



**SLOVENSKI STANDARD**  
**SIST EN 993-10:2020**

**01-december-2020**

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**Metode za preskušanje gostih oblikovanih ognjevdržnih izdelkov - 10. del:  
Ugotavljanje trajnih sprememb mer pri segrevanju**

Methods of test for dense shaped refractory products - Part 10: Determination of permanent change in dimensions on heating

Prüfverfahren für dichte geformte feuerfeste Erzeugnisse - Teil 10: Bestimmung der bleibenden Längenänderung nach Temperatureinwirkung

Méthodes d'essai pour produits réfractaires façonnés denses - Partie 10: Détermination de la variation permanente de dimensions sous l'action de la chaleur

**Ta slovenski standard je istoveten z: EN 993-10:2020**

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EUROPEAN STANDARD

EN 993-10

NORME EUROPÉENNE

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ICS 81.080

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English Version

## Methods of test for dense shaped refractory products - Part 10: Determination of permanent change in dimensions on heating

Méthodes d'essai pour produits réfractaires façonnés  
denses - Partie 10: Détermination de la variation  
permanente de dimensions sous l'action de la chaleur

Prüfverfahren für dichte geformte feuerfeste  
Erzeugnisse - Teil 10: Bestimmung der bleibenden  
Längenänderung nach Temperatureinwirkung

This European Standard was approved by CEN on 1 September 2020.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

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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 CEN-CENELEC Management Centre has the same status as the official versions.

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COMITÉ EUROPÉEN DE NORMALISATION  
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## European foreword

This document (EN 993-10:2020) 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 April 2021, and conflicting national standards shall be withdrawn at the latest by April 2021.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 993-10:1997.

The main change from the previous edition is the addition of precision data in clause 10 derived from a large scale interlaboratory study completed by 10 European laboratories.

Reproducibility and repeatability data are available only for a limited number of testing methods and materials, but may be complemented in subsequent editions.

The series of standards EN 993 'Methods of test for dense shaped refractory products' consists of 20 parts, some of which have been withdrawn and replaced by equivalent standards:

- Part 1: Determination of bulk density and 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 rupture, ambient temperatures
- Part 7: Determination of modulus of rupture, elevated temperatures
- Part 8: Determination of refractoriness-under-load – withdrawn – replaced by EN ISO 1893
- 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) – withdrawn – replaced by EN ISO 8894-1
- 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)
- Part 19: Determination of thermal expansion by a differential method

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— Part 20: Determination of resistance to abrasion at ambient temperature – withdrawn – replaced by *EN ISO 16282*

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

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## 1 Scope

This document specifies three methods for the determination of the permanent change in dimensions on heating of dense shaped refractory products.

NOTE The methods can be applied to materials sensitive to oxidation. However, some of these materials can be affected during the test in such a way as to make the measurement of the dimensional changes impossible to carry out to the required accuracy.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 993-1, *Methods of test for dense shaped refractory products - Part 1: Determination of bulk density, apparent porosity and true porosity*

ISO 13385-1, *Geometrical product specifications (GPS) — Dimensional measuring equipment — Part 1: Design and metrological characteristics of callipers*

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

## 3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

<https://standards.iteh.ai/catalog/standards/sist/fac9d8d-dd81-4912-8a64->

— IEC Electropedia: available at <https://www.electropedia.org/>

### 3.1

#### **permanent change in dimensions on heating**

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

Note 1 to entry: Change is either on the basis of length ( $\Delta L$ ) or volume ( $\Delta V$ ).

[SOURCE: ISO 2477:2005, 3.1]

### 3.2

#### **dense shaped refractory product**

product with specific dimensions, having a true porosity of less than 45 % by volume, when measured in accordance with EN 993-1

### 3.3

#### **sample**

representative collection of items that can be obtained by sampling in accordance with ISO 5022

### 3.4

#### **item**

refractory brick or shape

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## 3.5

**test piece**

piece of material extracted from an item (3.4) and suitably shaped and prepared for the test

## 4 Principle

Test pieces in the shape of rectangular prisms or cylinders are cut from each item, then dried, and their linear dimensions (Methods 1 and 2) or volume (Method 3) 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 Clause 6, in a continuously oxidizing atmosphere, at the specified rate (see 7.6), and of maintaining the test temperature for the required time.

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 (see 5.2), so that a continuous record of the temperature is obtained. Temperature shall be recorded with a minimum accuracy of  $\pm 5$  °C.

**5.4 Length measuring device**

**5.4.1 General**

Two measuring devices may be used, either the dial gauge apparatus (method 1) or callipers (method 2).

**5.4.2 Dial gauge apparatus**, (Method 1), 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 (see Figure 1), and a test piece carrier (see Figure 2), with three studs of equal length  $\pm 0,01$  mm 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 under surface 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.

**5.4.3 Callipers**, (Method 2), in accordance with ISO 13385-1, with a minimum accuracy of  $\pm 0,02$  mm.

**5.5 Volume measuring device**, (Method 3), of the water displacement type, the bulk volume being determined in accordance with the method specified in EN 993-1.

**5.6 Drying chamber**, capable of being controlled at  $(110 \pm 5)$  °C, which shall be fan-assisted and shall have openings which permit efficient ventilation.



## 6 Test pieces

At least four items form a sample. In the case of acceptance testing, the number of items forming the sample to be tested shall be determined according to ISO 5022.

The number of test pieces to be cut from each item is a matter of agreement between the interested parties and shall be stated in the test report (see Clause 9). In order to facilitate statistical analysis, the same number of test pieces shall be cut from each item.

Only one test piece located near the geometrical centre of the item should be taken from each item.

Test pieces shall be in the form of either:

- a) cylinders, 50 mm diameter and 60 mm length;
- b) rectangular prisms, 50 mm × 50 mm × 60 mm.

Tolerances on all dimensions shall be  $\pm 2$  mm.

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

The position of each test piece in the item shall be recorded. The 50 mm x 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 iTeh STANDARD PREVIEW

### 7.1 Drying of the test pieces (standards.iteh.ai)

Dry the test piece in the drying chamber (see 5.6) at  $(110 \pm 5)$  °C to constant mass.

### 7.2 Measurement of test pieces

#### 7.2.1 Linear measurement by dial gauge apparatus (Method 1)

Calibrate the length-measuring device (see 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 the nearest 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, between 20 mm and 25 mm from each corner. For cylindrical test pieces, the positions are 10 mm to 15 mm from the perimeter, on two diameters at right angles.

Record each measuring point.

#### 7.2.2 Linear measurement by Vernier callipers (Method 2)

Measure the length of the test piece using the Vernier callipers (see 5.4.3) to the nearest 0,02 mm. Measure the length at three positions using the measuring points shown in Figure 3. Mark the positions at which the measurements are made, either with refractory paint or by cutting small grooves across the edges of the test pieces (see Figure 3).