny hole peak	Cuhk Kongfeng	Crack peak
0.5	555.288	38.120	11.619	481.422	43.014	26.021	31230.680	317.277	50.925
1.0	778.775	42.799	15.880	511.075	55.160	19.618	32631.479	339.245	43.208
1.5	767.815	51.385	20.151	503.328	28.181	10.067	34711.858	332.341	87.810
2.0	752.200	68.160	23.523	594.737	46.989	17.976	35797.345	342.296	103.235

4. Conclusion

Through nuclear magnetic resonance (NMR) technology, analysis And draw the following conclusions:

(1) The nuclear magnetic resonance T2 spectrum of the coal sample has three peaks, respectively, T2=0.1~1ms corresponds to the micro-pore peak, T2=10~50ms corresponds to the medium-large pore peak, and T2>100ms is the crack peak; The small pores of the coal sample account for the main part, and the medium and large pores and cracks are relatively small. There are two zero points in these three areas, indicating that the connectivity is not good and the overall permeability of the coal sample is not high.

(2) In the range of gas pressure P=0.5~2.0MPa, the T2 spectrum distribution area of the tiny pores in the coal body gradually decreases with the increase of gas pressure, while the T2 spectrum distribution area of the medium and large pore peaks and the crack peaks are all The gradual increase with the increase of gas pressure indicates that the greater the gas pressure, the more obvious the impact on the microstructure of the coal body, and the permeability of the coal sample gradually increases.

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