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# NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA



## GB/T 9973-2025

Replacing GB/T 9973-2006

# Test methods for permeability of carbon materials

炭素材料透气度试验方法

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## 1 Scope

This document describes the test methods for the permeability of carbon materials.

This document is applicable to the determination of the permeability of carbon materials at room temperature and is also applicable to the determination of the permeability of blast furnace refractory materials.

## 2 Normative References

GB/T 8170

GB/T 8718

## 3 Terms and Definitions

The terms and definitions defined in GB/T 8718, and the following are applicable to this document.

### 3.1 Permeability

Under a certain temperature and pressure difference, a characteristic value indicating the ease with which gas passes through a carbon material.

NOTE. permeability is a property that varies with the determination direction (gas flow direction).

## 4 Principle

Gas at a certain pressure passes through a specimen under laminar flow conditions. Determine the pressure difference at both ends of the specimen at different flow rates. Based on the determined value and the shape and size of the specimen, calculate the permeability of the specimen.

Laminar flow conditions refer to flow with mutually parallel airflow streamlines. Usually, the direction of flow is defined as the direction of formation or use of the specimen. where 1 ?m2 = 1,013 mDa.

### 5.1.1.1 Schematic diagram of test device for water displacement method

See Figure 1 for a schematic diagram of the test device for water displacement method.

### 5.1.1.2 High-level water tank

A water tank that can be raised or lowered or has an adjustable water level. It has a water inlet, overflow port and connection port (for connection to the water-vapor displacement container).

The connection port has a micro-regulating valve.

The machined specimens are dried in a drying oven (5.1.2) at (110 ? 5) °C for 2 h ? 10 min.

They are then placed in a desiccator and cooled to room temperature.

### 5.3 Test Procedures

5.3.1 Measure the diameter d and height h of the specimen. the diameter d is measured six times along the specimen's axial direction (center point) at three points (the top, middle and bottom).

After measuring at each point once, based on its axis, rotate the specimen 90°, measure again and take the average value. The height h is measured 3 times at different locations around the specimen's end by rotating it 60° each time and taking the average value.

5.3.2 Check the airtightness of the test system and conduct a blank test. place the blank specimen in the specimen holder and use bolts to secure the cover plate, specimen tube and base. Inflate the flexible sealing sleeve lining the specimen tube with air to seal the sides of the specimen. The air pressure depends on the properties of the flexible sealing sleeve and generally, it needs to be between 0.15 MPa ~ 0.30 MPa. Fill the high-level water tank with water, open the micro-regulating valve, observe the U-shaped pressure gauge, and adjust the pressure difference deltap to 9.8 x 103 Pa (1,000 mmH2O). If the water level does not change within 30 minutes, then, the measurement system is considered airtight.

5.3.3 After the blank test, shut off the air supply, close the micro-regulating valve, and remove the standard specimen from the specimen holder. Then, place the specimen in the specimen tube of the specimen holder and tighten the bolts securing the cover plate, specimen tube and base.

5.3.4 Re-inflate the flexible sealing sleeve lining the specimen tube with air to seal the sides of the specimen.

5.3.5 Ensure the water level in the water tank remains constant. Open the micro-regulating valve of the high-level water tank to adjust the flow rate. Fill the water-vapor displacement container with water, until the pressure on the U-shaped pressure gauge stabilizes.

### 5.3.6 When starting timing after the pressure stabilizes, simultaneously record the reading (U1)

of the U-shaped pressure gauge connected to the specimen holder end and the reading (U2) of the open end of the U-shaped pressure gauge. Calculate the pressure difference deltap, and record the time required for the water level to rise by 60 mm (approximately 500 mL) as t. If the water level rises very slowly, record the change in the liquid level in the water-vapor displacement container over 30 minutes, read the atmospheric pressure (p2), and record the room temperature.

Find the corresponding air dynamic viscosity ? and water vapor correction factor alpha in Appendix B.

5.3.7 Adjust the water tank height or the water level in the tank. Continue testing the permeability of each specimen 3 times at different pressure differences and take the average value of the three tests.

### 5.4 Test Data Processing

5.4.1 The volume of gas passing through the specimen is calculated in accordance with Formula alpha---the water vapor correction factor (see B.2);

?p---the pressure difference of the gas at both ends of the specimen, expressed in (Pa);

p1---the absolute pressure of the gas entering the specimen end, which is the sum of the atmospheric pressure and the pressure difference during the test, expressed in (Pa);

p2---the absolute pressure of the gas leaving the specimen end, which is the atmospheric pressure during the test, expressed in (Pa).

NOTE 1.the unit of permeability in product standards is often millidarcy (mDa). 1 mDa = 0.987 x 10?3 µm2 = 0.987 x 10?11 cm2 = 0.987 x 10?15 m2.

NOTE 2.if the pressure difference deltap of the gas at both ends of the specimen is less than 1,000 Pa, make 2p1/(p1 + p2) = 1 in the Formula.

5.4.4 The results shall be rounded to two decimal places. The rounding-off of values shall comply with the provisions of GB/T 8170.

### 6.1.1.1 Schematic diagram of test device for external gas source method

See Figure 3 for a schematic diagram of the test device for external gas source method. During final assembly of the equipment, stainless steel pipes shall be used for connecting pipelines.

The pipeline shall be as short as possible to minimize the pressure loss ratio in the test device.

### 6.2 Specimen

Same as 5.2.

### 6.3 Test Procedures

6.3.1 Measure the diameter d and height h of the specimen, using the same measurement method as 5.3.1.

6.3.2 Perform a blank test using a blank specimen to prove that the test device is sealed and leak-proof. If the flow rate through the gas flow meter remains 0 for 30 minutes, then, it shall be considered that the test device is sealed and leak-proof.

6.3.3 Place the specimen into the holder and use the cover plate to compress the specimen.

6.3.4 Open the three-way valve (4 in Figure 3) in the test device to inflate the flexible sealing sleeve in the specimen holder, ensuring that the pressure of the flexible sealing sleeve is sufficient to prevent air leakage from the side surface of the specimen. The airtightness can be checked by increasing the pressure of the sealing sleeve; that is, when the pressure is increased, the gas flow rate and the pressure difference at both ends of the specimen shall not change.

### 6.3.5 Use the thermometer (6.1.5) to record the current room temperature. Simultaneously, use

the gas pressure gauge (13 in Figure 3) in the device to record the atmospheric pressure (p3).

Then, close the three-way valve (12 in Figure 3), open the three-way valve (11 in Figure 3), introduce the test gas into the specimen holder, and adjust the precision pressure regulating valve (9 in Figure 3) and set the pressure of the test gas in accordance with the test demands.

6.3.6 Wait for the gas pressure difference and flow rate to stabilize. Once both are stable,