



SLOVENSKI STANDARD
SIST EN 993-11:2008
01-marec-2008

BUXca Yý U.
SIST-TS CEN/TS 993-11:2004

Metode preskušanja gosto oblikovanih ognjevzdržnih izdelkov - 11. del:
Ugotavljanje odpornosti proti hitrim temperaturnim spremembam

Methods of test for dense shaped refractory products - Part 11: Determination of resistance to thermal shock

Prüfverfahren für dichte geformte feuerfeste Erzeugnisse - Teil 11: Bestimmung der Temperaturwechselbeständigkeit

(standards.iteh.ai)

Méthodes d'essai des produits réfractaires façonnés denses - Partie 11 : Détermination de la résistance au choc thermique [SIST EN 993-11:2008](https://standards.iteh.ai/catalog/standards/sist/43380a38-b16e-4c7c-bc4f-02dd64c55fef/sist-en-993-11-2008)

<https://standards.iteh.ai/catalog/standards/sist/43380a38-b16e-4c7c-bc4f-02dd64c55fef/sist-en-993-11-2008>

Ta slovenski standard je istoveten z: EN 993-11:2007

ICS:

81.080

SIST EN 993-11:2008

en,fr,de

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST EN 993-11:2008](https://standards.iteh.ai/catalog/standards/sist/43380a38-b16e-4c7c-bc4f-02dd64c55fef/sist-en-993-11-2008)

<https://standards.iteh.ai/catalog/standards/sist/43380a38-b16e-4c7c-bc4f-02dd64c55fef/sist-en-993-11-2008>

English Version

**Methods of test for dense shaped refractory products - Part 11:
Determination of resistance to thermal shock**

Produits réfractaires façonnés denses - Partie 11:
Détermination de la résistance au choc thermique

Prüfverfahren für dichte geformte feuerfeste Erzeugnisse -
Teil 11: Bestimmung der Temperaturwechselbeständigkeit

This European Standard was approved by CEN on 15 November 2007.

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 Management Centre or to any CEN member.

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 Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

iTeh STANDARD PREVIEW
(standards.iteh.ai)
<https://standards.iteh.ai/catalog/standards/sist/43380a38-b16e-4c7c-bc4f-02dd64c55fef/sist-en-993-11-2008>



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

Management Centre: rue de Stassart, 36 B-1050 Brussels

Contents

Page

Foreword.....	3
Introduction	5
1 Scope	6
2 Normative references	6
3 Terms and definitions	6
4 Principle.....	6
4.1 Method A.....	6
4.2 Method B.....	6
5 Apparatus	7
6 Test pieces	7
6.1 Number of test pieces	7
6.2 Preparation of test pieces	7
7 Procedure	8
7.1 Heating.....	8
7.2 Cooling.....	8
7.3 Measurement.....	8
8 Expression of results	9
8.1 Method A.....	9
8.2 Method B.....	9
9 Test report	9
Bibliography	11

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN 993-11:2008

[https://standards.iteh.ai/catalog/standards/sist/43380a38-b16e-4c7c-bc4f-](https://standards.iteh.ai/catalog/standards/sist/43380a38-b16e-4c7c-bc4f-02dd64c551e7/sist-en-993-11-2008)

[02dd64c551e7/sist-en-993-11-2008](https://standards.iteh.ai/catalog/standards/sist/43380a38-b16e-4c7c-bc4f-02dd64c551e7/sist-en-993-11-2008)

Foreword

This document (EN 993-11:2007) 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 2008, and conflicting national standards shall be withdrawn at the latest by June 2008.

This document supersedes CEN/TS 993-11:2003.

EN 993 '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

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 sulfuric 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, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST EN 993-11:2008](https://standards.iteh.ai/catalog/standards/sist/43380a38-b16e-4c7c-bc4f-02dd64c55fef/sist-en-993-11-2008)

<https://standards.iteh.ai/catalog/standards/sist/43380a38-b16e-4c7c-bc4f-02dd64c55fef/sist-en-993-11-2008>

Introduction

Thermal shock of refractory materials used in furnaces is influenced by three main factors:

- brick dimensions;
- heating/cooling conditions;
- material properties.

Thermal shock tests are usually intended to test material properties. This is done by standardizing brick dimensions and heating conditions through which a relative order of the quality of different types of bricks can be established. However, in case of thermal shock, this can lead to complications in the field of engineering.

The major complication is that, depending on the type of heating conditions, various material properties are involved. This can be best illustrated on the basis of thermal stress parameters, which are a measure for critical crack initiation.

Table 1 — Type of heating condition

Hot face condition	Stress parameter	Example
sudden temperature jump	ε/α	filling of metallurgical vessels
constant heat flow into brick	$\lambda \cdot \varepsilon/\alpha$	Furnace preheating
constant heating rate	$\lambda/(\rho \cdot c_p) \cdot \varepsilon/\alpha$	Controlled preheating
where ε maximum allowable deformation; α coefficient of expansion; λ thermal conductivity; ρ bulk density; c_p specific heat.		

1 Scope

This European Standard describes two alternative methods for determining the resistance to thermal shock of dense shaped refractory materials by an air quenching method, which proved to give the most reliable results when compared with the behaviour of refractories in furnace linings.

Method B can also be applied to unshaped refractory materials.

2 Normative references

The following referenced documents are indispensable for the application 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 993-6, *Methods of test for dense shaped refractory products - Part 6: Determination of modulus of rupture at ambient temperature*

3 Terms and definitions

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

3.1 thermal-shock resistance

resistance of refractory shapes to damage caused by sudden temperature changes between 950 °C and room temperature caused by air blowing

3.2 measure of thermal-shock resistance

for **method A** the number of quench cycles withstood under the test conditions, and for **method B** the residual cold modulus of rupture (MOR) and residual sonic velocity after 5 quench cycles under the conditions of the test

4 Principle

4.1 Method A

The test piece is homogeneously heated to 950 °C in an electric furnace then removed, placed on a steel plate and exposed to blowing air. After quenching, the test piece is subjected to a stress of 0,3 MPa in a bending machine. This cycle is repeated until failure of the test piece occurs.

The resistance to thermal shock is defined by the number of cycles withstood by the test piece before breaking.

4.2 Method B

The test piece is homogeneously heated to 950 °C in an electric furnace then removed, placed on a steel plate and exposed to blowing air. After quenching this is repeated 4 times. After cooling down, the residual cold MOR and the residual sonic velocity are determined.

The resistance to thermal shock is defined by the percentage residual MOR and residual sonic velocity related to the MOR and sonic velocity of non-quenched test pieces.

NOTE Sonic resonance frequency can also be measured but can give different results.

For both method A and method B, other quenching temperatures may be agreed upon by the parties concerned and shall be noted in the test report.

5 Apparatus

- 5.1 Electrically heated furnace**, capable of maintaining a temperature of $950\text{ }^{\circ}\text{C} \pm 25\text{ }^{\circ}\text{C}$.
- 5.2 Thermocouple**, for use at temperatures in excess of $1\ 000\text{ }^{\circ}\text{C}$.
- 5.3 Drying oven**.
- 5.4 Heating cabinet**, for preheating at $250\text{ }^{\circ}\text{C}$ to $300\text{ }^{\circ}\text{C}$.
- 5.5 Blowing device**, with a 8 mm diameter nozzle of 5 mm length.
- 5.6 Equipment** for measuring the cold MOR in accordance with EN 993-6.
- 5.7 Steel plate**, 400 mm x 250 mm x 20 mm, with pins to locate the test piece under the air-blast; depending on the dimensions of the test-piece, the pins are located in such a manner that the air jet blows at the intersection of the diagonals of the test-piece on cooling.
- 5.8 Equipment** for measuring the sonic velocity

NOTE Equipment for measuring the sonic velocity in refractories is commercially available and should be used in accordance with the manufacturers' instructions.

- 5.9 Insulated iron tongs** for handling the test piece after heating

<https://standards.iteh.ai/catalog/standards/sist/43380a38-b16e-4c7c-bc4f-02dd64c55fef/sist-en-993-11-2008>

6 Test pieces

6.1 Number of test pieces

6.1.1 Method A

Unless a different number of test pieces has been agreed upon, one test piece shall be taken from each item.

6.1.2 Method B

Unless a different number of test pieces has been agreed upon, four test pieces shall be used. Two test pieces are used for the determination of the cold MOR before testing, MOR_n . The other two test pieces are used for the thermal shock test. For all four test pieces, determine the sonic velocity, SV_n , axially in length of the test pieces before testing.

6.2 Preparation of test pieces

6.2.1 Shape

For method A the test pieces shall have the dimensions of a quarter-standard brick, i.e. 114 mm x 64 mm x 64 mm.

For method B the test pieces shall have the dimensions of a half-standard brick, i.e. 230 mm x 64 mm x 54 mm.