

ICS 29.050

CCS Q52



**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 24203-2024

**Method for determination of bulk density, true density, true
porosity and open porosity of carbon materials**

炭素材料体积密度、真密度、真气孔率、显气孔率的测定方法

Issued on: September 29, 2024

Implemented on: April 1, 2025

**Issued by: State Administration for Market Regulation;
Standardization Administration of the PRC**

Table of Contents

1	Scope
2	Normative references
3	Terms and definitions
4	Determination of bulk density
4.1	Instruments and apparatuses
4.1.1	Analytical balance. scale graduation
4.1.3	Vernier caliper. measuring range (0~200) mm, graduation value
5	Determination of true density
5.2.1	Reagents
5.2.2.14	Square-hole standard sieve. pore size
5.2.3	Sample preparation
5.2.4	Test procedures
5.3.2.6	Square-hole standard sieve. pore size
5.3.3	Test sample
5.3.4	Test procedures
5.3.5	Test data processing
6	Determination of true porosity
7	Determination of open porosity
7.2.1	Instruments and apparatuses
7.2.1.2	Vacuuming device. The vacuum degree can reach
7.2.2	Test sample
7.2.3	Test procedures

1 Scope

GB/T 24203-2024 gives the Chinese methods for determining the bulk density, true density, true porosity and open porosity of carbon materials. These four quantities are the basic characterisation of graphite electrodes, cathode blocks, anodes, carbon bricks and specialty graphite, and they govern everything the material is bought for: the bulk density predicts the strength and the electrical resistivity, the open porosity governs the penetration of molten metal, salt and oxidising gas that destroys a lining, and the difference between true and bulk density is the porosity itself. The standard sets, for each quantity, the principle, the apparatus, the specimen and its preparation and drying, the procedure, whether by

dimensional measurement, by liquid displacement with vacuum impregnation or by pycnometry on the ground material, the calculation, the precision and the reporting, together with the treatment of impregnated and anisotropic materials. It takes effect on 1 April 2025.

This document specifies the method for determination of bulk density, true density, true porosity and open porosity of carbon materials. This document is applicable to the determination of bulk density, true density, true porosity and open porosity of carbon materials at room temperature.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 1427, Sample method of carbon material

GB/T 1997, Coke-sampling and preparation of samples

GB/T 8170, Rules of rounding off for numerical values & expression and judgment of limiting values

GB/T 8718, The terms of carbon materials

3 Terms and definitions

For the purpose of this document, terms and definitions given in GB/T 8718 apply.

4.1.1 Analytical balance. scale graduation

0.01 g.

4.1.2 Blast drying oven. equipped with an automatic temperature control device, capable of maintaining the temperature at $(110 \pm 5) ^\circ\text{C}$.

4.1.3 Vernier caliper. measuring range (0~200) mm, graduation value

0.02 mm. Where. a - length of the rectangular test sample, in millimeters (mm); b - width of the rectangular test sample, in millimeters (mm); c - height of the rectangular test sample, in millimeters (mm).

4.4.3 Calculate the bulk density of the test sample (D_b) according to Formula (3). Where. D_b - bulk density of the test sample, in grams per cubic centimeter (g/cm^3); m_1 - mass of the test sample, in grams (g);

4.4.4 The calculated value shall be rounded to two decimal places and the numerical value shall be rounded off in accordance with the provisions of GB/T 8170.

4.5 Allowable error The allowable error in bulk density determination shall not exceed 0.01 g/cm³.

5 Determination of true density

5.1 General This Chapter specifies two methods for determining true density - Method 1 (boiling method) and Method 2 (helium method).

5.2.1 Reagents

5.2.1.1 Absolute ethanol. not less than 99.7%, analytical grade or above.

5.2.1.2 Sulfuric acid. chemically pure or above.

5.2.1.3 Acetone. chemically pure or above.

5.2.2.5 Blast drying oven. equipped with automatic temperature control device, capable of heating to 200 °C.

5.2.2.6 Desiccator. containing desiccant.

5.2.2.7 Filter paper.

5.2.2.8 Electric hot plate or thermostatically controlled electric stove.

5.2.2.9 Thermometer. (0 ~ 50) °C, graduation value 0.1 °C.

5.2.2.10 Beakers. 300 mL, 500 mL, 1000 mL.

5.2.2.11 Sand bath.

5.2.2.12 Jaw crusher.

5.2.2.13 Crusher.

5.2.2.14 Square-hole standard sieve. pore size

0.15 mm.

5.2.3 Sample preparation

5.2.3.1 Take samples of carbon materials in accordance with GB/T 1427; if necessary, crush the samples to less than 1 mm [If the samples are damp, they shall be first dried in a blast drying oven at (150 ± 10) °C for 20 min]; reduce the samples to (50 ~ 60) g by quartering; crush all to pass through a

0.15 mm square-hole standard sieve.

5.2.3.2 The number and mass of incremental samples of calcined coke and calcined anthracite shall be in accordance with the industrial analysis samples in GB/T 1997, and the laboratory preparation procedures shall be the same as above.

5.2.4 Test procedures

5.2.4.1 Calibration of density bottle 5.2.4.1.1 Determination of density bottle mass (m_2).

First, soak the density bottle in a saturated solution of potassium dichromate in concentrated sulfuric acid for (1 ~ 2) hours; then take it out (if it is a new density bottle or it has not been used many times, inject hydrochloric acid solution to 2/3 of the bottle and boil it on a sand bath for more than 30 minutes); use water to rinse it; then use absolute ethanol and acetone to wash it respectively; use detergent powder to clean the outer wall of the bottle. Finally, use distilled water to clean the inner wall of the bottle; place it in a drying oven and dry it at $120\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ for 2 h; take it out and place it in a desiccator; cool it to room temperature; weigh it with the reading accurate to 0.000 1 g. Repeat the above operation by using distilled water to clean the inner and outer walls of the bottle several times and measure its mass. The weighing error shall be within 0.000 4 g for at least three times. Take the average value as the density bottle mass, which is m_2 .

5.2.4.1.2 Determination of density bottle water value (mass m_3 of density bottle plus distilled water).

Fill bubble-free distilled water into the density bottle in 5.2.4.1.1 (distilled water can be boiled before use) and place it together with the dropping bottle in a constant temperature water bath. The water level in the water bath shall be slightly above the scale line of the density bottle or level with the bottle mouth of the capillary density bottle. Keep the temperature at $(25 \pm 0.2)\text{ }^{\circ}\text{C}$ for 20 minutes. When the scale line of the density bottle is not exposed above the water surface, use a filter paper roll or a dropping bottle to suck out or add distilled water in the density bottle so that the liquid level is accurately at the scale line; wipe the inner wall above the liquid level clean (if a capillary density bottle is used, the stopper shall be immediately covered). Take out the density bottle; use a clean absorbent towel to carefully wipe the outside of the density bottle; quickly weigh its mass with the reading accurate to 0.000 1 g. Repeatedly inject distilled water and measure its mass according to the above operation. The weighing error of the density bottle water value shall be no more than 0.002 4 g for at least 3 times. Take the average value, which is the density bottle water value, that is, m_3 .

5.2.4.1.3 The density bottle water value shall be calibrated every three months. If the frequency of use is low, it can be delayed appropriately.

5.2.4.2 Determination of true density of test sample 5.2.4.2.1 Determination of true density

of test sample wettable by distilled water Weigh 3 g of the sample as m_4 , with the reading accurate to 0.000 2 g; place it in a clean density bottle; fill bubble-free distilled water (distilled water can be boiled before use) to 2/3 of the bottle and boil for 3 minutes; do not allow the sample to splash out at this time. After removing the bottle, inject bubble-free distilled water (distilled water can be boiled before use) to a level slightly above the scale line or to the same level as the mouth of the capillary density bottle. Put it together with the