INTERNATIONAL STANDARD

ISO 5016

Shaped insulating refractory products — Determination of bulk density and true porosity

Produits réfractaires isolants façonnés — Détermination de la masse volumique apparente et de la porosité réelle

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 5016 was prepared by Technical Committee ISO/TC 33, *Refractories.*

This second edition cancels and replaces the first edition (ISO 5016:1986), which has been technically revised.

Shaped insulating refractory products — Determination of bulk density and true porosity

1 Scope

This International Standard specifies a method for the determination of the bulk density and true porosity of shaped insulating refractory products.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 5017:—[1], *Dense shaped refractory products — Determination of bulk density, apparent porosity and true porosity.*

ISO 5018:1983, *Refractory materials — Determination of true density.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 bulk density, ρ_b : Ratio of the mass of the dry material of a porous body to its bulk volume.

3.2 bulk volume, V_b : Sum of the volumes of the solid material, the open pores and the closed pores in a porous body.

> NOTE — The roughness of the surface limits the accuracy of definition of the bulk volume and, in consequence, the bulk density. Also, the notion of bulk density becomes less precise when the volume of the sample diminishes below certain limits or when its texture (size of pores and grains) is too coarse.

---

1) To be published. (Revision of ISO 5017:1988)

3.3 true density, ρ_t : Ratio of the mass of the solid material of a porous body to its true volume.

3.4 true volume : Volume of the solid material in a porous body.

3.5 open pores : Those pores that are penetrated by the immersion liquid in the test specified in ISO 5017.

> NOTE — These pores are, in principle, all those that are connected with the atmosphere, either directly or via one another. Here also the roughness of the surface imposes a limit to the accuracy of the definition of the volume of the open pores.

3.6 closed pores : Those pores that are not penetrated by the immersion liquid in the test specified in ISO 5017.

3.7 true porosity, π_t : Ratio of the total volume of the open pores and the closed pores in porous body to its bulk volume.

3.8 shaped insulating product : Shaped product having a true porosity of not less than 45 % (v/v).

4 Principle

The mass of a dry test piece of a specified geometrical form is determined by weighing and the dimensions are measured. From these values and from the true density of the material, (determined by the method specified in ISO 5018, the volume, bulk density and true porosity are determined by calculation.

> NOTE — The method of immersion in a liquid and determination of the mass of the test piece when immersed and when soaked is not suitable for insulating refractory products because of their very open texture, which can lead to serious errors in the determination of the mass of the test piece when soaked.

The precision of the results does not require any correction to be made for the fact that weighing is carried out in air, not in a vacuum.

5 Apparatus

5.1 Callipers, graduated in 0,5 mm, or **flat metal rule**, graduated in 0,5 mm and having a square at one end which can be fitted to the edge of the test piece.

5.2 Drying oven, capable of being controlled at (110 ± 5) °C.

5.3 Balance, with an accuracy of $\pm 0,1$ g.

5.4 Desiccator.

6 Test pieces

6.1 The number of items (for example, bricks or blocks) to be tested shall be determined by agreement between the interested parties.

6.2 If several items are tested, the same number of test pieces shall be taken from each item, so as to facilitate statistical calculation.

> NOTE — The number of test pieces per item should be the subject of agreement between the interested parties.

6.3 The test pieces shall be rectangular with plane and parallel surfaces. The volume of each test piece shall be not less than 500 cm^3 and no dimension of a test piece shall be less than 50 mm. The faces of each test piece shall be precisely formed to obtain a parallelepiped. For the purposes of this test, the test piece shall be considered to be a parallelepiped if, for each pair of opposite faces, the four measurements made along the centre lines of the faces that separate them do not differ by more than 1,0 mm.

6.4 In the case of insulating bricks that have been finished by sawing, the whole brick may be used as a test piece, provided that the faces are plane and parallel, the parallelism tolerance being as specified in 6.3.

7 Procedure

7.1 Using the callipers or the flat metal rule (5.1), measure the three principal dimensions (length l, breadth b, thickness d) of each test piece to within 0,5 mm. The measurements shall be made at the centre line of each face (i.e. four times for each dimension) and the mean of the four measurements shall be noted for each of the three dimensions.

7.2 Dry the test pieces carefully in the drying oven (5.2), controlled at (110 ± 5) °C, allow to cool to ambient temperature in the desiccator (5.4), and weigh each test piece to the nearest 0,1 g.

7.3 Repeat the drying, cooling and weighing operations until constant mass is reached, i.e. until two successive weighings made before and after at least 2 h in the drying oven do not differ by more than 0,1 %.

7.4 Determine the true density in accordance with ISO 5018.

8 Expression of results

8.1 The bulk volume V_b of the test piece is given, in cubic centimetres, by the equation

$$V_b = lbd$$

where l, b and d are the length, breadth and thickness, respectively, in centimetres, of the test piece.

8.2 The bulk density ρ_b of the test piece is given, in grams per cubic centimetre, by the equation

$$\rho_b = \frac{m}{V_b}$$

where

m is the dry mass, in grams;

V_b is the bulk volume, in cubic centimetres.

8.3 The bulk density shall be expressed in grams per cubic centimetre or in kilograms per cubic metre (by multiplying the result in 8.2 by 10^3). The calculation shall be made to three significant digits.

8.4 The true porosity π_t is given, as a percentage, by the equation

$$\pi_t = \frac{\rho_t - \rho_b}{\rho_t} \times 100\,\%$$

where

ρ_t is the true density of the product, in grams per cubic centimetre, determined in accordance with ISO 5018;

ρ_b is the bulk density, in grams per cubic centimetre (see 8.2).

8.5 The calculation of the true porosity shall be made to the nearest 0,1 %.

9 Test report

The test report shall include the following information:

a) the name of the testing establishment;

b) the date of the test;

c) reference to this International Standard, i.e. "Determined in accordance with ISO 5016";

d) the designation of the material tested (manufacturer, type, batch number);

e) the number of test pieces per item; alternatively a statement that a whole brick was used (see 6.2 and 6.4);

f) the individual values and the mean value of the bulk density and true porosity for each item.