SLOVENSKI STANDARD
SIST ENV 993-11:1998

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Gosti oblikovani ognjevzdržni izdelki - 11. del: Ugotavljanje odpornosti proti hitrim temperaturnim spremembam

Dense shaped refractory products - Part 11: Determination of resistance to thermal shock

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

Méthodes d'essai des produits réfractaires façonnés denses - Partie 11: Détermination de la résistance au choc thermique

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ICS:

81.080	Ognjevzdržni materiali	Refractories

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English version

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Foreword

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

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

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 sulfuric acid
Part 17 : Determination of bulk density of granular material (mercury method)
Part 18 : Determination of bulk density of granular material (water method)

Introduction

Thermal shock of refractory materials placed in furnaces is influenced by three items:

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

Thermal shock tests usually intend to test material properties. This is done by standardizing brick dimensions and heating conditions. In this way, 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	$\lambda . \varepsilon/\alpha$	furnace preheating
constant heating rate	$\lambda/(\rho . c_p) . \varepsilon/\alpha$	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 Prestandard specifies the method for determining the resistance to thermal shock of dense shaped refractory materials by the air quenching method which proved to give the most reliable results as compared with the behaviour of the refractories placed in furnace linings.

2 Normative Reference

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

EN 993-6 Methods of test for dense shaped refractory products - Determination of modulus of rupture at ambient temperature

3 Definitions

For the purpose of this European Prestandard, the following definitions apply:

3.1 Thermal-shock resistance is the resistance of refractory bricks to damage caused by sudden temperature changes between 950°C and room temperature due to air blowing.

3.2 Measure of thermal-shock resistance is the number of quenchings withstood under the conditions of this test.

4 Principle

The test piece is homogeneously heated to 950 °C in an electric furnace, then removed, placed on a steel plate and exposed to air blowing. 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.
The resistance to thermal shock is defined by the number of cycles withstood by the test piece before breaking.

5 Apparatus

- electrically heated furnace, capable of maintaining a temperature 950°C ± 25 °C
- thermocouple for use for temperatures in excess of 1000 °C
- drying oven
- heating cabinet for preheating at 250 °C to 300 °C
- blowing device with a 8 mm diameter nozzle of 5 mm length
- three point bending device according to EN 993-6
- steel plate of 400 mm x 250 mm x 20 mm with pins to determine the location of the test piece under the blast; according to the dimensions of the test-piece, the pins will be located in such a manner that the air jet blows at the intersection of the diagonals of the test-piece on cooling

6 Test pieces

6.1 Number of test pieces

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

6.2 Preparation of test pieces

6.2.1 Shape

The test pieces shall have the dimensions of a quarter-standard brick, i.e. 114 mm x 64 mm x 64 mm. They shall be sawn or ground from bricks.

NOTE : The use of other shapes may be agreed by the parties, but the results will not be directly comparable with those obtained using the test-pieces stated above.

The test pieces shall be prepared with great care so that the brick texture is not damaged. The location in the bricks from which the test pieces are to be taken shall be agreed upon.

6.2.2 Drying of the test pieces

Dry the test pieces at 110 °C ± 5 °C to constant mass. Constant mass is obtained when the change in mass after two successive periods of one hour drying, is not more than 0,1 %. Protect test pieces from moisture before testing.

7 Procedure

7.1 Heating

7.1.1 Place the test pieces on one of their long faces into a heating cabinet previously heated to between 250 to 300 °C and keep them at this temperature for, at least, four hours.

7.1.2 Put the test pieces into the furnace at 950 °C ± 25 °C. The temperature of the furnace is measured with a thermocouple positioned over the centre of the basal area of the furnace approximately 20 mm above the test pieces. Immediately after the door of the furnace has been closed, the temperature should not be less than 750 °C.

7.1.3 The heat capacity of the furnace shall be sufficient for the temperature to rise again to 950 °C within 15 to 30 min after placing the first test piece into the furnace. After the temperature has risen to 950 °C, the test pieces shall remain in the furnace for a further 45 min.