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Shaped insulating refractory products — Determination of permanent change in dimensions on heating

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

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Reference number
ISO 2477:1987 (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 2477 was prepared by Technical Committee ISO/TC 33, *Refractories*.

This second edition cancels and replaces the first edition (ISO 2477:1973), the principal differences being in the requirements concerning selection, size 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.

Shaped insulating refractory products — Determination of permanent change in dimensions on heating

1 Scope and field of application

This International Standard specifies a method for determining the permanent change in dimensions on heating of a shaped insulating refractory product.

2 References

ISO 5016, *Shaped insulating refractory products — Determination of bulk density and true porosity*.

ISO 5019-1, *Refractory bricks — Dimensions — Part 1 : Rectangular bricks*.

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 insulating refractory product : A refractory product having a true porosity greater than 45 % (V/V) when measured in accordance with ISO 5016.

4 Principle

Test pieces in the shape of rectangular prisms are cut from each brick, or item, then dried and the distance between two opposite faces on each test piece is 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

test pieces are measured again, and the permanent change in dimensions 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 instrument enabling measurements to be made of the distance between opposite faces of the test pieces to an accuracy of 0,1 mm, e.g. a Vernier caliper or a dial-gauge comparator.

5.5 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

6.2.1 One test piece, comprising a rectangular prism having dimensions 100 mm × 114 mm × 76 mm or 100 mm × 114 mm × 64 mm, shall be cut from each item.

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

6.2.2 If, owing to the size of the item, a test piece cannot be cut having the dimensions specified in 6.2.1, a rectangular test prism shall be obtained by cutting a 100 mm length from the item, and the width and thickness of the test piece shall be measured and recorded.

NOTE — Standard rectangular bricks in accordance with ISO 5019-1 have a width of 114 mm and a thickness of 76 mm or 64 mm.

6.2.3 The two opposite faces of the test piece (100 mm apart) shall be plane and parallel before the test.

7 Procedure

7.1 Drying of the test pieces

Dry each test piece in the drying oven (5.5) at 110 ± 5 °C to constant mass.

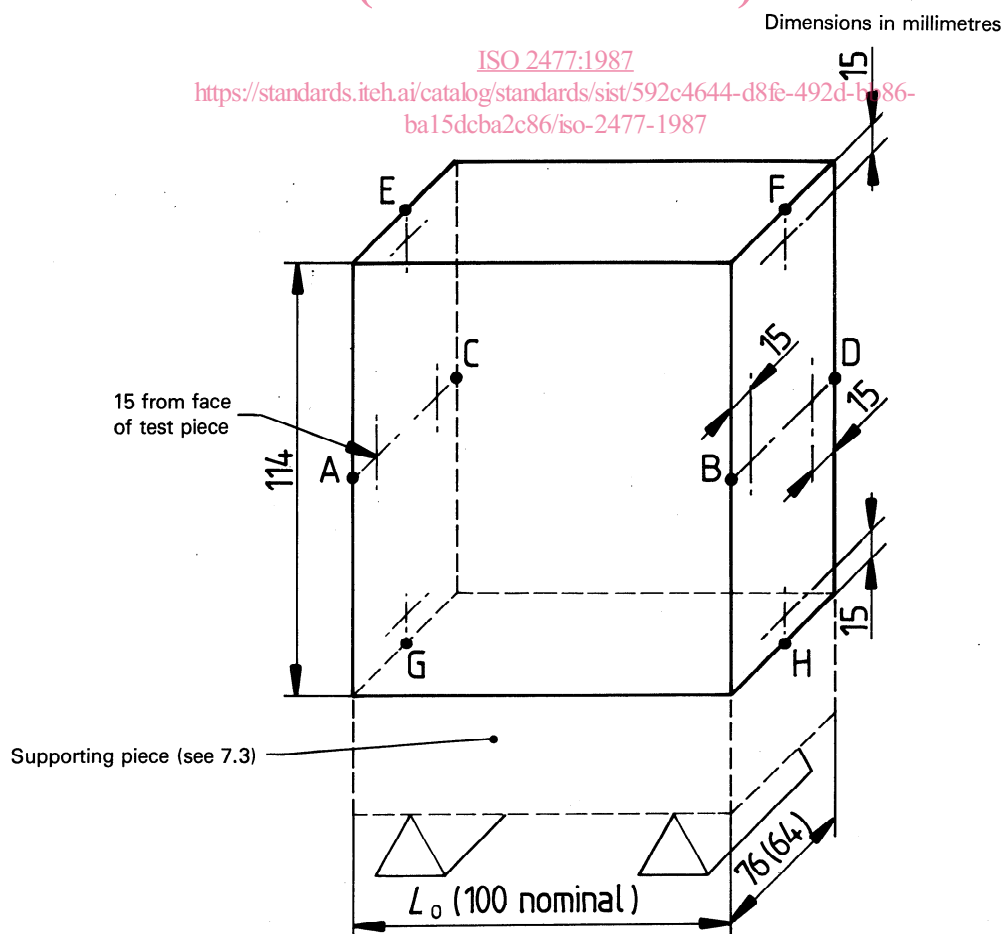
7.2 Measurement of test pieces

Make four measurements on each test piece, to the nearest 0,2 mm, of the distance, L_o , between the two opposite faces nominally 100 mm apart. Make two of these measurements parallel to the centrelines (EF and GH in the figure) of the top and bottom faces of the test pieces, 15 mm in from the edges of those faces, and two parallel to the centrelines (AB and CD) of the front and rear faces of the test piece, 15 mm in from the edges of those faces. Mark the positions of measurement with refractory paint.

7.3 Mounting of test pieces in the furnace

Place the test pieces in the furnace (5.1), each one resting on a 100 mm × 76 mm (or 100 mm × 64 mm) face 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 50 mm, and shall be not nearer than 70 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, as shown in the figure.



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 12 h. Record the mean of these three temperatures as the actual test temperature.

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

Record the appearance of the test pieces. Measure the distance between the two opposite faces of each test piece as described in 7.2.

8 Expression of results

Express the permanent change in dimensions as the change in dimension of the brick, ΔL , calculated as a percentage of the original length, L_0 , i.e. $100 \Delta L/L_0$. Calculate the change at each of the four positions of measurement.

Report increases in length 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 in accordance with ISO 2477";
- 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 (see 6.1);
- g) the dimensions of the test pieces and their positions in the brick (see 6.2);
- h) the type of furnace used (see 5.1);
- i) the oxygen content of the furnace atmosphere, if required (see 7.8);
- j) the heating schedule used (see 7.6);
- k) the nominal test temperature (see 7.4);
- l) the actual mean temperature (see 7.7);
- m) the period at the actual mean temperature (see 7.7);
- n) the appearance of the test pieces after heating (see 7.10);
- o) the individual values and the mean value of the percentage linear change (and whether positive or negative) for each test piece and each item.

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