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Methods of test for dense shaped refractory products — Determination of resistance to abrasion at ambient temperature

Méthodes d'essai des produits réfractaires façonnés denses — Détermination de la résistance à l'abrasion à température ambiante

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 16282 was prepared by Technical Committee ISO/TC 33, *Refractories*.

Methods of test for dense shaped refractory products — Determination of resistance to abrasion at ambient temperature

1 Scope

This International Standard specifies a method intended primarily for the determination of the abrasion resistance of shaped refractory materials at ambient temperature. It can also be used for unshaped refractory materials. It provides an indication of the suitability of the material for service in abrasive or erosive conditions.

NOTE This International Standard is based on and technically identical to EN 993-20, published by the European Committee for Standardization.

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.

ISO 565, *Test sieves — Metal wire cloth, perforated metal plate and electroformed sheet — Nominal sizes of openings*

ISO 5017, *Dense shaped refractory products — Determination of bulk density, apparent porosity and true porosity*[1)]

3 Terms and definitions

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

3.1
resistance to abrasion
resistance of refractory test pieces to the surface wear caused by the mechanical action of moving solids

3.2
resistance to erosion
resistance of refractory test pieces to the surface wear caused by the mechanical action of a fluid, which may or may not contain solid material

4 Principle

The method determines the volume of material abraded from a flat surface of a test piece placed at right angles to a nozzle through which 1 000 g of size-graded silicon carbide is blasted by compressed air at 450 kPa.

1) EN 993-1, which is referred to in the text of EN 993-20, is closely based on ISO 5017.

5 Apparatus

5.1 Abrasion tester, consisting of the equipment specified in 5.1.1 and 5.1.2.

5.1.1 Venturi blast assembly (see Figure 1) or **blast gun** (see Figure 2), consisting of a suitable housing with an air nozzle delivering air into the barrel of the assembly which acts as a venturi tube, the abrasive entering the barrel from the side. The air-delivery nozzle shall have an inlet inside diameter between 2,84 mm and 2,92 mm and an outlet inside diameter between 2,36 mm and 2,44 mm. The air nozzle may be protected from abrasion by covering it with a nominally 9,4 mm long piece of vinyl tubing of inside diameter 4,7 mm and wall thickness 1,5 mm. The inside diameter of the barrel of the assembly shall not exceed 10 mm and the barrel shall be checked periodically for wear.

5.1.2 Nozzle (see Figures 1 and 2), for directing the abrading medium onto the test piece, consisting of a piece of glass tubing 115 mm long, 7 mm in outside diameter, with a nominally 1,1 mm thick wall. This glass tube is attached to the blast assembly and held perpendicular to the test piece using a 70 mm long piece of stainless steel tubing, 7,15 mm inside diameter. The steel tube is glued inside a 9,53 mm tubing nut which is screwed onto the end of the blast assembly barrel. The glass tube is inserted through this steel tube and an air pressure seal made using a suitable rubber grommet compressed when the tubing nut is attached to the assembly barrel.

The end of the glass tube within the blast assembly barrel shall be positioned at a distance of 2 mm from the air-delivery nozzle. This is achieved by placing the glass tube on a brass rod 4,5 mm in diameter, with a 7,9 mm shoulder 117 mm from the tip. This allows the glass tube to be inserted through the steel tube and into the barrel of the assembly until the end of the brass rod touches the air-delivery nozzle, thus ensuring a 2 mm gap between the end of the glass tube and the air-delivery nozzle.

A new piece of glass tubing shall be used for each determination.

5.2 Feed mechanism, capable of supplying 1 000 g of abrasive to the blast assembly in (450 ± 15) s. Secondary air shall be allowed to enter the system with the abrasive. A suitable feed mechanism is shown in Figures 3 and 4. It consists of three funnels:

a) an upper (charging) funnel;

b) a middle (feed control) funnel with a metal, glass or plastic orifice which provides the required feed rate;

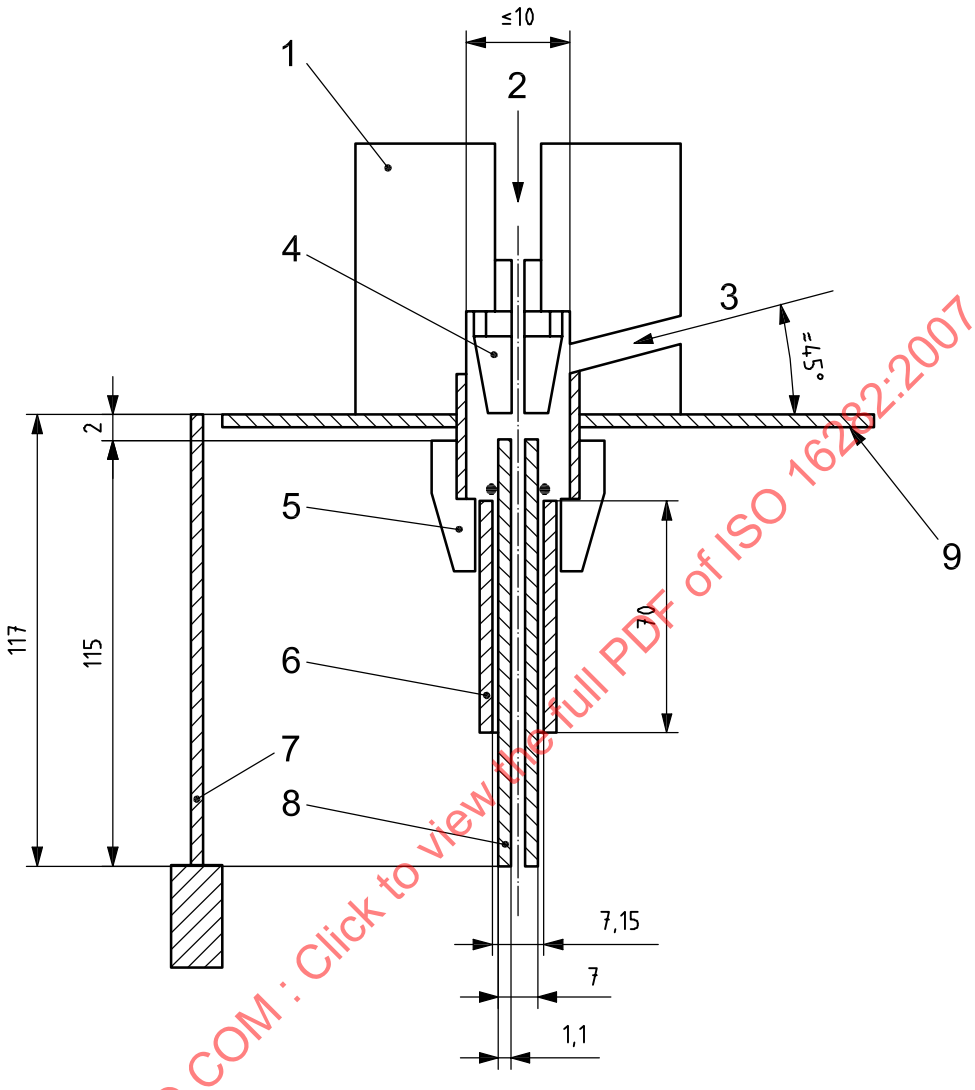
c) a lower (delivery) funnel.

5.3 Test chamber (see Figure 3), consisting of a tightly sealed enclosure with a door to permit ready access for mounting and removing the test pieces. The blast assembly is mounted vertically in the top of the test chamber so that the downward stream of abrasive travels (203 ± 1) mm from the tip of the glass nozzle to the surface of the test piece.

The chamber shall be fitted with an exhaust vent and a butterfly valve to regulate the pressure in the chamber during the test. A cloth dust-collecting bag of adequate capacity may fitted over the end of the exhaust vent.

The upper part of the chamber shall be fitted with a tube and stopcock to allow the connection of a manometer.

Dimensions in millimetres

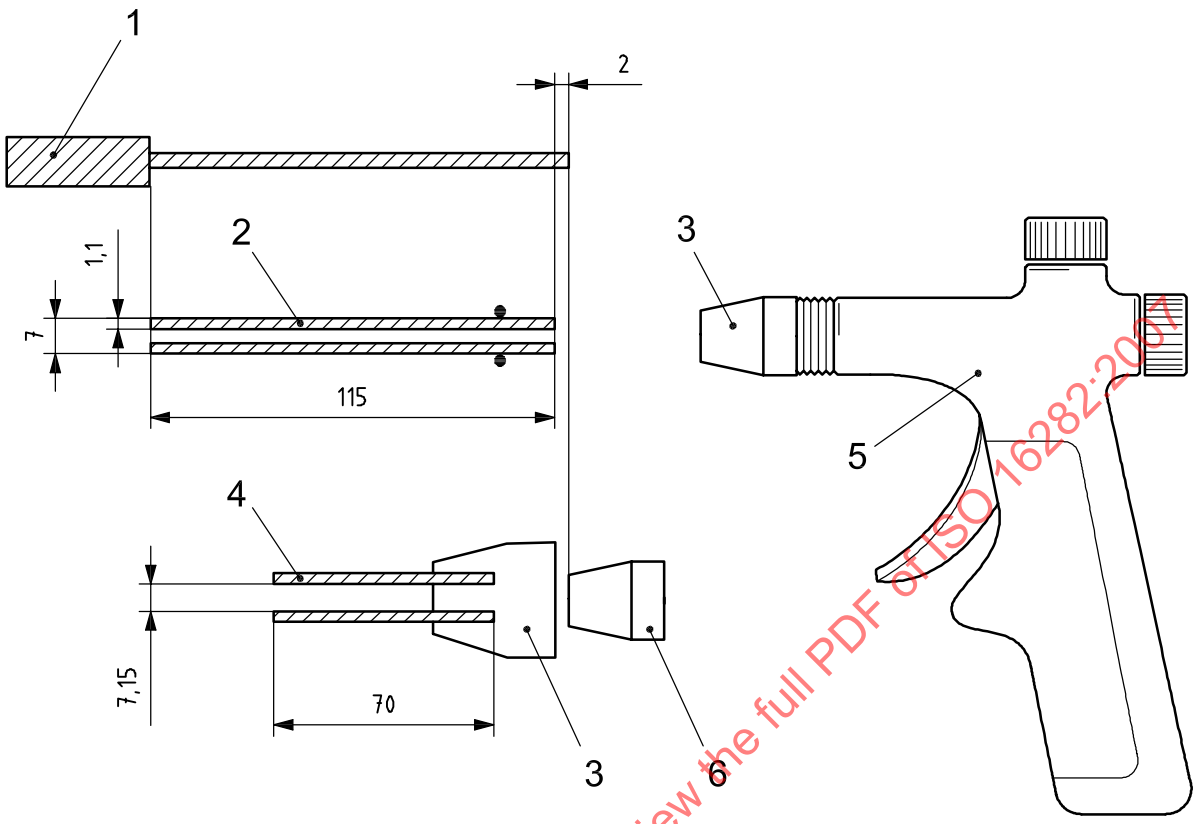


Key

1 venturi housing
2 air supply
3 supply of abrasive
4 air-delivery nozzle: inside diameter at inlet 2,84 mm to 2,92 mm
inside diameter at outlet 2,36 mm to 2,44 mm
5 tubing nut
6 steel stabilizing sleeve
7 brass rod for positioning glass tube
8 glass tube with grommet
9 top of test chamber

Figure 1 — Example of venturi blast assembly

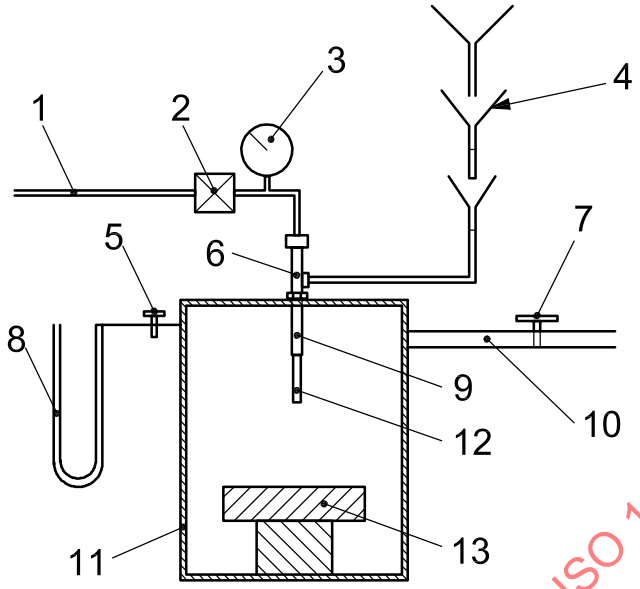
Dimensions in millimetres



Key

1 brass rod for positioning glass tube
2 glass tube with grommet
3 tubing nut
4 steel stabilizing sleeve
5 sand blast gun
6 air-delivery nozzle

Figure 2 — Example of blast gun (dismantled)



Key

1	air supply line
2	pressure regulator
3	pressure gauge
4	feed system
5	stopcock
6	venturi
7	butterfly valve
8	manometer
9	steel tube
10	exhaust vent
11	test chamber
12	glass tube
13	test piece

Figure 3 — Schematic diagram of abrasion tester

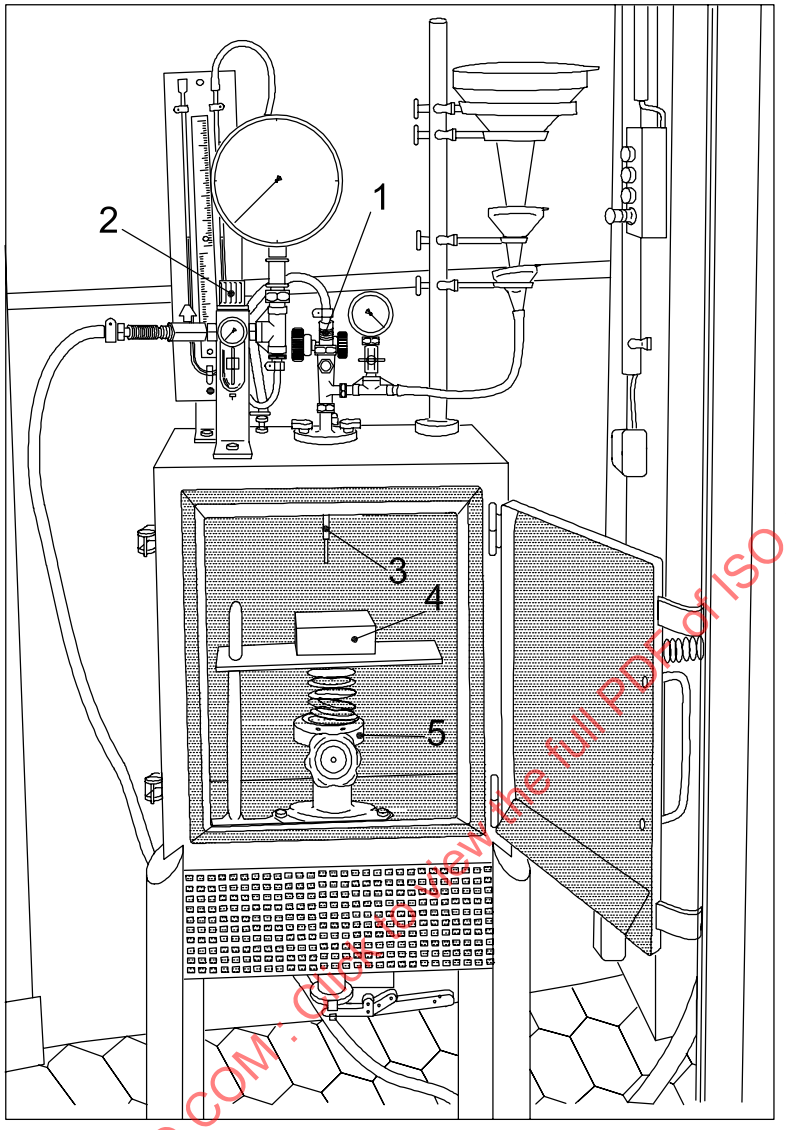
5.4 Manometer, capable of measuring up to 400 Pa (41 mm of water), to measure the pressure inside the chamber during the test.

5.5 Vacuum gauge, capable of measuring up to 750 mm of mercury (gauge pressure), to check the pressure at the entry port for the abrasive on the blast assembly.

5.6 Balance, capable of weighing to the nearest ±0,1 g.

5.7 Callipers, capable of measuring to the nearest ±0,5 mm.

5.8 Test sieves, conforming to the requirements of ISO 565.



Key

1 blast assembly
2 air pressure regulator
3 glass tube and steel stabilizing sleeve
4 test piece
5 adjustable platform

Figure 4 — Abrasion tester — Introduction of test piece

5.9 Abrasive, consisting of silicon carbide with a particle-size distribution as given in Table 1. Before use, remove the material retained on the 850 μm ISO sieve and that passing the 300 μm ISO sieve.

Table 1 — Sieve analysis of abrasive

Size of opening (ISO 565 — R 40/3) μm	Amount retained %
850	Trace
600	20 ± 2
300	80 ± 3
212	2 max.
< 212	Trace

NOTE This silicon carbide corresponds to FEPA grit size grade P36.

5.10 Compressed-air supply: Clean, dry, compressed air supplied to the blast assembly at the required pressure by means of a regulator and an air-pressure gauge capable of being read in 7 kPa increments, mounted as close to the blast assembly as possible.

6 Test pieces

6.1 General

The number of items to be tested and the number of test pieces per item shall be agreed between the parties and stated in the test report.

6.2 Shaped refractories

For all materials except the most abrasion-resistant, test pieces measuring 114 mm × 114 mm × 64 mm shall be cut from refractory bricks or shapes so that one of the square faces of each test piece is a flat original surface not bearing a brand mark (see, however, Note 1 to Clause 7). Test pieces measuring 100 mm × 100 mm × 25 mm may be used for the most abrasion-resistant materials. The test piece dimensions shall be stated in the test report.

6.3 Unshaped refractories

Test pieces of the above-mentioned dimensions shall be prepared directly from the material under test. The preparation procedure, including treatment and firing and the temperature of firing, shall be agreed between the interested parties. One of the square faces of each test piece shall be the face which was in contact with the bottom of the mould (see, however, Note 1 to Clause 7). The test piece preparation conditions and the test piece dimensions shall be stated in full in the test report.

7 Procedure

Dry the test pieces at (110 ± 5) °C to constant mass.

Weigh the test pieces to ±0,1 g. Determine their volume by measuring their length, width and thickness to the nearest 0,5 mm using callipers (5.7).

Place one of the test pieces in the test chamber with a square face perpendicular to the glass nozzle (see, however, Note 2), at a distance of (203 ± 1) mm from the nozzle tip. For test pieces from shaped refractories, the flat original surface not bearing a brand mark shall be used for the test (see, however, Note 1). For test pieces from unshaped refractories, the test surface shall be the face which was in contact with the bottom of the mould (see, however, Note 1).

NOTE 1 If required, and agreed between the interested parties, other faces, including cut surfaces, may be used in the test.

NOTE 2 If agreed between the parties, an impact angle other than 90° may be used in the test.

Turn on the compressed-air supply and regulate the pressure to (450 ± 7) kPa. Check the air pressure before and after the abrasive has run through the system.

Measure the pressure in the test chamber using the water manometer and maintain the pressure in the chamber at 310 Pa (32 mm of water) by means of the butterfly valve in the exhaust vent.

After the pressure of the compressed air supplied to the blast assembly and the test chamber pressure have been adjusted, disconnect the abrasive feed line and connect the 750 mmHg vacuum gauge to the abrasive entry port on the blast assembly (see Note 3). If the vacuum gauge does not show a minimum pressure of 375 mmHg, check the position of the glass tube or the condition of the air-delivery nozzle. After obtaining the correct vacuum, reconnect the abrasive feed line and recheck the test chamber pressure before placing (1 000 ± 5) g of dry abrasive in the upper (charging) funnel. The lower (delivery) funnel shall not be completely filled or flooded with abrasive. Connect the feed mechanism to the blast assembly. It shall deliver the abrasive in the specified time of (450 ± 15) s.

NOTE 3 As an alternative, a suitable vacuum gauge may be built into the apparatus (see Figure 4).

Remove the test piece from the test chamber, blow off the dust, and immediately weigh to the nearest 0,1 g.

NOTE 4 The time between abrading and weighing the abraded test piece should not exceed 10 min, to prevent the test piece absorbing moisture from the air.

Repeat the procedure with the next test piece, using fresh silicon carbide abrasive and a new piece of glass tubing.

8 Calculation

Calculate the bulk density of each test piece, in grams per cubic centimetre, from the mass and the volume determined in Clause 7, or by the method given in ISO 5017.

Calculate the volume of material lost by abrasion from each test piece, A, in cubic centimetres, as follows:

$$A = \left(\frac{m_1 - m_2}{\rho}\right) = \frac{m}{\rho}$$

where

ρ is the bulk density, in grams per cubic centimetre;

m_1 is the mass of the test piece before testing, in grams;

m_2 is the mass of the test piece after testing, in grams;

m is the loss in mass of the test piece, in grams.

9 Precision

No precision data were available at the time of the preparation of this International Standard, but precision data may be added later if and when they become available.