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**Porous ceramics - Determination of apparent porosity and bulk
density**

多孔陶瓷 显气孔率和体积密度的测定

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1 Scope

The document describes a test method for determining the apparent porosity and the bulk density of porous ceramics.

It applies to the determination of the apparent porosity and the bulk density of porous ceramic products.

3 Terms and definitions

3.1 Porous ceramics: ceramic material with a pore size of 0.05 micrometres to 100 micrometres and an apparent porosity of 25 % to 90 %. Source: GB/T 17991-2009, 2.1.36, modified.

3.2 Bulk density: the dry mass of a specimen per unit volume. Note: expressed in grams per cubic centimetre. Source: GB/T 17991-2009, 2.3.2, modified.

3.3 Apparent porosity: the percentage that the volume of the open pores of a specimen, meaning the pores communicating with the atmosphere, forms of the total volume of the specimen. Note: expressed as a percentage.

4 Apparatus, equipment and materials

4.1 A drying oven able to control the temperature at 110 °C plus or minus 5 °C.

4.2 A weighing device with an accuracy of 0.001 g.

4.3 A gas-tight apparatus able to reduce the absolute pressure inside the vessel to not more than 2 500 Pa, as shown in Figure 1. The key to Figure 1 identifies the following items: 1, vacuum vessel; 2, lid; 3, rubber gasket; 4, stopcock connecting the vacuum vessel to the buffer bottle; 5 and 11, vacuum rubber tubing; 6, stopcock; 7, vacuum pump; 8, buffer bottle; 9, water reservoir bottle; 10, stopcock for supplying water to and draining water from the vacuum vessel; 12, specimen holder; 13, specimen; 14, glass window for observing the water level in the vacuum vessel; 15, vacuum gauge.

4.4 A heating device and vessel able to heat distilled water to boiling.

4.5 A vessel with an overflow tube, holding the immersion liquid when the suspended mass of the saturated specimen in the immersion liquid is weighed.

4.6 The immersion liquid is normally distilled water. Where the specimen undergoes a hydration reaction on contact with water, or where water damages the structure of the specimen, distilled kerosene or another suitable organic liquid may be used as the immersion liquid, care being taken that the immersion liquid cannot fractionate during the whole test.

4.7 A wire basket woven from metal wire of not more than 0.25 mm diameter, used to weigh

the mass of the specimen saturated with immersion liquid.

4.8 A suspension thread of not more than 0.25 mm diameter, inelastic and clean.

5 Specimens

5.1 Specimens shall be cut from an actual component or prepared as furnace-companion specimens. Each specimen may be a prism or cylinder of not less than 50 cubic centimetres in volume, or a plate or curved piece at least one of whose faces has an area of not less than 10 square centimetres; the specimen shall include at least one main surface of the original product, that is, the surface through which fluid passes perpendicularly, and shall have no macroscopic closed pores.

5.2 If a specimen is contaminated, the contamination shall be removed completely by an effective method.

5.3 Under the same test conditions the number of specimens tested is five.

6 Test procedure

6.1 The test is carried out in a temperature-controlled environment at 23 °C plus or minus 2 °C.

6.2 The cleaned specimen is placed in the drying oven, dried at 110 °C plus or minus 5 °C to constant mass and then cooled to room temperature in a desiccator. The dry mass of each specimen is measured to 0.001 g.

6.3.1 The boiling procedure applies to materials that do not react with water. The dried specimen is placed in a boiling vessel filled with distilled water, with clean gauze between the specimen and the bottom of the vessel and the specimens kept from touching one another. The distilled water is heated and kept boiling for 2 h and is then cooled to room temperature. A note requires the water level to be kept at least 50 mm above the specimen during boiling.

6.3.2 The vacuum procedure is the referee procedure. The dried specimen is placed in the vacuum vessel and the vacuum pump is started until the residual pressure in the vessel is below 2 500 Pa, the specimen being held at that vacuum for 15 min. The stopcock between the vacuum vessel and the liquid reservoir bottle is opened and the immersion liquid is admitted so that within 3 min it stands 20 mm above the specimen. Evacuation is continued for a further 30 min, after which the vacuum pump is switched off, the vessel is returned to atmospheric pressure and the specimen is kept immersed at atmospheric pressure for at least 30 min.

6.4 The impregnated saturated specimen is placed in the wire basket and suspended in the vessel with the overflow tube filled with immersion liquid, and the suspended mass of the saturated specimen in the immersion liquid is weighed to 0.001 g.

6.5 A pure cotton towel selected in accordance with GB/T 29862 is cut into a square of 14 cm side and soaked in the immersion liquid for 5 min; it is then taken out, folded into a square of 7 cm side and laid flat under the ram of a press, the ram being large enough to cover the towel completely. The pressure is raised to 3.3 kN plus or minus 0.2 kN and held for 10 s; the liquid expelled around the ram is wiped up with a clean cotton cloth and the towel, still containing immersion liquid, is then removed.

6.6 The specimen is taken out of the immersion liquid, the liquid adhering to its surface is wiped off with the towel saturated with immersion liquid and the mass of the saturated specimen in air is weighed within 30 s to 0.001 g.

6.7 The density of the immersion liquid at the test temperature is determined in accordance with GB/T 22230 to 0.001 g/cm³. Where distilled water is used as the immersion liquid, the density is taken as 1.000 g/cm³ in the range 21 °C to 25 °C.

7 Results and calculation

7.1 The apparent porosity is calculated by Formula (1), whose symbols are: the apparent porosity; the mass of the saturated specimen in air, in grams; the dry mass of the specimen, in grams; and the suspended mass of the saturated specimen in the immersion liquid, in grams.

7.2 The bulk density is calculated by Formula (2), whose symbols are: the bulk density of the specimen, in grams per cubic centimetre; and the density of the immersion liquid at the test temperature, in grams per cubic centimetre; together with the masses defined for Formula (1).

7.3 The range error is calculated by Formula (3), whose symbols are: the error range; the maximum value of the apparent porosity or bulk density; the minimum value; and the mean value, each expressed in grams per cubic centimetre or as a percentage.

7.4 The apparent porosity and bulk density are calculated from the measured data, the highest and the lowest of the test results are discarded and the remaining results are rounded in accordance with GB/T 8170, the result being retained to two decimal places. If the range error of the apparent porosity exceeds 3 %, the test is repeated. If the range error of the bulk density exceeds 3 %, the specimen is made into a rectangular block, a cube or a cylinder, its dimensions are measured with a vernier caliper to within 0.02 mm, its volume is calculated, the specimen volume being not less than 150 cubic centimetres, the number and preparation of specimens following Clause 5, and the bulk density is finally obtained by dividing the dry mass by the specimen volume.

8 Test report

The test report shall contain the following: the name of the test item and the number of the document applied; the name of the testing organisation and the report number; the type