BRITISH STANDARD

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Unshaped refractory products —

Part 8: Determination of complementary properties

The European Standard EN 1402-8:2003 has the status of a British Standard

ICS 81.080

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National foreword

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Summary of pages

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English version

Unshaped refractory products - Part 8: Determination of complementary properties

Produits réfractaires non façonnés - Partie 8: Détermination des caractéristiques complémentaires

Ungeformte feuerfeste Erzeugnisse - Teil 8: Bestimmung zusätzlicher Eigenschaften

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

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

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Contents

Foreword

This document (EN 1402-8:2003) 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of an identical text or by endorsement, at the latest by April 2004, and conflicting national standards shall be withdrawn at the latest by April 2004.

This document supersedes ENV 1402-8:1999.

EN 1402 *Unshaped refractory products* consists of eight parts:

— *Part 1: Introduction and classification*

— *Part 2: Sampling for testing*

— *Part 3: Characterization as received*

— *Part 4: Determination of consistency of castables*

— *Part 5: Preparation and treatment of test pieces*

— *Part 6: Measurement of physical properties*

— *Part 7: Tests on pre-formed shapes*

— *Part 8: Determination of complementary properties*

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

1 Scope

This European Standard specifies methods for determination of the properties of unshaped refractory materials from test pieces prepared and stored in accordance with EN 1402-5. The methods complement those described in EN 1402-6.

The methods have been adapted from standards for shaped refractory products to make them applicable to dense and insulating castables, and ramming materials as defined in EN 1402-1, before and after firing.

2 Normative references

This European Standard incorporates by dated or undated reference, 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 993-3, *Methods of test for dense shaped refractory products - Part 3: Test methods for carbon - containing refractories.*

EN 993-4, *Methods of test for dense shaped refractory products - Part 4: Determination of permeability to gases.*

ENV 993-11:1997*, Dense shaped refractory products - Part 11: Determination of resistance to thermal shock.*

EN 993-14:1998, *Methods of testing dense shaped refractory products - Part 14: Determination of thermal conductivity by the hot wire (cross array) method.*

EN 993-15:1998, *Methods of test for dense shaped refractory products - Part 15: Determination of thermal conductivity by the hot wire (parallel) method.*

EN 993-16, *Dense shaped refractory products - Methods of test - Part 16: Determination of resistance to sulfuric acid.*

prEN 993-20, *Methods of test for dense shaped refractory products - Part 20: Determination of resistance to abrasion at ambient temperature.*

EN 1402-1, *Unshaped refractory products - Part 1: Introduction and classification.*

EN 1402-2, *Unshaped refractory products - Part 2: Sampling for testing.*

EN 1402-3, *Unshaped refractory products - Part 3: Characterization as received.*

EN 1402-5, *Unshaped refractory products - Part 5: Preparation and treatment of test-pieces.*

EN 1402-6, *Unshaped refractory products - Part 6: Measurement of physical properties.*

EN ISO 12676, *Refractory products - Determination of resistance to carbon monoxide (ISO 12676:2000).*

3 Principle

The complimentary properties of unshaped refractory products are determined by the procedures given in EN 993-3*,* EN 993-4, ENV 993-11, EN 993-14, EN 993-15, EN 993-16, prEN 993-20, EN 1402-1, EN 1402-2, EN 1402-3, EN 1402-5, EN 1402-6 and EN ISO 12676.

The methods complement those described in EN 1402-6. It is not necessary to use all the methods to characterize a material.

4 Determination of permeability to gases

4.1 Principle

This determination shall be carried out on test-pieces after drying or after firing at a temperature and time to be agreed between the parties.

4.2 Test-pieces

Use cylindrical test-pieces with dimensions defined in EN 993-4 and obtained from shapes A, B or C by sawing or coring, and prepared, stored, dried and/or fired according to the relevant sections of EN 1402-5. The direction from which the test-pieces are cut with regard to the direction of shaping shall be stated in the test report; the plane faces of the cylinder shall be at least at 4 mm away from the initial faces of shape.

If the test-pieces cannot be obtained by sawing or coring, due to the nature of the material, they may be prepared directly and this shall be noted in the test report.

In all cases, the test-pieces shall be dried at 110 °C ± 5 °C for a minimum of 24 h and fired at a temperature and time to be defined between the parties and noted in the test report.

4.3 Procedure

Determine the permeability to gases in accordance with EN 993-4.

5 Determination of the resistance to thermal shock

5.1 Principle

This determination shall be carried out on test-pieces fired at a temperature equal to or higher than the temperature of the test.

The standard quenching temperature shall be 950 °C and prefiring of the test-pieces shall be carried out at 950 °C or above for 5 h.

Other quenching and prefiring temperatures and times may be agreed upon by the parties concerned and shall be noted in the test report.

5.2 Test-pieces

Test-pieces with dimensions of shape B, i.e. 230 mm × 64 mm × 54 mm shall be used. They shall be prepared and prefired according to EN 1402-5 at a temperature and time which was agreed between the involved parties (see 5.1).

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

5.3 Procedure

Determine the resistance to thermal shock of the prefired test-pieces in accordance with ENV 993-11:1997, method B.

6 Determination of thermal conductivity

6.1 Principle

This determination may be carried out on fired or unfired, dried test-pieces in accordance with EN 993-14 (hot wire, cross array) or with EN 993-15 (hot wire, parallel).

For both fired and unfired, dried test-pieces, variation in thermal conductivity can occur due to time dependent mineralogical and microstructural changes if the test-piece has not been prefired to a temperature equal to or higher than the measurement temperature.

It is therefore necessary to take special care to ensure that equilibrium is attained when testing such test pieces. This can entail holding the test furnace at the measurement temperature for prolonged periods.

6.2 Test pieces

Test-pieces shall be used corresponding to shape A as defined in EN 1402-5.

For fired test-pieces, the firing shall be carried out in accordance with EN 1402-5 or as agreed between the parties.

6.3 Procedure

Determine the thermal conductivity at each defined measurement temperature in accordance with EN 993-14 or EN 993-15.

For unfired test pieces, the rate of rise of the test furnace shall be in accordance with that specified in EN 1402-5 for the type of material under test.

In all cases where the test piece has been prefired, (either before or during the test) to a lower temperature than the measurement temperature, it can be necessary to maintain the furnace at this temperature for extended periods to attain equilibrium (see 6.8 of EN 993-14:1998, or 6.6 of EN 993-15:1998). In some cases, it can be advisable to maintain the temperature overnight.

7 Determination of sulfuric acid resistance

7.1 Principle

Determination of sulphuric acid resistance consists of the chemical attack by sulfuric acid on test-pieces crushed to a specific grain size.

7.2 Test pieces

Use shape A test-pieces prepared in accordance with EN 1402-5, stored and dried at 110 °C ± 5 °C for a minimum of 24 h. Samples shall be taken out from test-pieces in accordance with EN 993-16.

Any pre-treatment of the test-pieces shall be agreed between the parties and noted in the test report.

7.3 Procedure

Determine the resistance to sulfuric acid in accordance with EN 993-16.

8 Tests for products containing carbon

8.1 Principle

The physical properties of products containing carbon are determined before and after removal of volatile components by carbonization and after removal of all carbon.

8.2 Test-pieces

The test-pieces shall be of the size specified for each individual test method and shall be taken from shapes A, B or C, and prepared in accordance with EN 1402-5.

8.3 Procedure

8.3.1 **Tests before carbonization**

The physical properties of the prepared test pieces shall be determined in accordance with EN 993-3.

8.3.2 **Tests after carbonization**

Volatile components shall be removed according to the carbonizing procedure defined in EN 993-3 which also entails the determination of the following properties:

— carbonization mass loss;

— residual carbon content;

— carbon yield.

Determination of the physical properties of the carbonized test-pieces shall be carried out in accordance with the relevant sections of EN 993-3.

8.3.3 **Tests after removal of all carbon**

Total carbon removal from the carbonized test pieces shall be in accordance with EN 993-3. The test-pieces shall be tested by the methods in EN 993-3, EN 993-4, ENV 993-11, EN 993-14, EN 993-15, EN 993-16, prEN 993-20, EN 1402-1, EN 1402-2, EN 1402-3, EN 1402-5, EN 1402-6 and EN ISO 12676.

9 Determination of the resistance to carbon monoxide

This determination shall be carried out in accordance with EN ISO 12676.

10 Determination of resistance to abrasion at ambient temperature

This determination shall be carried out in accordance with prEN 993-20.

11 Test report

The test report shall include the following:

a) all information necessary for identification of the sample tested including the designation of the material tested, i.e. type, group, etc.;

b) a reference to this European Standard i.e. EN 1402-8;

c) the methods used including reference to the European Standards used as necessary;

d) the state of the test-piece or sample for each test performed including its preparation and any information required by the preparation standards EN 1402-2, EN 1402-1, EN 1402-3 and EN 1402-5;

e) the results of the tests, as appropriate including the results of the individual determinations and their mean, calculated in accordance with the European Standards used, i.e.

   1) the determination of permeability to gases in accordance with clause 4 and EN 993-4;

   2) the determination of the resistance to thermal shock in accordance with clause 5 and ENV 993-11;

   3) the determination of of thermal conductivity in accordance with clause 6 and EN 993-14 or EN 993-15;

   4) the determination of sulfuric acid resistance in accordance with clause 7 and EN 993-16;

   5) the result of tests for products containing carbon in accordance with clause 8 and EN 993-3;

   6) the determination of the resistance to carbon monoxide in accordance with clause 9 and EN ISO 12676;

   7) the determination of resistance to abrasion at ambient temperature in accordance with clause 10 and prEN 993-20;

f) any additional information required by the European Standard method used;

g) any deviations from the procedure specified;

h) any unusual features (anomalies) observed during the test;

i) the name of the testing establishment;

a) the date of the test.

The test report shall also include any additional information required by the methods in EN 993-3, EN 993-4, ENV 993-11, EN 993-14, EN 993-15, EN 993-16, prEN 993-20, EN 1402-1, EN 1402-2, EN 1402-3, EN 1402-5, EN 1402-6 and EN ISO 12676.

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