STANDARD **8302**

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Thermal insulation — Determination of steady-state thermal resistance and related properties — Guarded hot plate apparatus

Isolation thermique — Détermination de la résistance thermique et des propriétés connexes en régime stationnaire — Méthode de la plaque chaude gardée

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Contents

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Annexes

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.

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.

International Standard ISO 8302 was prepared by Technical Committee ISO/TC 163, *Thermal insulation*.

Annex A forms an integral part of this International Standard. Annexes B, C and D are for information only.

Introduction

0.1 Document subdivision

This International Standard is divided into three sections, representing the most comprehensive assemblage of information required to use the guarded hot plate apparatus, i.e.

Section 1: General considerations

Section 2: Apparatus and error evaluation

Section 3: Test procedures

While the user of the method specified in this International Standard for test purposes may need to concentrate only on section 3, he must also be familiar with the other two sections in order to obtain accurate results. He must be particularly knowledgeable about the general requirements. Section 2 is directed towards the designer of the apparatus, but he also, in order to provide good apparatus, must be concerned with the other sections of this method. Thus, the method will serve its purpose well.

0.2 Heat transfer and measured properties

A large proportion of thermal testing is undertaken on light density porous materials. In such cases, the actual heat transfer within them can involve a complex combination of different contributions of

— radiation;

— conduction both in the solid and gas phase; and

— convection (in some operating conditions);

plus their interactions together with mass transfer, especially in moist materials. For such materials, the heat transfer property, very often wrongly called "thermal conductivity", calculated from a defined formula and the results of measurements of heat flow-rate, temperature difference and dimensions, for a specimen may be not an intrinsic property of the material itself. This property, in accordance with ISO 9288, should therefore be called "transfer factor" as it may depend on the test conditions (the transfer factor is often referred to elsewhere as apparent or effective thermal conductivity). Transfer factor may have a significant dependence on the thickness of the specimen and/or on the temperature difference for the same mean test temperature.

Heat transfer by radiation is the first source of dependence of transfer factor on specimen thickness. As a consequence, not only material properties influence results, but also the radiative characteristics of the surfaces adjoining those of the specimen. Heat transfer by radiation also contributes to the dependence of transfer factor on temperature differences. This dependence can be experimentally detected for each type of material and for each mean test temperature when the temperature difference exceeds defined limits. Thermal resistance is therefore the property that better describes the thermal behaviour of the specimen, provided it is accompanied by information on the radiative characteristics of the adjoining surfaces. If there is the possibility of the onset of convection within the specimen (e.g. in light mineral wool for low temperatures), the apparatus orientation, the thickness and the temperature difference can influence both the transfer factor and the thermal resistance. In such cases, as a minimum it is required to fully specify the geometry and the boundary conditions of the specimen tested, even though information supplied in section 3 on test procedures does not cover these test conditions in detail. In addition, it will take considerable knowledge to evaluate the measurement, as such, especially when applying the measured values in practice.

The influence of moisture within a specimen on the heat transfer during a measurement is also a very complex matter. Therefore, dried specimens only shall be tested according to standard procedures. Measurements on moist materials need additional precautions not covered in detail in this International Standard.

The knowledge of the physical principles mentioned is also extremely important when a heat transfer property, determined by this test method, is used to predict the thermal behaviour of a specific material in a practical application even though other factors such as workmanship can influence this behaviour.

0.3 Background required

The design and subsequent correct operation of a guarded hot plate to obtain correct results and the interpretation of experimental results is a complex subject requiring great care. It is recommended that the designer, operator and the user of measured data of the guarded hot plate should have a thorough background of knowledge of heat transfer mechanism in the materials, products and systems being evaluated, coupled with experience of electrical and temperature measurements, particularly at low signal levels. Good laboratory practice in accordance with general test procedures should also be maintained.

The in-depth knowledge in each area mentioned may be different for the designer, operator and data user.

0.4 Design, size and national standards

Many different designs of guarded hot plate apparatus exist worldwide which conform to present national standards. Continuing research and development is in progress to improve the apparatus and measurement techniques. Thus, it is not practical to mandate a specific design or size of apparatus, especially as total requirements may vary quite widely.

0.5 Guidelines supplied

Considerable latitude both in the temperature range and in the geometry of the apparatus is given to the designer of new equipment since various forms have been found to give comparable results. It is recommended that designers of new apparatus read the comprehensive literature cited in annex D carefully. After completion of new apparatus, it is recommended that it be verified by undertaking tests on one or more of the various reference materials of different thermal resistance levels available.

This International Standard outlines just the mandatory requirements necessary to design and operate a guarded hot plate in order to provide correct results.

Limit values for the apparatus performance and testing conditions stated in this International Standard are given in annex A.

This International Standard also includes recommended procedures and practices plus suggested specimen dimensions which together should enhance general measurement levels and assist in improving inter-laboratory comparisons and collaborative measurement programmes.

Thermal insulation — Determination of steady-state thermal resistance and related properties — Guarded hot plate apparatus

Section 1: General

1.1 Scope

This International Standard lays down a test method which defines the use of the guarded hot plate method to measure the steady-state heat transfer through flat slab specimens and the calculation of its heat transfer properties.

This is an absolute or primary method of measurement of heat transfer properties, since only measurements of length, temperature and electrical power are required.

Reports conforming to this standard test method shall never refer to specimens with thermal resistance lower than 0,1 m²·K/W provided that thickness limits given in 1.7.4 are not exceeded.

The limit for thermal resistance may be as low as 0,02 m²·K/W but the accuracy stated in 1.5.3 may not be achieved over the full range.

If the specimens satisfy only the requirements outlined in 1.8.1 , the resultant properties shall be described as the thermal conductance and thermal resistance or transfer factor of the specimen.

If the specimens satisfy the requirements of 1.8.2, the resultant property may be described as the mean measurable thermal conductivity of the specimen being evaluated.

If the specimens satisfy the requirements of 1.8.3, the resultant property may be described as the thermal conductivity or transmissivity of the material being evaluated.

1.2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 7345:1987, *Thermal insulation — Physical quantities and definitions.*

ISO 9229:—[1], *Thermal insulation — Materials, products and systems — Vocabulary.*

ISO 9251:1987, *Thermal insulation — Heat transfer conditions and properties of materials — Vocabulary.*

ISO 9288:1989, *Thermal insulation — Heat transfer by radiation — Physical quantities and definitions.*

ISO 9346:1987, *Thermal insulation — Mass transfer — Physical quantities and definitions.*

1.3 Definitions

For the purposes of this International Standard, the following definitions apply.

The following quantities are defined in ISO 7345 or in ISO 9251:

1) To be published.