SLOVENSKI STANDARD
SIST EN 993-19:2004

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Metode preskušanja gostih oblikovanih ognjevzdržnih izdelkov - 19. del: Ugotavljanje toplotnega raztezka z metodo razlikovanja

Methods of test for dense shaped refractory products - Part 19: Determination of thermal expansion by a differential method

Prüfverfahren für dichte geformte feuerfeste Erzeugnisse - Teil 19: Bestimmung der Wärmeausdehnung nach einem Differentialverfahren

Méthodes d'essai des produits réfractaires denses façonnés - Partie 19: Détermination de la dilatation thermique

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ICS:

81.080	Ognjevzdržni materiali	Refractories

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This European Standard was approved by CEN on 24 March 2004.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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Foreword

This document (EN 993-19:2004) 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of an identical text or by endorsement, at the latest by November 2004, and conflicting national standards shall be withdrawn at the latest by November 2004.

This document includes a Bibliography.

EN 993 with the general title “*Methods of test for dense shaped refractory products*” consists of 20 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[1]

Part 12: Determination of pyrometric cone equivalent (refractoriness)

Part 13: Specification for pyrometric reference cones for laboratory use

Part 14: Determination of thermal conductivity by the hot-wire (cross-array) method

Part 15: Determination of thermal conductivity by the hot-wire (parallel) method

Part 16: Determination of resistance to sulphuric acid

Part 17: Determination of bulk density of granular materials by the mercury method with vacuum

Part 18: Determination of bulk density of granular materials by the water method with vacuum

Part 19: Determination of thermal expansion by a differential method

Part 20: Determination of resistance to abrasion at ambient temperature

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

[1] Published as a TS with the general title *“Dense shaped refractory products”*

1 Scope

This European Standard describes a method for determining the thermal expansion of dense shaped refractory products under rising temperature by a differential method.

NOTE The test can be carried out up to a maximum temperature of 1 700 °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 (including amendments).

EN 60584-1, *Thermocouples — Part 1: Reference tables (IEC 60584-1:1995).*

EN 60584-2, *Thermocouples — Part 2: Tolerances (IEC 60584-2:1982+A1:1989).*

ISO 3611, *Micrometer callipers for external measurement.*

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

3.1
thermal expansion
uniaxial extension which occurs when a material is heated under contact load

3.2
contact load
total constant compressive load applied to the test piece during the performance of the test

4 Principle

A cylindrical test piece is subjected to a defined compressive contact load and heated in air at a specified uniform rate of temperature increase. Its change in height and temperature are recorded and the percentage change in height is evaluated as a function of temperature.

NOTE If the test is applied to material liable to oxidation, the results may be influenced.

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 contact stress of 0,01 MPa is applied in a downward direction from above the test piece resting directly or indirectly on a fixed base. The change in height of the test piece is measured by a device that passes either through the applied load or through an intermediate base. The contact load shall not vary by more than ± 1 N.

5.1.2 Fixed column

The fixed column shall be at least 45 mm in overall diameter and with an axial bore (see 5.1.5).

5.1.3 Moving column

The moving column shall be 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. In this case, a counter balancing weight will be necessary to achieve the required contact stress.

5.1.4 Two discs

Two discs shall be 5 mm to 10 mm thick, at least 50,5 mm in diameter and not less than the actual diameter of the test pieces. The discs 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 column 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 Arrangement of the apparatus

The arrangement of the two columns, the two discs, the platinum sheet, if used, and the test piece is shown in Figure 1, which also shows typical diameters of the bores in the fixed column and the disc between them.

5.1.6 Applying the load

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_5 value. T_1 and T_5 correspond to temperatures for which the deformation values measured according to EN 993-8 are respectively 1 % and 5 %.

5.2 Furnace

The furnace (preferably with a vertical axis) shall be capable of raising the temperature of the test piece to the final test temperature at the specified rate (see clause 7) 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 ± 10 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 reached easily, 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.

Key
NOTE Typical dimensions, in mm, marked*

1 Moving column (see 5.1.3)
ϕ ext. 45 min.*
2 Upper disc (see 5.1.4)
3 Pt-Rh sheet
Φ ext. 50,5*
Φ int.: 12
4 Test piece
Φ ext.: 50 ± 0,5
Φ int.: 12 min., 13 max.
5 Pt-Rh sheet
Φ ext.: 50,5*
Φ int.: 10*
6 Lower disc (see 5.1.4)
Φ ext.: 50,5 mm
Φ int.: 10*
7 Fixed column (see 5.1.2)
Φ ext.: 45 mm
Φ int.: 20 mm.
8 Outer alumina tube (see 5.3.a)
Φ ext.: 15*
Φ int: 10 Φ ext. : 50,5 mm.
9 Central thermocouple (see 5.4.1)
10 Inner alumina tube (see 5.3.b)
Φ ext.: 8*.
Φ int.: 5*

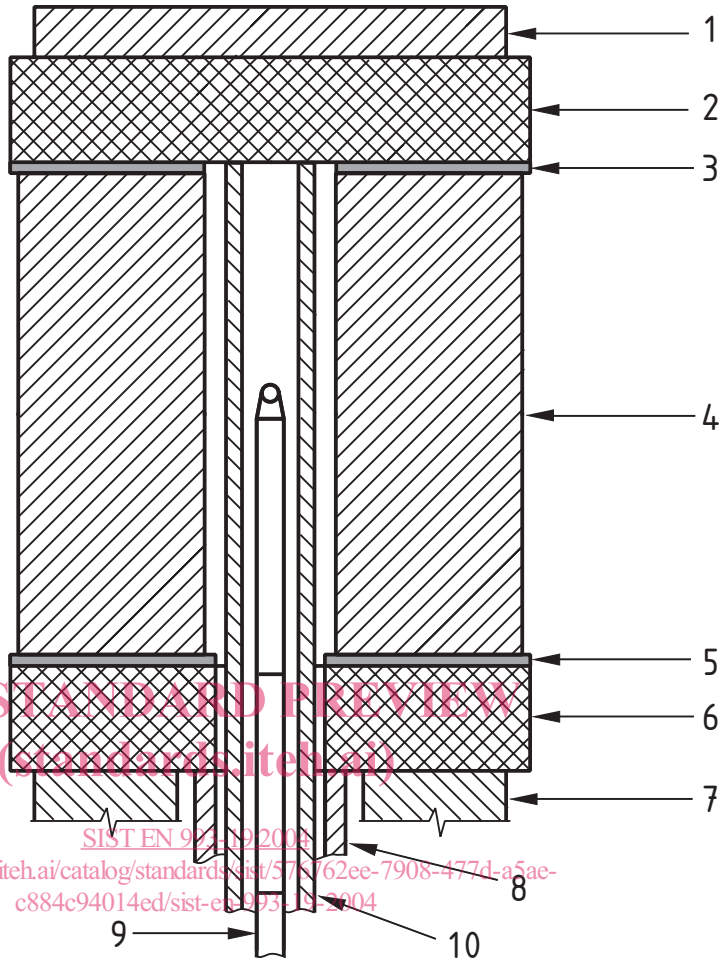


Figure 1 — Example for an arrangement of test piece, columns, discs and tubes

5.3 Measuring device

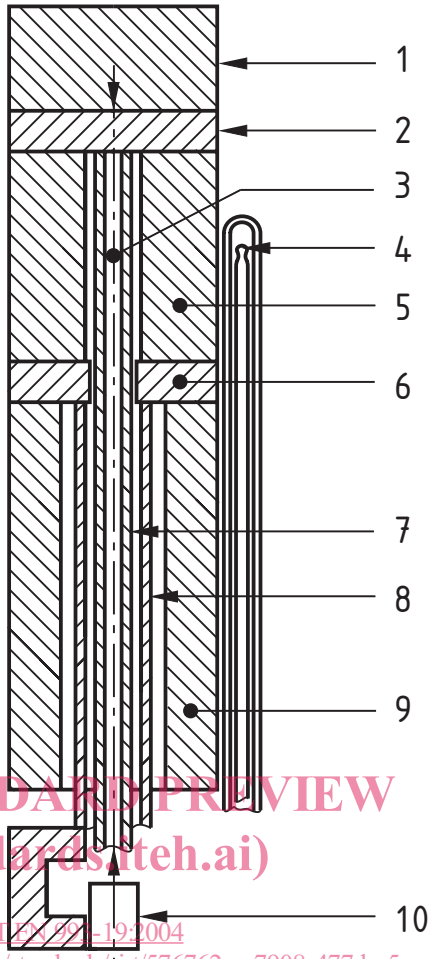
The measuring device shall preferably be placed below the test piece, (see Figures 1 and 2), consisting of the following items.

a) 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 c)).

b) 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 c)). 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.

c) The arrangements of the two tubes, the two discs and test pieces are as shown in Figure 1, which also indicates typical external and internal diameters of the outer and inner alumina tubes.

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



Key

1 Moving column (see 5.1.3)
2 Disc (see 5.1.4)
3 Position of central thermocouple (see 5.4.1)
4 Control thermocouple (see 5.4.2)
5 Test piece (see clause 6)
6 Disc (see 5.1.4)
7 Inner alumina tube (see 5.3.b)
8 Outer alumina tube (see 5.3.a)
9 Fixed column (see 5.1.2)
10 Measuring instrument (see 5.3.d)

Figure 2 — Test apparatus

5.4 Temperature measurement devices

5.4.1 Central thermocouple, passing through the inner alumina tube (see 5.3) 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 2), for regulating the rate of rise of temperature.

NOTE 1 For certain furnace constructions, it may 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 central thermocouple can 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 Callipers

Callipers shall be capable of measuring to 0,1 mm, in accordance with ISO 3611.