



SLOVENSKI STANDARD

SIST EN 993-1:2019

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Nadomešča:
SIST EN 993-1:1998

Metode za preskušanje gostih oblikovanih ognjevzdržnih izdelkov - 1. del: Ugotavljanje prostorninske mase, navidezne poroznosti in prave poroznosti

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

Prüfverfahren für dichte geformte feuerfeste Erzeugnisse - Teil 1: Bestimmung der Rohdichte, offenen Porosität und Gesamtporosität

Méthodes d'essai pour produits réfractaires façonnés denses - Partie 1 : Détermination de la masse volumique apparente, de la porosité ouverte et de la porosité totale

Ta slovenski standard je istoveten z: EN 993-1:2018

ICS:

81.080 Ognjevzdržni materiali Refractories

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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 993-1

December 2018

ICS 81.080

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English Version

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

Méthodes d'essai pour produits réfractaires façonnés
denses - Partie 1 : Détermination de la masse
volumique apparente, de la porosité ouverte et de la
porosité totale

Prüfverfahren für dichte geformte feuerfeste
Erzeugnisse - Teil 1: Bestimmung der Rohdichte,
offenen Porosität und Gesamtporosität

This European Standard was approved by CEN on 5 October 2018.

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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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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

This document (EN 993-1:2018) 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 June 2019, and conflicting national standards shall be withdrawn at the latest by June 2019.

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 993-1:1995.

It is closely based on the corresponding International Standard, ISO 5017 “Dense shaped refractory products - Determination of bulk density, apparent porosity and true porosity”.

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

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)*

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- *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*
- *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, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

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1 Scope

This document specifies a method for the determination of the bulk density, apparent porosity and true porosity of dense shaped refractory products.

NOTE For shaped insulating refractory products, the bulk density and true porosity are determined in accordance with EN 1094-4.

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 993-2, *Methods of test for dense shaped refractory products — Part 2: Determination of true density*

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:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

bulk density

ρ_b

ratio of the mass of the dry material of a porous body to its bulk volume, expressed in grams per cubic centimetre or in kilograms per cubic metre

3.2

bulk volume

V_b

sum of the volumes of the solid material, the open pores and the closed pores in a porous body

Note 1 to entry: The roughness of the surface limits the accuracy of definition of the bulk volume and, in consequence, of the bulk density. Also, the concept of bulk density becomes less precise when the volume of the test piece diminishes below certain limits or when its texture (size of pores and grains) is too coarse.

3.3

true density

ρ_t

ratio of the mass of the solid material of a porous body to its true volume, expressed in grams per cubic centimetre or in kilograms per cubic metre

3.4

true volume

volume of the solid material in a porous body

EN 993-1:2018 (E)**3.5****open pores**

pores that are penetrated by the immersion liquid in the current test

Note 1 to entry: These pores are, in principle, all those that are connected with the atmosphere, either directly or via one another. Here also the roughness of the surface imposes a limit to the accuracy of the definition of the volume of the open pores.

3.6**closed pores**

pores that are not penetrated by the immersion liquid in the current test

3.7**apparent porosity**

π_a
ratio of the total volume of the open pores in a porous body to its bulk volume, expressed as a percentage of the bulk volume

3.8**closed porosity**

π_c
ratio of the total volume of the closed pores in a porous body to its bulk volume, expressed as a percentage of the bulk volume

3.9**true porosity**

π_t
ratio of the total volume of the open and closed pores to the bulk volume of the material, expressed as a percentage

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Note 1 to entry: Consequently, the true porosity is the sum of the apparent porosity and the closed porosity.

3.10**dense shaped refractory product**

product with specific dimensions, having a true porosity of less than 45 % by volume, when measured in accordance with the current test

3.11**sample**

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

3.12**item**

refractory brick or shape

3.13**test piece**

piece of material extracted from an item (3.12) and suitably shaped and prepared for the test

4 Principle

4.1 The following are determined by weighing: the mass of a dry test piece, then its apparent mass when immersed in a liquid with which it has been impregnated under vacuum, and then its mass in air while still soaked with the liquid.

From these values and from the true density of the material, determined by the method specified in EN 993-2, its bulk density, apparent porosity and true porosity are determined by calculation.

4.2 The precision of the results does not require any correction to be made for the fact that weighing are carried out in air, not in a vacuum.

5 Apparatus

5.1 Drying oven, capable of being controlled at (110 ± 5) °C.

5.2 Balance, with an accuracy of $\pm 0,01$ g.

5.3 Bridge, to be placed over the load-bearing scale pan of the balance (see 7.3), if a two-pan balance is used.

5.4 Evacuating equipment, capable of reducing the pressure to a value not greater than 2 500 Pa and a means of measuring the pressure used.

5.5 Thermometer, accurate to ± 1 °C.

5.6 Immersion liquid: For materials that do not react with water, the immersion liquid may be cold distilled water. For materials that are sensitive to contact with water, a suitable organic liquid shall be used.

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NOTE 1 For example, distilled paraffin can be used for hydratable materials.

NOTE 2 The use of paraffin as immersion liquid is often uncomfortable and more expensive. Furthermore, commercial paraffins may show variations in viscosity and density, leading to different degrees of infiltration of the material when tested in different laboratories, which may leads to a higher standard deviation of the testing results between laboratories.

5.7 Desiccator.

5.8 Sponging material, the use of linen cloth or sponging towel is recommended.

NOTE 1 Consistent results have been obtained by keeping for this purpose alone a linen cloth which, having been washed two or three times when new to remove the dressing, is immersed in the immersion liquid and lightly wrung out by hand before each use.

NOTE 2 A chamois leather cloth is not recommended because when it is used, lower reliability in testing results is expected.

6 Test pieces

6.1 At least four items (for example, bricks, shapes, nozzles) 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.

6.2 The number of test pieces to be tested per item shall be agreed between the parties and reported (see Clause 9). If the test pieces are cut out of bricks or blocks, the same number shall be cut from each one, in order to facilitate statistical analysis.