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МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

Dense shaped refractory products — Determination of permanent change in dimensions on heating

Produits réfractaires façonnés denses — Détermination de la variation permanente de dimensions sous l'action de la chaleur

Reference number
ISO 2478 : 1987 (E)

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 2478 was prepared by Technical Committee ISO/TC 33, *Refractories.*

This second edition cancels and replaces the first edition (ISO 2478 : 1973), the principal differences being in the requirements concerning selection, measurement and mounting of test pieces, and the heating schedule applied in the procedure.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Dense shaped refractory products — Determination of permanent change in dimensions on heating

1 Scope and field of application

This International Standard specifies two methods for determining the permanent change in dimensions of a dense shaped refractory product. It does not apply to products containing carbon.

2 References

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

ISO 5022, *Shaped refractory products — Sampling and acceptance testing.*

3 Definitions

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

3.1 permanent change in dimensions on heating : The expansion or contraction that remains in a shaped refractory product that is heated to a specified temperature for a specified time and then cooled to ambient temperature.

3.2 dense shaped refractory product : A refractory product having a true porosity of less than 45 % (V/V) when measured in accordance with ISO 5017.

4 Principle

Test pieces in the shape of rectangular prisms or cylinders are cut from each brick or item, then dried, and their linear dimensions (Method 1) or volume (Method 2) measured. The test pieces are heated in a furnace having an oxidizing atmosphere at a prescribed rate to a specified temperature, which is maintained for a specified time. After cooling to ambient temperature, the measurements on the test pieces are repeated, and the permanent change in dimensions or volume is calculated.

5 Apparatus

5.1 Furnace, either electric or gas-fired, capable of heating the test pieces described in 6.2, in a continuously oxidizing atmosphere, at the specified rate (see 7.6), and of maintaining the test temperature for the required time.

NOTE — The use of an electric furnace is recommended, but a gas-fired furnace may be used provided that the furnace atmosphere is continuously oxidizing and there is provision for monitoring this condition.

5.2 Thermocouples, a minimum of three, to measure the temperature and the temperature distribution over the space occupied by the test pieces.

5.3 Temperature/time registration device, for use in conjunction with the thermocouples (5.2), so that a continuous record of the temperature is obtained.

5.4 Length-measuring device (for Method 1), which shall preferably be a dial-gauge apparatus consisting of a dial-gauge or micrometer with an accuracy of 0,01 mm, mounted on a stand which has a surface-ground base plate (figure 1), and a test piece carrier, as shown in figure 2, with three studs to support the test piece and two pins to locate it. The dimensions of the locating pins shall be as shown in figure 2. The undersurface of the carrier shall be ground flat. A diagonal mark shall be inscribed at one corner to enable a rectangular test piece to be placed symmetrically on the studs. A cylinder of known length shall be used to calibrate the device.

The carrier shall be used to support and locate the test piece so that measurements with the dial-gauge or micrometer before and after firing are made at the same points on the test piece surface.

5.5 Volume-measuring device (for Method 2), of the water-displacement type, the bulk volume being determined in accordance with the method specified in ISO 5017.

1) At present at the stage of draft.

5.6 Drying oven, which shall be fan-assisted and shall have openings which permit efficient ventilation.

6 Test pieces

6.1 Sampling

The number of items (e.g. bricks) to be tested shall be determined in accordance with a sampling plan, e.g. ISO 5022, agreed to by the interested parties.

6.2 Preparation of test pieces

One test piece shall be taken from each item (see note 1). Test pieces shall be in the form of either

a) rectangular prisms, 50 mm × 50 mm × 60 ± 2 mm, or

b) cylinders, 50 mm diameter and 60 ± 2 mm long.

NOTES

1 Where the size of the item permits, more than one test piece may be taken, although one is preferred.

2 The 60 mm dimension should coincide with the direction of the forming pressure during manufacture if this direction is known.

The position of each test piece in the brick shall be recorded. The 50 mm × 50 mm faces of the prism, or the ends of the cylinder, shall be ground plane and parallel before the test. Each test piece shall be identified by appropriate marking.

7 Procedure

7.1 Drying of the test pieces

Dry each test piece in the drying oven (5.6) at 110 ± 5 °C to constant mass.

7.2 Measurement of test pieces

7.2.1 Linear measurement (Method 1)

Calibrate the length-measuring device (5.4) using the cylinder of known length. Place the test piece on the carrier, with the 60 mm dimension vertical. For rectangular test pieces, align one corner with the diagonal mark on the carrier, and mark this corner so that the test piece may be placed in the same position for measurement after firing. Mark cylindrical test pieces adjacent to the diagonal mark.

Measure the length of the test piece in four positions, to an accuracy of 0,01 mm, by moving the carrier with the test piece over the base plate. For rectangular test pieces, the four positions are located on the diagonals, 20 to 25 mm from each corner. For cylindrical test pieces, the positions are 10 to 15 mm from the perimeter, on two diameters at right angles.

Record each measuring point.

7.2.2 Volume measurement (Method 2)

Determine the bulk density of the test piece in accordance with ISO 5017.

Calculate the bulk volume, V_B, in cubic centimetres, from the measurements taken, using the following equation :

$$V_B = \frac{m_2 - m_1}{\varrho}$$

where

m_1 is the apparent mass, in grams, of the immersed test piece;

m_2 is the mass, in grams, of the soaked test piece;

ϱ is the density, in grams per cubic centimetre, of the immersion liquid.

7.3 Mounting of test pieces in the furnace

Place the test pieces in the furnace (5.1), each one resting on one of its 50 mm × 50 mm faces (for prisms) or on end (for cylinders), and protected from direct radiation in an electrically heated furnace or from the flame of the gas burner in a gas-fired furnace. Do not superimpose test pieces one on another. To allow free circulation of the hot gases, the test pieces shall be separated from each other by a distance of not less than 20 mm, and shall be not nearer than 50 mm to the walls of the furnace.

The test pieces shall be placed in the furnace on bricks, 30 to 65 mm thick, of the same material as the test pieces, laid flat on the apices of two supports of triangular cross-section, 20 to 50 mm in height and about 80 mm apart.

7.4 Test temperature

The test temperature shall be 800 °C or a higher temperature in multiples of 50 °C.

7.5 Temperature measurement and distribution

Using at least three thermocouples placed away from the walls of the furnace, away from the heaters and so as not to be in contact with any flames, measure and record the temperature distribution over the limits of the space occupied by the test pieces. The variation in temperature shown between the thermocouples shall not be greater than 20 °C.

7.6 Heating

Raise the temperature in the furnace at one of the following rates :

a) for test temperatures up to 1 250 °C :

— from ambient temperature up to 50 °C below the test temperature : between 5 and 10 °C/min;

— for the last 50 °C : between 1 and 5 °C/min.

b) for test temperatures above 1 250 °C :

— from ambient temperature up to 1 200 °C : between 5 and 10 °C/min;

— from 1 200 °C up to 50 °C below the test temperature : between 2 and 5 °C/min;

— for the last 50 °C : between 1 and 5 °C/min.

NOTE — For the last 50 °C, rates of temperature increase between 1 and 2 °C/min are preferred.

7.7 Maintenance of test temperature

Maintain the temperature recorded on each of the three thermocouples (5.2) to within ± 10 °C of the test temperature for a period of 5 h. Record the mean of these three temperatures as the actual test temperature.

NOTE — If required, further tests may be carried out for periods of 12 h or 24 h.

7.8 Sampling of furnace atmosphere

Sample the atmosphere of gas-fired furnaces in the vicinity of the test pieces at some time during the heating period specified in 7.7, and determine its oxygen content.

7.9 Cooling

Switch off the furnace and allow it to cool at its natural rate, the test pieces being allowed to cool in the furnace.

7.10 Measurement of test pieces after firing

7.10.1 Linear measurement (Method 1)

Examine the test pieces, noting particularly any blisters or accretions produced during firing. If any of the measurement points might be affected by such a defect, measure instead at the nearest point unaffected. If necessary, rotate the test piece to avoid contact between defects and any of the three supports of the measuring device.

Subject to these restrictions, measure the length of the test piece at each of the four positions specified in 7.2.1.

7.10.2 Volume measurement (Method 2)

Measure the volume of the test piece by the same method as used in 7.2.2.

8 Expression of results

Express the permanent change in dimensions either as the change in length (Method 1) or as the change in volume (Method 2). Calculate the change in the relevant quantity, ΔL or ΔV, as a percentage of the original value L_o or V_o, i.e. $100\ \Delta L/L_o$ or $100\ \Delta V/V_o$. For Method 1, calculate the change in length for each measuring point.

Report increases in length or volume as positive (+), and decreases as negative (−).

Report the individual values calculated for each test piece, together with the mean value.

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) a reference to this International Standard, i.e. "Determination of permanent change of dimensions on heating [by Method 1 or Method 2] in accordance with ISO 2478";

d) description of the material tested (manufacturer and type, batch number, etc.);

e) the number of items tested (see 6.1);

f) the number of test pieces per item or brick;

g) the dimensions of the test pieces and their positions in the brick (see 6.2);

h) if appropriate, the type of length-measuring device used;

i) the type of furnace used (see 5.1);

j) the oxygen content of the furnace atmosphere, if required (see 7.8);

k) the heating schedule used (see 7.6);

l) the nominal test temperature (see 7.4);

m) the actual mean temperature (see 7.7);

n) the period at the actual mean temperature (see 7.7);

o) the appearance of the test pieces after heating (see 7.10.1);

p) the individual values and the mean value of the percentage linear or volume change (and whether positive or negative) for each test piece and each item.

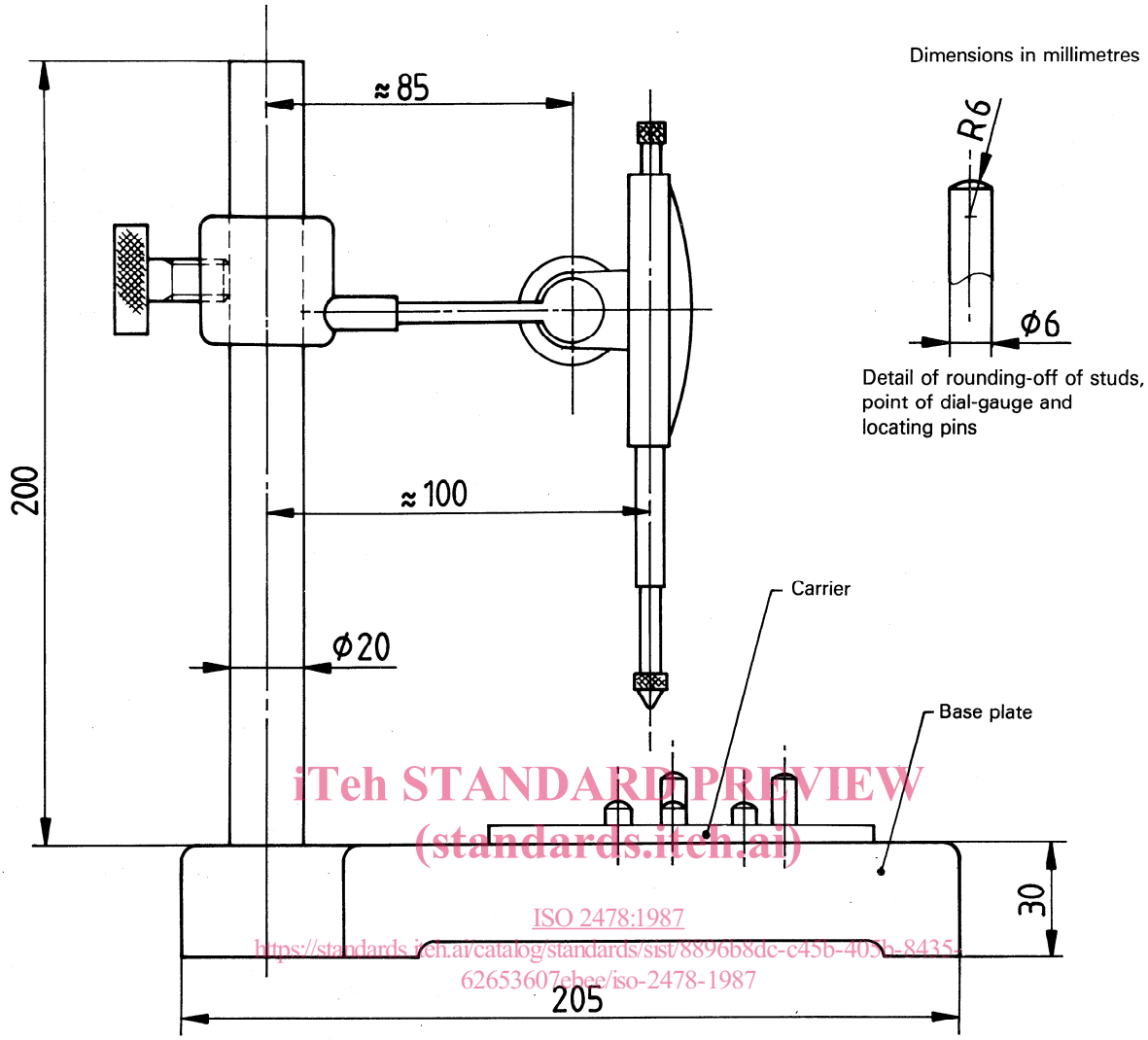

Figure 1 — Length-measuring device

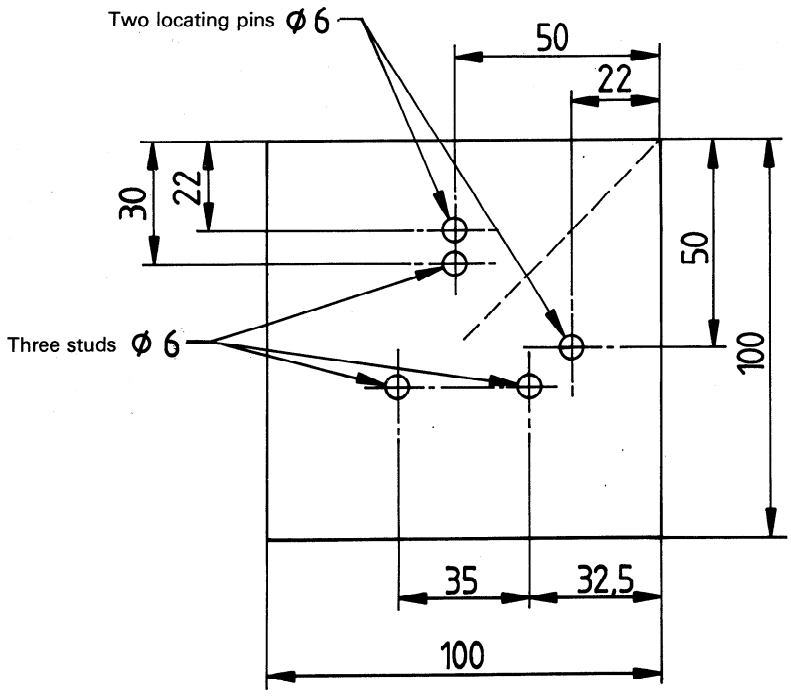

Figure 2 — Test piece carrier

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