SLOVENSKI STANDARD
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Metode za preskušanje gostih oblikovanih ognjevzdržnih izdelkov - 8. del: Ugotavljanje ognjevzdržnosti pod obremenitvijo

Methods of testing dense shaped refractory products - Part 8: Determination of refractoriness-under-load

Prüfverfahren für dichte geformte feuerfeste Erzeugnisse - Teil 8: Bestimmung des Erweicherungsverhaltens unter Druck

Méthodes d'essai pour produits réfractaires façonnés denses - Partie 8: Détermination de l'affaissement sous charge

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English version

Methods of testing dense shaped refractory products - Part 8: Determination of refractoriness-under-load

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CEN

European Committee for Standardization
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Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 187 "Refractory products and materials", the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 1997, and conflicting national standards shall be withdrawn at the latest by November 1997

It is closely based on the corresponding International Standard, ISO 1893,'Shaped refractory products - Determination of refractoriness-under-load, published by the International Organization for Standardization (ISO).

Reproducibility and repeatability data are not available at present but may be included in a subsequent edition.

EN 993 'Methods of test for dense shaped refractory products' consists of 18 Parts:

Part 1 : Determination of bulk density, apparent porosity and true porosity
Part 2 : Determination of true density
Part 3 : Test methods for carbon-containing refractories
Part 4 : Determination of permeability to gases
Part 5 : Determination of cold crushing strength
Part 6 : Determination of modulus of rupture at ambient temperature
Part 7 : Determination of modulus of rupture at elevated temperatures
Part 8 : Determination of refractoriness-under-load
Part 9 : Determination of creep in compression
Part 10 : Determination of permanent change in dimensions on heating
Part 11 : Determination of resistance to thermal shock (ENV)
Part 12 : Determination of pyrometric cone equivalent
Part 13 : Specification for pyrometric cones
Part 14 : Determination of thermal conductivity (hot wire, cross-array)
Part 15 : Determination of thermal conductivity (hot wire, parallel)
Part 16 : Determination of resistance to acids
Part 17 : Determination of bulk density of granular material (mercury method)
Part 18 : Determination of bulk density of granular material (water method)

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies a method for determining the deformation of dense and insulating shaped refractory products subjected to a constant load under conditions of progressively rising temperature (or refractoriness under load) by a differential method, with rising temperature. The test may be carried out up to a maximum temperature of 1700 °C.

2 Normative references

This European Standard incorporates by dated or undated references, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 993-9 : Methods of test for dense shaped refractory products - Part 9 : Determination of creep in compression

EN 60584-1 : Thermocouples - Part 1: References tables

EN 6058-2 : Thermocouples - Part 2 : Tolerances

ISO 3599 : Vernier calipers reading to 0,1 mm and 0,05 mm.

3 Definitions

For the purposes of this European Standard, the following definition applies :

3.1 refractoriness-under-load: A particular measure of the behaviour of a refractory material subjected to the combined effects of load, rising temperature and time.

4 Principle

A cylindrical test piece is subjected to a specified constant compressive load and heated at a specified rate of temperature increase until a prescribed deformation or subsidence occurs. The deformation of the test piece is recorded as the temperature increase, and the temperatures corresponding to specified proportional degrees of deformation are determined.

5 Apparatus

5.1 Loading device

5..1.1 General

The loading device shall be capable of applying a load centred on the common axis of the loading column, the test piece and the supporting column, and directed vertically along this axis at all stages of the test. The loading device consists of the items given in 5.1.2 to 5.1.5.

A constant compressive load is applied in a downward direction from above the test piece resting directly or indirectly on a fixed base. The deformation of the test piece is measured by a device that passes either through the applied load or through an intermediate base.

The text and figures 1 and 2 show the measuring device passing through the base but, by interchanging the bored column and refractory plate with the unbored column and plate, the measuring device may pass through the load, as in figure 3.

NOTE : Although both arrangements are within the scope of the standard, it is preferable that the measuring device should be positioned below the assembly, as shown in the figures. The reasons for this are outlined in annex A.

5.1.2 Fixed column, at least 45 mm in overall diameter and with an axial bore (see 5.1.5).

5.1.3 Moving column, at least 45 mm in overall diameter.

NOTE : Arrangements can be made for the upper moving column to be fixed to the furnace, and the combination of furnace and column then forms the moveable loading device.

5.1.4 Two discs, 5 mm to 10 mm thick, at least 50,5 mm in diameter and not less than the actual diameter of the test pieces, which shall be of an appropriate refractory material compatible with the material under test.

NOTE : For example, high fired mullite or alumina for alumino-silicate products, and magnesia or spinel for basic products.

These discs are placed between the test piece and the fixed and moving columns. The disc placed between the test piece and the fixed column shall have a central bore (see 5.1.5). The ends of the fixed and moving columns shall be plane and perpendicular on their axes; the face of each disc shall be plane and parallel.

If chemical reaction is expected between discs and test piece, a platinum or platinum/rhodium foil (0,2 mm thickness) shall be placed between them.

5.1.5 The arrangement of the two columns, the two discs, the platinum sheet if used, and the test piece is shown in figure 2, which also shows typical diameters of the bores in the fixed column and the disc between then.

5.1.6 The columns and the discs shall be capable of withstanding the applied load up to the final test temperature without significant deformation. There should be no reaction between the discs and the loading system.

NOTE : The material from which the discs are made should have a T_1 value greater than or equal to the temperature at which the test material has a T_6 value (see 8.5).

5.2 Furnace (preferably with a vertical axis), capable of raising the temperature of the test piece to the final test temperature at the specified rate (see 7.3) in an atmosphere of air. The temperature of the region of the furnace occupied by the test piece, when at a stable temperature above 500 °C, shall be uniform around the test piece (12,5 mm above and below) to within ± 20 K; this shall be verified by carrying out tests using the thermocouples located at different points on the curved surface of the test piece.

NOTE : The furnace design should be such that the whole of the column assembly can be easily reached, either by movement of the supporting column or, if access into the furnace is restricted, by movement of the furnace itself. The assembly should be such that the test piece and loading column stand vertically and co-axial with the support column when unrestrained.

5.3 Measuring device, consisting of the following items:

5.3.1 Outer alumina tube, placed inside the fixed column to abut on the lower side of the lower disc, and free to move within the fixed column (see 5.3.3).

5.3.2 Inner alumina tube, placed inside the outer alumina tube and passing through the bores in the lower disc and in the test piece to abut on the lower face of the upper disc, and free to move within the outer alumina tube, the lower disc and the test piece (see 5.3.3).

The alumina tubes shall be capable of withstanding the load imposed on them by the measuring instrument at all temperatures up to the final test temperature without significant distortion.

5.3.3 The arrangements of the two tubes, the two discs and test pieces as shown in figure 2, which also indicates typical external and internal diameters of the outer and inner alumina tubes.

5.3.4 Appropriate measuring instrument (for example a dial-gauge or length transducer connected to an automatic recording system), fixed to the end of the outer tube (see 5.3.1) and actuated by the inner tube (see 5.3.2). The sensitivity of the measuring device shall be at least 0,005 mm.

5.4 Temperature-measurement devices

5.4.1 Central thermocouple, passing through the inner alumina tube (see 5.3.2) of the dilatometer, with its junction at the mid-point of the test piece, for measuring the temperature of the test piece at its geometric centre.

5.4.2 Control thermocouple, which shall be placed in a sheath and situated outside the test piece (see figure 1), for regulating the rate of rise of temperature.

> NOTE 1 : For certain furnace constructions, it may be advisable to place the thermocouple nearer to the heating elements.

The thermocouples (see 5.4.1 and 5.4.2) shall be made from platinum and/or platinum-rhodium wire, and shall be compatible with the final test temperature. They shall be in accordance with EN 60584-1 and EN 60584-2. The accuracy of the thermocouples shall be checked on a regular basis.

> NOTE 2 : The thermocouple may be connected to a continuous recording device which may form part of a temperature/displacement recording system. In this case calibration of the instrumentation should be carried out regularly.

5.5 Vernier calipers, to measure to 0,1 mm, in accordance with ISO 3599.

6 Test pieces

6.1 The test piece shall be a cylinder 50 mm ± 0,5 mm in diameter and 50 mm ± 0,5 mm in height, with a hole from 12 mm to 13 mm in diameter, extending throughout the height of the test piece, bored co-axially with the outer cylindrical surface.

> NOTE : The axis of the test piece should preferably be in the direction in which the product was pressed.

6.2 The top and bottom faces of the test piece shall be made plane and parallel by sawing (and grinding, if necessary), and shall be perpendicular to the axis of the cylinder. All surfaces of the cylinder shall be free from visible defects. Measurements of the height at any two points, using Vernier callipers (see 5.5) shall not differ by more than 0,2 mm. When one face of the test piece is placed on a plane surface and a set square also in contact with the surface is brought into contact with any part of the periphery of the test piece, the gap between the side of the test piece and the square shall not exceed 0,5 mm.

6.3 To ensure that the top and bottom ends of the test piece are flat over their entire surface, each end shall in turn be pressed on to a levelling plate which is lined with carbon paper and hard filter paper (0,15 mm in thickness). As an alternative to carbon paper, the ends of the test piece may be inked using a stamp pad. Test pieces that do not show two complete, clearly visible coloured impressions shall be re-ground.

> NOTE : The flatness of the surface may also be controlled with a straightedge.