International Standard

ISO 5014

Dense and insulating shaped refractory products — Determination of modulus of rupture at ambient temperature

Produits réfractaires façonnés denses et isolants — Détermination du module de rupture à température ambiante

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This fourth edition cancels and replaces the third edition (ISO 5014:1997), which has been technically revised.

The main changes are as follows:

— revised definitions;

— addition of a clause on significance and use;

— addition of an informative annex on precision and bias.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Dense and insulating shaped refractory products — Determination of modulus of rupture at ambient temperature

1 Scope

This document specifies a method for the determination of the modulus of rupture of dense and insulating shaped refractory products at ambient temperature, under conditions of a constant rate of increase of stress.

Shaped refractories are those which have fixed geometry and dimensions when delivered to the user. This document is accordingly applicable to standard shape refractory bricks, but also special shapes refractory products and pre-cast products.

This document is also applicable to unshaped refractories (see ISO 1927-6) after preparation of test specimens according to ISO 1927-5.

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.

ISO 13385-1, *Geometrical product specifications (GPS) — Dimensional measuring equipment — Part 1: Design and metrological characteristics of callipers*

ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
modulus of rupture
MOR
σ_F
maximum stress that a prismatic test piece of specified dimensions can withstand when it is bent in a *three-point bending* (3.2) device

3.2
three-point bending
means of bending a beamlike test piece whereby the test piece is supported on bearings near its ends, and a central force is applied

3.3
dense shaped refractory product
product with specific dimensions, having a true porosity of less than 45 % by volume, when measured in accordance with ISO 5017

3.4
shaped insulating refractory
shaped refractory having a true porosity of not less than 45 % by volume, when measured in accordance with ISO 5016

3.5
sample
representative collection of items that can be obtained by sampling according to a sampling plan agreed upon by the interested parties

Note 1 to entry: An example of an applicable sampling plan is given in ISO 5022.

3.6
item
refractory brick or shape

3.7
test piece
test specimen
piece of material extracted from an *item* (3.6) and suitably shaped and prepared for the test

4 Significance and use

This test is intended to be used for research, material development, manufacturing process control and design data acquisition purposes. The strength level determined by the test is calculated on the basis of linear elastic bending of a beam on the assumption that the material being tested is elastically homogeneous, isotropic and shows linear (Hookean) stress-strain behaviour.

The modulus of rupture can be significantly affected by a large number of factors associated with the microstructure of the material, the surface finishing procedure applied in preparation of the test pieces, the size and shape of the test piece, the orientation of the test piece during testing, the geometry and functions of the testing jig and the stress rate. Comparisons of the results between different determinations should accordingly not be made if one or more of these parameters differ between the two determinations.

As a consequence of the brittle nature of refractories, there is usually a considerable range of results obtained from a number of nominally identical test pieces. Caution in the interpretation of test results is hence required. For many purposes, and as described in this document, the results of the MOR test may be described in terms of a mean value and a standard deviation. Further statistical evaluation of results is required for design data acquisition and can be desirable for other purposes. In particular, any extrapolation of modulus of rupture data to other geometries of stressing, to multiaxial stressing, to other rates of stressing or to other environments should be viewed with caution.

This method places closely defined restrictions on the size and shape of the test piece and on the function of the test apparatus in order to minimize the errors that can arise as a consequence of the test method.

The method relates primarily to shaped and fired refractories. If it is to be applied to chemically bonded or carbon-bonded bricks, they will usually require some form of preliminary heat treatment. This preliminary treatment is a matter of agreement between the interested parties and shall be described in the test report.

This method can also be applied to unshaped refractories, more specifically on test pieces prepared according to ISO 1927-5 and ISO 1927-6.

5 Principle

Bending a prismatic test piece of the product to be tested at a constant rate of increase of stress until failure occurs, whereby the test piece is supported on bearings near its ends, and a central force is applied.