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Refractories — Determination of dynamic Young's modulus (MOE) at elevated temperatures by impulse excitation of vibration

Produits réfractaires — Détermination du module de Young dynamique (MOE) à hautes températures par excitation de vibration par impulsion

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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 documents 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.*

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.

Refractories — Determination of dynamic Young's modulus (MOE) at elevated temperatures by impulse excitation of vibration

1 Scope

This document specifies a method for determining the dynamic Young's modulus of rectangular cross-section bars and circular cross-section specimens of refractories by impulse excitation of vibration at elevated temperature. The dynamic Young's modulus is determined using the resonant frequency of the specimen in its flexural mode of vibration.

This document does not address the safety issues associated with its use. It is responsibility of the users of this standard to establish appropriate safety and health practices.

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 5022, *Shaped refractory products — Sampling and acceptance testing*

ISO 8656-1, *Refractory products — Sampling of raw materials and unshaped products — Part 1: Sampling scheme*

ISO 12680-1, *Methods of test for refractory products — Part 1: Determination of dynamic Young's modulus (MOE) by impulse excitation of vibration*

ISO 16835, *Refractory products — Determination of thermal expansion*

IEC 60584-1, *Thermocouples — Part 1: EMF specifications and tolerances*

IEC 60584-2, *Thermocouples — Part 2: Tolerances*

3 Terms and definitions

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

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

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

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

3.1
modulus of elasticity
MOE
ratio of stress to strain below the *proportional limit* (3.2)

3.2
proportional limit
greatest stress which a material is capable of sustaining without deviation form proportionality of stress to strain (Hooke's Law)

3.3
homogeneous
uniform composition, density and texture

Note 1 to entry: A result of homogeneity is that any smaller specimen taken from the original is representative of the whole. In refractory practice, as long as the geometrical dimensions of the specimen are large with respect to the size of individual grains, crystals, components, pores and microcracks, the body can be considered homogeneous.

3.4
isotropic
condition of a specimen such that the values of the elastic properties are the same in all directions in the specimen

3.5
resonant frequency
natural frequencies of vibration of a body driven into *flexural vibration* (3.6)

Note 1 to entry: Resonant frequencies are determined by the elastic modulus, mass and dimensions of the specimen. The lowest resonant frequency in a vibrational mode is the fundamental resonant.

3.6
flexural vibrations
displacements in a *slender bar or rod* (3.11) in the plane normal to its length

3.7
nodes
location on a *slender bar or rod* (3.11) in resonance having a constant zero displacement

Note 1 to entry: For the fundamental flexural resonance of such a rod or bar, the nodes are located at 0,224L form each end, where L is the length of the specimen.

3.8
anti-nodes
locations, generally two or more, of local maximum displacement in an unconstrained *slender bar or rod* (3.11) in resonance

Note 1 to entry: For the fundamental flexural resonance, the anti-nodes are located at the two ends and the centre of the specimen.

3.9
out-of-plane flexure
flexural mode for rectangular parallelepiped geometry specimens in which the direction of the displacement is perpendicular to the major plane of the specimen

3.10
in-plane flexure
flexural mode for rectangular parallelepiped geometry specimens in which the direction of the displacement is in the major plane of the specimen

3.11
slender bar
slender rod
slender bar whose ratio of length to width is at least 3 and the ratio of length to thickness is at least 5, slender rod whose ratio of length to diameter is at least 5

Note 1 to entry: This applies to dynamic property testing.