

Thermal insulation — Determination of steady-state thermal transmission properties — Calibrated and guarded hot box

The European Standard EN ISO 8990:1996 has the status of a British Standard

ICS 27.220

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee RHE/9, Thermal insulating materials, upon which the following bodies were represented:

- Autoclaved Aerated Concrete Products Association
- Chartered Institution of Building Services Engineers
- Concrete Block Association
- Cork Industry Federation
- Cranfield University
- Department of Health
- Department of the Environment (Building Research Establishment)
- Department of Trade and Industry (National Physical Laboratory)
- Electricity Association
- Eurisol (UK Mineral Wool Association)
- European Phenolic Foam Association
- Gypsum Products Development Association
- Power Generation Contractors Association ((PGCA)(BEAMA Ltd.))
- Royal Institute of British Architects
- Thermal Insulation Manufacturers and Suppliers Association (TIMSA)
- Thermal Insulations Contractors Association

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

- Aggregate Concrete Block Association
- Association of Lightweight Aggregate Manufacturers
- British Ceramic Research Ltd.
- British Precast Concrete Federation Ltd.
- Department of The Environment (British Board of Agreement)
- Flat Glass Manufacturers' Association
- Institute of Refrigeration
- Institute of Chemical Engineers
- Insulation Jacket Manufacturers Federation
- Polyethylene Foam Insulation Association
- University of Salford

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National foreword

This British Standard has been prepared by Technical Committee RHE/9 and is the English language version of EN ISO 8990 *Thermal insulation — Determination of steady-state thermal transmission properties — Calibrated and guarded hot box*, published by the European Committee for Standardization (CEN).

EN ISO 8990 was produced as a result of international discussions in which the United Kingdom took an active part.

Cross-reference

Publication referred to	Corresponding British Standard
EN ISO 7345:1995	BS EN ISO 7345:1996 <i>Thermal insulation — Physical quantities and definitions</i>

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 20, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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English version

Thermal insulation — Determination of steady-state thermal transmission properties — Calibrated and guarded hot box

(ISO 8990:1994)

Isolation thermique — Détermination des propriétés de transmission thermique en régime stationnaire — Méthodes à la boîte chaude gardée et calibrée
(ISO 8990:1994)

Wärmeschutz — Bestimmung der Wärmedurchgangseigenschaften im stationären Zustand Verfahren mit dem kalibrierten und dem geregelten Heizkasten
(ISO 8990:1994)

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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Foreword

The text of the International Standard from Technical Committee ISO/TC 163, Thermal insulation, of the International Organization for Standardization (ISO) has been taken over as a European Standard by Technical Committee CEN/TC 89, Thermal performance of buildings components, the secretariat of which is held by SIS. 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 February 1997, and conflicting national standards shall be withdrawn at the latest by February 1997.

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

NOTE Normative references to International Standards are listed in annex ZA (normative).

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Section 1. General

Introduction

Data on the thermal transmission properties of insulants and insulated structures are needed for various purposes including judging compliance with regulations and specifications, for design guidance, for research into the performance of materials and constructions and for verification of simulation models.

Many thermal insulating materials and systems are such that the heat transfer through them is a complex combination of conduction, convection and radiation. The methods described in this International Standard measure the total amount of heat transferred from one side of the specimen to the other for a given temperature difference, irrespective of the individual modes of heat transfer, and the test results can therefore be applied to situations when that is the property required. However, the thermal transmission properties often depend on the specimen itself and on the boundary conditions, specimen dimensions, direction of heat transfer, temperatures, temperature differences, air velocities, and relative humidity. In consequence, the test conditions must replicate those of the intended application, or be evaluated if the result is to be meaningful.

It should also be borne in mind that a property can only be assessed as useful to characterize a material, product or system if the measurement of the steady-state thermal transmission properties of the specimen and the calculation or interpretation of the thermal transmission characteristics represent the actual performance of the product or system.

Further, a property can only be characteristic of a material, product or system if the results of a series of measurements on a number of specimens from several samples provide sufficient reproducibility.

The design and operation of the guarded or calibrated hot box is a complex subject. It is essential that the designer and user of such apparatus has a thorough background knowledge of heat transfer, and has experience of precision measurement techniques.

Many different designs of the calibrated and the guarded hot box exist worldwide conforming to national standards. Continuing research and development is in progress to improve apparatus and measurement techniques. Also the variation of structures to be tested may be so great, and the requirements for test conditions so different, that it would be a mistake to restrict the test method unnecessarily and to confine all measurements to a single arrangement. Thus it is not practical to mandate a specific design or size of apparatus.

1.1 Scope

This International Standard lays down the principles for the design of the apparatus and minimum requirement that shall be met for determination of the laboratory steady-state thermal transmission properties of building components and similar components for industrial use. It does not, however, specify a particular design since requirements vary, particularly in terms of size, and also to a lesser extent in terms of operating conditions.

This International Standard describes also the apparatus, measurement technique and necessary data reporting. Special components, for example windows, need additional procedures which are not included in this International Standard. Also excluded are measurements of the effect on heat flow of moisture transfer or redistribution but consideration shall be given in the design and operation of the equipment as to the possible effect of moisture transfer on the accuracy and the relevance of test results. The properties which can be measured are thermal transmittance and thermal resistance. Two alternative methods are included: the calibrated hot box method and the guarded hot box method. Both are suitable for vertical specimens such as walls and for horizontal specimens such as ceilings and floors. The apparatus can be sufficiently large to study full-scale components.

The methods are primarily intended for laboratory measurements of large, inhomogeneous specimens, although homogeneous specimens can, of course, also be tested, and these are necessary for calibration and validation.

When testing homogeneous specimens in accordance with this International Standard, experience has shown that an accuracy within $\pm 5\%$ can generally be achieved. However, the accuracy of each individual apparatus shall be estimated with reference homogeneous specimens of thermal conductance extending over the range to be measured using the apparatus.

The estimation of accuracy for nonhomogeneous specimens will be more complex and involve an analysis of the heat flow mechanism in the particular types of inhomogeneous specimens being tested. Such analyses are not covered by this International Standard.

The method does not provide for measurements where there is mass transfer through the specimen during the test.

1.2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was 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 edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards. ISO 7345:1987, *Thermal insulation — Physical quantities and definitions*.

1.3 Definitions

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

1.3.1

mean radiant temperature, T_r

appropriate weighting of the temperatures of surfaces “seen” by the specimen for the purpose of determining the radiant heat flow rate to the surface of the specimen (see annex A)

1.3.2

environmental temperature, T_n

appropriate weighting of air and radiant temperatures, for the purpose of determining the heat flow rate to the surface of the specimen (see annex A)

1.4 Symbols, units and relationships

The following recommended symbols are used:

i	Interior, usually hot side	
e	Exterior, usually cold side	
s	Surface	
n	Environmental	
λ	Thermal conductivity	[W/(m · K)]
R	Thermal resistance	[(m ² K)/W]
U	Thermal transmittance	[W/(m ² K)]
h	Surface coefficient of heat transfer	[W/(m ² K)]
Φ	Heat flow rate	[W]
Φ_p	Total power input, heating or cooling	[W]
Φ_1	Heat flow rate through specimen	[W]
Φ_2	Imbalance, heat flow rate parallel to specimen	[W]
Φ_3	Heat flow rate through metering box walls	[W]

Φ_4	Flanking loss, heat flow rate flanking specimen	[W]
Φ_5	Peripheral loss, heat flow rate, parallel to specimen surface at the edges of the specimen	[W]
A	Area perpendicular to heat flow	[m ²]
q	Density of heat flow rate	[W/m ²]
d	Specimen thickness	[m]
T_a	Air temperature	[K]
T_r	Mean radiant temperature	[K]
T_n	Environmental temperature	[K]
T_s	Surface temperature	[K]
$R_s = A(T_{si} - T_{se})/\Phi_1$		
$R_s = 1/h$		
$R_{si} = A(T_{ni} - T_{si})/\Phi_1$		
$R_{se} = A(T_{se} - T_{ne})/\Phi_1$		
$R_u = 1/U$		
$U = \Phi_1/A(T_{ni} - T_{ne})$		
$\Phi_1 = \Phi_p - \Phi_3 - \Phi_2$ [for guarded hot box]		
$\Phi_1 = \Phi_p - \Phi_3 - \Phi_4$ [for calibrated hot box]		

NOTE 1 This method does not directly measure the thermal conductivity although it can be derived in case of opaque, homogeneous, flat specimens using the relationship, $\lambda = d/R_s$.

1.5 Principle

1.5.1 General

Both types of apparatus, the guarded hot box (GHB) and the calibrated hot box (CHB), are intended to reproduce conventional boundary conditions of a specimen between two fluids, usually atmospheric air, each at uniform temperature.

The specimen is placed between a hot and a cold chamber in which environmental temperatures are known.