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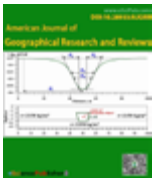

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Study on Adsorption Characteristics of Coal Reservoirs in Yangyi Mine

ZHANG Beibei[1,2], SHEN Junping[3], SHEN Shuxing[4], YAN Zhifeng[5*]

[1] School of Earth Science and Engineering, HUE, School of Hebei University of Engineering, Handan 0560382, China; [2]Key Laboratory of Coal bed methane Resources and accumulation process of China University of Mining and Technology, Xuzhou 221116, China; [3]Aksu Industrial Vocational and Technical College, Aksu, 842000, China; [4]Aksu No. 17 Middle School, Aksu, 843000; [5]School of Mining, Liaoning Technical University, Fuxin 123000 , China.

ABSTRACT

The method for studying the adsorption characteristics of the coal seam has the density method, the mercury-pressing method and the adsorption method. In this experiment, a low temperature nitrogen adsorption method was used to determine the relative data of the coal-like porosity by using the surface area meter TriStarI3020 to determine the arrangement of the nitrogen molecules on the surface of the coal-like samples.

Before the beginning of the experiment, the samples of Yang dong coal reservoir were prepared, weighed, the devaporation time was set at 2h, and the temperature was kept at 105^0C.The low temperature nitrogen adsorption experiment was carried out by TriStarII3020.The data of adsorption of nitrogen molecules by coal samples at low temperature are obtained by experiments. The gap characteristics of coal samples are studied by analyzing the characteristic folding points and relative relations of the generated linear diagram.

Get coal samples under the condition of low temperature changing with pressure adsorption nitrogen molecular data changes, through the analysis of the linear graph of generated features that are characteristic of fold point and relative relationship to study the space characteristics of the coal sample. Through the analysis can determine the area mainly for both ends of the open pores in coal mine, the porosity of the thin neck bottle type, this research has great significance to the adsorption of gas in the coal reservoir, facilitate monitoring

***Correspondence to Author:**
YAN Zhifeng
School of Mining, Liaoning Technical University, Fuxin 123000 ,China

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during the coal mining operations have an impact on safety production of the gas such as gas. Can get the conclusion: in the low relative pressure p/p°< 0.1 the surface of the coal samples are distributed in nitrogen molecular monolayer, with the increase of pressure surface of coal samples began to multilayer adsorption intensified will appear the characteristics of the molecular cohesion, condensation of a pressure value after the single nitrogen molecules adsorption quantity also presents the geometric growth tend to be infinite. The pore of coal is mainly based on open type and fine neck bottle, and there is a small number of open pores.

Key words: Coal, Isotherm adsorption, Micropore, Specific surface

INTRODUCTION

Coal is a natural adsorbent, similar to microporous substances such as activated carbon, and has a great adsorption capacity. The pore characteristics of coal is one of the determinants of coal adsorption. In addition, the porosity of coal also determines the desorption and permeability of coal. Therefore, studying the pore characteristics of coal seams is essential for understanding the accumulation process and development and utilization of coalbed methane resources. of great significance. The traditional research methods are not deep enough in the study of coal pores, and cannot quantitatively test parameters such as average pore size, total pore volume, specific pore volume, and specific surface area of coal sample, mercury intrusion and adsorption.

In order to study the pore structure of Yangyi Mine, low-temperature nitrogen adsorption experiments were carried out on the coal samples of Yangyi Mine, and isotherm diagrams were obtained. The study of multiple sets of experimental data and linear graphs can determine which isotherm adsorption model of the coal sample from Yangyi Mine is. Therefore, it is more scientific and intuitive to judge the pore characteristics and specific surface area characteristics of the Yangyi coal reservoir represented by the coal sample.

1. Geological situation

1.1 Regional stratigraphy

The Fengfeng mining area is a semi-covered area, and the bedrock is mostly exposed in Gushan, Jiushan Mountains and the gullies in marginal areas and hilly areas. Other areas are covered by Quaternary strata of about 0-40m.

Yangyi Mine is located in the foothills of Gushan Mountain, a branch of Taihang Mountains. There are some exposed rock formations in the hilly area and gully area formed by flowing water in the mining area. By analyzing the geological survey reports and mining area survey reports of Yang No. 1 Mine in previous years, it can be seen that the main stratigraphic structures are: Ordovician, Carboniferous, Permian, Triassic and Quaternary strata.

1.1 Fault situation

The faults in the mining area are mainly NEE and NNE strikes, and the fault dip angle is generally 62°~70°, see Figure 1-2. By analyzing the geological environment data of exploration and mining in Yangyi Mine in recent years, the faults in the mining area are summarized as follows:

(1) Fault properties: there are many faults, most of which are normal faults with high extensional angle;

(2) Faults Trend: The first group is dominated by the NNE direction, the second group is in the NEE direction, and the third group is the least developed.

(3) Plane combination characteristics of faults: From the perspective of fault combination shape, the plane combination characteristics are generally arranged in a broom-like arrangement of faults such as F1, F2, FYR4, FYR6, FY7, FR7, FY8, F3, and F5. Large-scale faults often become the main trunk of the "broom" shape, and the rest of the faults constitute the main body of the "broom" shape.

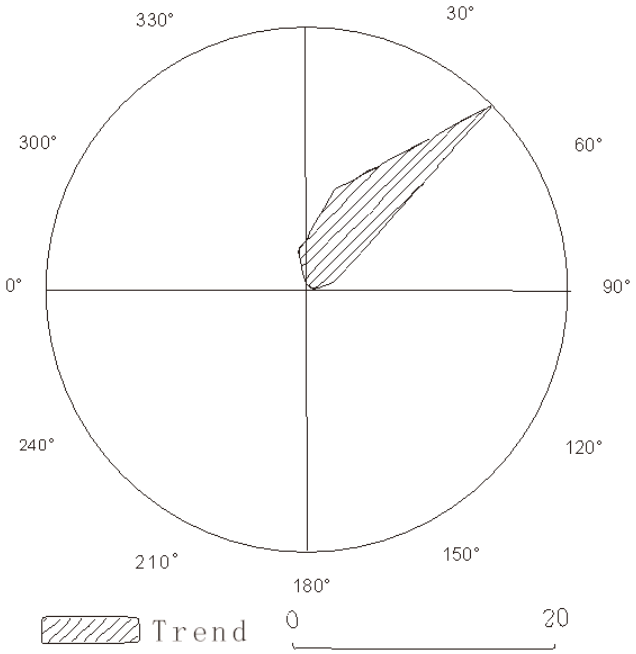

Figure 1-2. Rose diagram of major fault strikes in Yang 1 and Yang 2 well fields

2. Coal quality characteristics

The coal quality of the Fengfeng Coalfield is centered on the Fuyang River, and the degree of metamorphism of the coal in the south and north gradually increases, from fat coal to coking coal, lean coal, lean coal, and anthracite. There is a transition between different coal qualities The coal quality change is distributed in a belt along the stratigraphic strike. Yangyi Mine is located in the east wing of the central part of Fengfeng Coalfield. The coal quality of the mine field belongs to the section of coking coal, lean coal and lean coal in the coal quality metamorphic zone of Fengfeng Coalfield.

Within the scope of the minefield, along the stratigraphic strike from south to north, the degree of coal seam metamorphism increases continuously, and also presents a zonal distribution, that is, the coking coal in the south flank of the minefield gradually turns into lean coal and lean coal toward the north. The same coal seam in the inclined direction, the coal quality is relatively stable, little change. In the vertical direction of the stratum, the metamorphic degree of the upper coal seam is low, and the metamorphic degree of the lower coal seam gradually increases, that is, the lower the coal seam level, the higher the coal seam metamorphism degree.

The color of each coal seam in Yangyi Mine gradually changes from dark black to light black from south to north; the light transmittance and reflectivity of the coal seam increase with the increase of the degree of coal metamorphism. The type of coal and rock is semi-bright briquette, strong glass luster, strip-like structure, uneven fracture, with edges and corners. Coking coal in the area can be used as coking coal alone, but generally used as the main coking blending coal; lean coal is used as coking blending coal, and also used as civil or power fuel; lean coal is mainly used as gasification power and civil fuel, and is also used as coking blending coal. Thinner for coal. The hardness of coal is 2.0~2.5 Mohs hardness. The coal seam structure is strip-shaped, with high brittleness, and the characteristics of coal seams with endogenous fractures are quite stable, which constitutes a good basis for stratigraphic correlation. Therefore, the coal seam contrast signs in this area are obvious and the comparison is reliable. The 2# coal of Shanxi Formation is a mineable coal seam in the whole area. The coal seam has a large thickness, stable horizon and reliable coal seam comparison. The Taiyuan Formation contains 5 recoverable and partially recoverable coal seams and 5 limestone layers. From top to bottom, they are Yeqing, Shanqing, Fuqing, Xiaoqing and Daqing limestones. Bit stable and easy to compare, it is

a stable and reliable marking layer.

3. Experiments

The experiment uses the American TriStar II 3020 liquid nitrogen adsorption type automatic specific surface area and physical adsorption analyzer, which can be used to determine the specific surface area, pore volume, pore size, pore distribution, isothermal adsorption and desorption by means of the principle of gas adsorption (typically nitrogen). analyze. This instrument adopts the principle of "static volume method" isothermal adsorption, and is equipped with a liquid nitrogen liquid level holding device (ie, liquid nitrogen isothermal clamp) to ensure the accuracy of the analysis. It is also equipped with an analysis station and two degassing stations. The station and the analysis station are each equipped with an independent vacuum system. Among them, the degassing station is a two-stage mechanical pump, and the analysis station is equipped with a two-stage mechanical pump and a molecular turbo pump. The mechanical pump can choose oil-free pump, the degassing station and the analysis station are fully automatic operation. The lower limit of the specific surface area measurement is 0.0005m^2/g, no upper limit, the pore size analysis range is 0.35-500.00 nm, the resolution of the micropore section is 0.02 nm, and the minimum pore volume detection is 0.0001mm^3/g.

3.1 Setting of experimental conditions

The degassing temperature in the experiment was 100 °C, the degassing time was 6 hours, and the drying time for coal samples was 2 hours.

3.2 Experimental methods

The coal sample taken in this experiment is the coal sample of Yangyi Mine. The experimental sample is broken to 60-80 mesh (0.18~0.25mm), the sample is put into the oven for vacuum drying, and the dried coal sample is put into TriStar II 3020 liquid nitrogen adsorption type automatic specific surface area and physical adsorption analyzer. The mass of each sample is 2g. The adsorption experiment of the sample is carried out by "static volumetric method". The adsorption medium is 99.999% nitrogen. The temperature is liquid nitrogen temperature, and the sample is heated and vacuum degassed and placed in a Dewar bottle containing liquid nitrogen. After the experiment begins, the system carries out adsorption experiments according to the preset pressure, thus obtaining nitrogen adsorption under different pressures. According to the experimental data of liquid nitrogen adsorption, the software of the instrument automatically calculates the specific surface area of the sample according to BET (Brunauer, Emmett Teller) multi-molecular layer adsorption formula, and then uses BJH (Barret). Joyner and Halenda) model to calculate the pore size and pore size distribution of coal samples. There are many pore type classification schemes. In this paper, with reference to Zhao Sheng classification scheme, pore types are divided into micropores, small pores, medium pores and macropores (micropore diameter < 10nm < 10nm < micropore diameter < 100nm < 100nm < medium pore diameter < 1000nm < 1000nm < large pore diameter)

4. Experimental results and discussion

4.1Characteristics of isothermal adsorption line

First of all, according to the results of isotherm map (Fig1), the shape of low temperature nitrogen adsorption curve of Yangyi coal sample is inverted s type, which indicates that the adsorption curve of Yangyi coal sample belongs to type Ⅱ of BET scheme. The isotherm of the relative pressure rises rapidly when the relative pressure is less than 0.1, and the nitrogen molecules are only monolayer in the pores on the surface of the coal sample at lower pressure. The rise of the curve becomes very slow when the relative pressure is between 0.1and 0.8. this is because the ultramicropores with pores smaller than 0.86nm have been filled, the number of single molecules filled with larger pores has increased, and even multi-layer adsorption has occurred. This process is more difficult than the previous adsorption process, the adsorption rate is naturally much smaller, and the rising degree of the curve is reflected in the isotherm map. However, the

isotherm increases sharply when the relative pressure is between 0.9-1.0, because when the relationship between the p max pº and the pore size of the pores accords with the Kelvin equation, then this type of pores will occur capillary condensation. With the increase of the relative pressure, the nitrogen molecular layer will gradually accumulate, and molecular condensation will occur in the pores with larger pores. When the pram pº gradually approaches 1, the amount of nitrogen absorbed by the coal sample increases geometrically due to the high pressure, and the slope of the isotherm is also close to infinity.

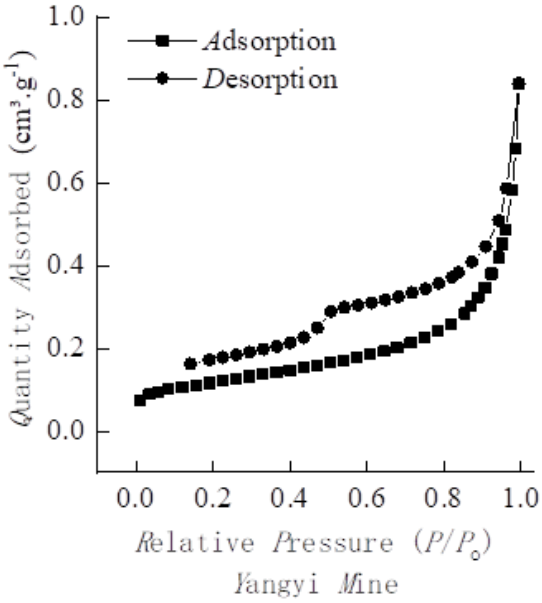

Fig 1 isotherm diagram

4.2 Relationship between adsorption loop and pore structure

According to the theory of adsorption and condensation, the pores of the corresponding radius Kelvin will agglomerate with the change of pº. Desorption occurs when the nitrogen molecules in the pressure pores begin to decrease under high pressure. Because the shapes of pores in coal samples are different, the relative pressure of capillary pores will change when condensation adsorption and desorption occurs, which forms the desorption curve, which reflects the shape characteristics of pores and the relevant pore size data can be obtained.

According to the characteristic diagram (Fig2) of the desorption curve produced in the experiment, it is concluded that the possible pores in coal samples are cylindrical pores with openings at both ends, slit pores and ink bottle pores. In this experiment, the desorption curve decreases sharply and trembles especially when the pstroke pº is between 0.9 and 1.0, indicating that the resolution rate is very high. The adsorption-desorption curve is also very similar, and the shape is very similar. After this stage, the slope difference between the adsorption curve and the desorption curve becomes larger and larger. When the relative pressure drops to 0.52, the desorption curve changes sharply at the inflection point, and gradually approaches the adsorption curve, and the shape of the whole curve is Fig3. According to the relationship between the relative pressure and the pore diameter of Kelvin formula, the corresponding pore diameter can be calculated to be about rk= * 2 × 8.85 × 10 ~ (- 3) × 34.65 × 10 ~ (- 4) × 1 × ln0.52=1.46, so the pore diameter is about 3nm according to the relationship between relative pressure and pore diameter of 3nm formula. The curve produces desorption loop when the relative pressure is high, but the pressure reduction curve is close. The characteristics of the adsorption loop show that the pores smaller than 3nm in Yangyi coal sample are characterized by pores with one end

opening, and the pores with diameter larger than 3nm are mainly composed of pores with openings at both ends and ink bottle-shaped pores, and there are also a small number of pores with one end opening.

Because there is a sharp decline in the desorption curve, it is judged that the coal sample has a thin-necked bottle-like pores. after a layer of nitrogen molecules are adsorbed on the pore wall during the adsorption process, the nitrogen molecules are first distributed at the neck with the increase of relative pressure. then condensed in the bottle until the whole pores were filled with nitrogen molecules. In the process of desorption, because the condensate at the neck of the bottle seals the inside of the bottle, it cannot be desorbed even though the phammer p^o corresponds to the radius in the pore; then, with the continuous decrease of the relative pressure, the nitrogen molecule at the neck is the first to evaporate, and the gas-liquid interface becomes hemispherical under pressure, so the relative pressure in the process of condensation and desorption begins to be different. When all the nitrogen molecules in the bottle neck evaporate, because the evaporation pressure inside the bottle is much greater than the relative pressure outside, the nitrogen molecules in the bottle will suddenly escape in large numbers, and the adsorption loop corresponds to a sharp decline in the turning point in the curve. The relative pressure at the break point is 0.52. according to Darwin's formula, the diameter of the thin neck of the pore is about 3nm.

5. Conclusion

Through the experimental study on the low temperature nitrogen adsorption characteristics of coal reservoir samples in Yangyi Coal Mine, the following conclusions are drawn:

(1) the low temperature nitrogen adsorption characteristic curve of Yangyi coal reservoir is inverted S shape, and the sample adsorption characteristic is the II curve in BET classification.

(2) the pore characteristics of the coal sample of Yangyi Coal Mine are complex pore system, which is mainly composed of pores whose pore diameter is less than 3nm and opens at one end, and whose diameter is larger than 3nm, which is dominated by two-end opening and thin-necked bottle, and there are a few capillaries with one end opening.

(3) the pore structure in the coal of Yangyi Coal Mine can be divided into type Ⅰ pores with open ends, type Ⅱ pores with thin neck, and a few type III pores with air impermeability closed at one end. The bottleneck diameter of ink bottle-shaped hole is about 3nm, and the diameter of type Ⅲ capillary is less than 3nm.

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