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Thermal insulation for buildings — Reflective insulation products — Determination of thermal performance

Isolation thermique des bâtiments — Produits d'isolation réfléchissants — Détermination de la performance thermique

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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 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 3, *Thermal insultation products, components and systems,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 89, *Thermal performance of buildings and building components,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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Introduction

Reflective (low emissivity at the appropriate wavelength) surfaces are utilized in a number of ways to enhance the thermal performance of insulating products. Their role is to reduce the heat transfer by thermal radiation in some parts of the system. This is achieved because low emissivity surfaces reduce the radiant heat transferred through a product that is wholly or partially transparent to infra-red radiation (e.g. very low-density fibrous insulation). They also reduce the radiant heat transfer across any air gap or gaps that are present in the system. In some cases, air gaps can be an intrinsic part of the structure and in other cases the insulation can be installed in such a way as to deliberately create an air gap between the reflective surfaces and the structure.

When correctly installed in buildings, the thermal performance of reflective insulation products can be influenced quite significantly by such air gaps, hence the value of thermal performance reported from any of the test procedures should also be accompanied by a statement indicating the presence of, and sizes of, any adjacent air spaces. For maximum versatility and reduced confusion, the measured values from any test should be given as the combination of the thermal resistance of the "core" of the product together with the measured value of the emissivity of the surfaces. This does not preclude the provision of values indicating the total thermal resistance of a product and one or two airspaces (where relevant) as additional information, provided full details of the product and the air spaces are included. Some reflective insulation products have poorly defined thickness due to the nature of the materials and the manufacture. Care is thus needed to define either the nominal thickness or the test thickness, or both. When installed in buildings, the final thickness depends upon the degree of handling and fixing, which is not addressed in this document. The purpose of this document is to provide harmonized procedures to give reproducible measured thermal performance values that can be readily compared with other thermal insulation products.

Since all conventional thermal insulation products declare their thermal performance on the basis of the value to be expected over a reasonable working life, this is also addressed in a limited manner in this document in the assessment of emissivity of the surface(s) of reflective insulation. In the absence of any quantified and certified data on the aged performance of a facing over a normal lifetime for a building material, the ageing of the low emissivity surface is assessed by use of an accelerated ageing procedure.

How the thermal properties of insulation materials that utilize reflective surfaces are determined depends on the form in which they are sold and how they are intended to be used. This document describes a number of different approaches which can be utilized and specifies which approach to use for the different types of product. Where a product is already subject to a product specification that describes procedures for the measurement of the aged 90/90 fractile thermal conductivity or thermal resistance of the core insulation material, the following guidance should only be used to determine the component of its thermal performance that depends on the emissivity of its external faces. However, the measured value is only the first step, giving comparative performance values under specified conditions, and the design value can give more information for use by the designer in specific applications, especially under different climatic conditions.

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Thermal insulation for buildings — Reflective insulation products — Determination of thermal performance

1 Scope

This document describes a set of procedures for using existing standardized CEN or ISO test and calculation methods to determine the thermal performance of reflective insulation products. This document supports and does not replace existing CEN or ISO test methods.

This document applies to any thermal insulation product that derives a proportion of its claimed thermal properties from the presence of one or more reflective or low emissivity surfaces together with any associated airspace(s). It does not replace the existing procedures for the determination of the thermal performance of products already covered by an existing harmonized product standard where the declared value of these products does not specifically include any claims attributable to the emissivity of the facing. It does not, and cannot, give an in-use or design value of thermal performance, but provides standardized information from which these can be determined.

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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/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

Deleted: EN ISO 29466, *Thermal insulating products for building applications — Determination of thickness*¶
EN 1946-1, *Thermal performance of building products and components — Specific criteria for the assessment of laboratories measuring heat transfer properties — Part 1: Common criteria*¶
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EN 1946-2, *Thermal performance of building products and components — Specific criteria for the assessment of laboratories measuring heat transfer properties — Part 2: Measurements by guarded hot plate method*

EN 1946-3, *Thermal performance of building products and components — Specific criteria for the assessment of laboratories measuring heat transfer properties — Part 3: Measurements by heat flow meter method*

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EN 1946-4, *Thermal performance of building products and components — Specific criteria for the assessment of laboratories measuring heat transfer properties — Part 4: Measurements by hot box methods*

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ISO 6946, *Building components and building elements — Thermal resistance and thermal transmittance — Calculation methods*

ISO 7345, *Thermal performance of buildings and building components — Physical quantities and definitions*

ISO 8301, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Heat flow meter apparatus*

ISO 8302, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Guarded hot plate apparatus*

ISO 8990, *Thermal insulation — Determination of steady-state thermal transmission properties — Calibrated and guarded hot box*

ISO 9229, *Thermal insulation — Vocabulary*

ISO 9288, *Thermal insulation — Heat transfer by radiation — Vocabulary*

ISO 10456:2007, *Building materials and products — Hygrothermal properties — Tabulated design values and procedures for determining declared and design thermal values*

EN 12664, *Thermal performance of building materials and products — Determination of thermal resistance by means of guarded hot plate and heat flow meter methods — Dry and moist products of medium and low thermal resistance*

EN 12667, *Thermal performance of building materials and products — Determination of thermal resistance by means of guarded hot plate and heat flow meter methods — Products of high and medium thermal resistance*

ISO 29466:2022, *Thermal insulating products for building applications — Determination of thickness*

3 Terms, definitions and symbols

For the purposes of this document, the terms and definitions given in ISO 7345, ISO 9288, ISO 9229 and the following 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 Terms and definitions

3.1.1
indentation
concave depression in the surface of the facing (foil), such that shallow air pockets are created when the surface is in contact with a smooth flat plate

3.1.2
core thermal resistance
thermal resistance of the product from face to face at the tested thickness, excluding the contribution of any low *emissivity* (3.1.3) outer surface or any air space(s) adjacent to the product

3.1.3
emissivity
ratio of the energy radiated by a surface relative to the energy radiated by a blackbody at the same temperature

Note 1 to entry: It is a measure of a material's ability to radiate heat.

3.1.4
reflective surface
low emissivity surface
surface, which has a low emissivity at the appropriate wavelength within the temperature range found in building elements

3.1.5
reflective insulation
insulation product, which has one or both external face(s) comprising a reflective (low emissivity) surface

3.2 Symbols and units

For the purposes of this document, the following symbols and units apply.

Symbol	Quantity	Unit
P	perimeter	m
R	thermal resistance	m^2 K/W
U	sensor signal	V
ε	emissivity	—

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ISO 7345, *Thermal insulation — Physical quantities and definitions* ¶
ISO 8990, *Thermal insulation*
Deleted: *steady-state thermal transmission properties — Calibrated and guarded hot box*
Deleted: ISO 9229, *Thermal Insulation — Vocabulary* ¶
ISO 9288, *Thermal insulation — Heat transfer by radiation — Physical quantities and definitions* ¶
ISO 10456, *Building materials and products — Hygrothermal properties — Tabulated design values and procedures for determining declared and design thermal values* ¶
ISO 8301, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Heat flow meter apparatus*¶
ISO 8302, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Guarded hot plate apparatus*¶
ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*¶
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Symbol	Quantity	Unit
λ	thermal conductivity	W/(m K)
ϕ	heat flow rate	W
ψ	linear thermal transmittance	W/(m K)
$\Delta\theta$	temperature difference	K

Symbol	Quantity
L	low
H	high
e	edge
sur	surround
90/90	90 % fractile with a confidence level of 90 %

4 Description of product types

4.1 Product classification

Clause 4 describes the various generic product types to which this document refers. Product type is defined solely for the purpose of selecting the most appropriate test method (product type number does not refer to a generic species of product). Together with 4.2, 4.3 and 4.4, the flow charts in Annexes A, B and C shall be followed in assigning a given product to a product type.

In 4.2, 4.3 and 4.4, the product type is determined by reference to its compressibility or otherwise to achieve flat parallel surfaces. This implies the removal of measurable air gaps between the specimen and the hot and cold plates of the test apparatus whilst not unduly reducing the overall thickness of the specimen to be tested. The thickness shall be determined using the procedures in 5.2 and shall, if less than the nominal thickness, be the thickness subsequently used for the measurement of the core thermal resistance and given in the test report. Otherwise, the nominal thickness shall be used.

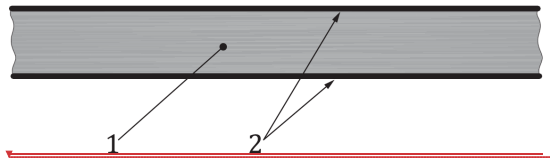
4.2 Product Type 1

A product shall be classified as Type 1 when:

— it has a regular geometry with parallel faces; or

— it is compressible so that the product can be contained between, and in full contact with, the hot and cold plates of the apparatus. Such Type 1 products can be so constrained without significantly compressing the product below its nominal thickness or the thickness measured using the procedure in Clause 5, whichever is the lesser. This is usually achieved when its surfaces are predominantly smooth and flat with no discernible depth of pattern or indentation.

EXAMPLE Including (but not limited to) multi-foil insulation product which is stitched or seamed only at the edges and substantially flat with parallel faces (see also the limitation in Clause 1) and some other insulation materials with aluminium foil facing on each side (see Figure 1).



Key

1 insulation core

2 low emissivity surface or surfaces

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Figure 1 — Example of insulation material with reflective facing on each side

4.3 Product Type 2

A product shall be classified as Type 2 when:

— it has a regular geometry with parallel faces; or

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— it is compressible so that the product can be contained between the test apparatus hot and cold plates without significantly compressing the product below its nominal thickness or the thickness measured using the procedure in Clause 5, whichever is the lesser. In addition, the surface or surfaces may not be flat and smooth and can have indentations of less than 5 mm depth. The indentations shall be measured using the pin and plate described in ISO 29466:2022, Clause B.1, or an alternative method with at least the same level of accuracy. The pin shall be placed in the lowest point of any indentation but shall not pierce the surface.

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If the indentations are 5 mm or greater, it shall be classified as product Type 3.

EXAMPLE Including, but not limited to, some types of bubble foil insulation with reflective surfaces (see Figure 2).

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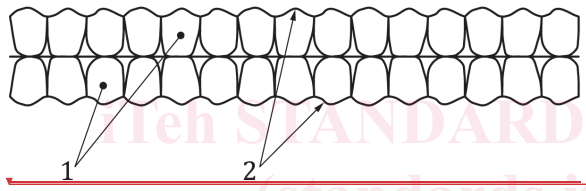

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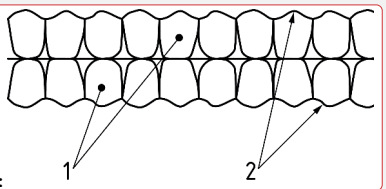

Key

1 air filled plastic bubbles

2 reflective surface(s)

Figure 2 — Example of bubble foil insulation with reflective surfaces

4.4 Product Type 3

A product shall be classified as Type 3 when:

— it has irregular thickness geometry and does not have flat parallel faces; or

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— it cannot be installed between the hot and cold plates of the apparatus using the lesser of the nominal thickness or the thickness measured using the procedure in Clause 5 to produce flat and parallel faces, free of air spaces.

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A small degree of compression may be permitted to eliminate air gaps, but not exceeding 10 % of the thickness, or 5 mm, whichever is the greater in mm.

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NOTE 1 Its surfaces might or might not have indentations, the depth of which is not limited to any specific value.

NOTE 2 It can include stitching or seams. A typical example would be the stitched multi-foil reflective insulation products or sealed “pockets” or “pillows” made from reflective foil sheets, as shown in Figure 3.

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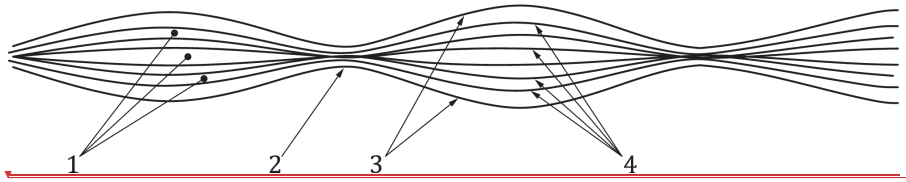

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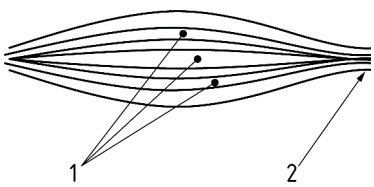


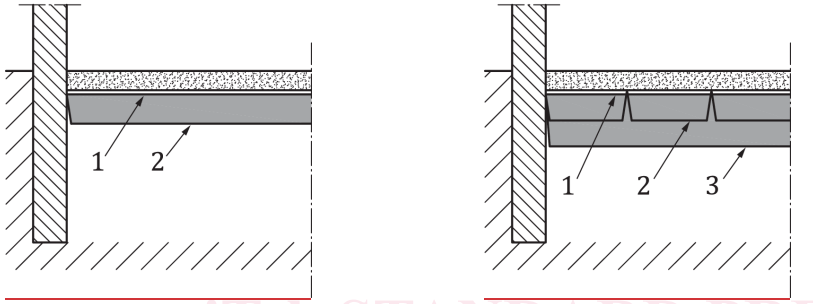
Key

1 air filled plastic bubbles
2 reflective surface(s)

Figure 3 — Example of stitched multi-foil insulation

4.5 Product Type 4

Product Type 4 is a thin film or sheet, less than 2 mm thickness, using single or in multiple layers, which makes use of a low emissivity surface to increase the thermal resistance of adjacent or enclosed air space(s), but which has no significant thermal resistance of its own (see Figure 4).



a) 2-layer foil system b) 3-layer foil system

Key
1, 2, 3 foil layers

Figure 4 — Example of multiple layers of product Type 4 under flooring

5 Methods of assessment

5.1 General

In addition to the general requirements for testing thermal performance in accordance with EN 12664, EN 12667 and ISO 8990, the specific requirements for mounting of specimens given in 5.4 to 5.8 shall also be followed. The measurement of thermal performance of reflective insulation products Type 1, Type 2 and Type 3 shall require the measurement of the thickness of the specimens.

Thickness measurement shall be in accordance with 5.2.

The test conditions should be chosen to represent the intended market (temperate or tropical), according to ISO 10456:2007, Table 1, and the relevant conditions for testing for determination of a declared value shall be stipulated in the relevant product technical specification. Unless stipulated elsewhere, thermal testing should use a mean temperature of either 10 °C or 23 °C. By default, this document uses 10 °C as the reference condition.

5.2 Thickness measurement

With the exception of thin single layer films or sheets, the thickness of all types of product which are in excess of a 2 mm nominal declared thickness shall be determined according to ISO 29466 using the procedures in the relevant product technical specification, e.g. prEN 16863 or ISO 21239[1]. For all other reflective products or in the absence of a product technical specification, the thickness shall be determined in accordance with ISO 29466 using the lowest weight of plate permitted by the test method that substantially eliminates any air gaps as per the compressibility criteria in Clause 4.

EXAMPLE The minimum weight of plate may be reduced from 50 Pa to 25 Pa.

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The method of assessment for thickness and the values used for testing shall be given in the test report.

The thickness of thin films and sheets with a nominal, declared thickness of < 2 mm may not be measured.

5.3 Test specimens

5.3.1 Size and number of specimens

The specimen size shall be appropriate to the apparatus being used. In the absence of harmonised product specifications for any product type and to permit statistical calculation of the thermal performance, a minimum of three samples shall be tested, taken from at least three different production batches wherever possible, but shall be representative of the mean value of weight per unit area of the product under test. Where a harmonized product specification exists, the rules from that standard should be followed.

5.3.2 Conditioning and specimen preparation

Except for the measurement of emissivity, where special conditioning requirements exist, all test specimens shall be stored for at least 6 h at (23 ± 5) °C. In cases of dispute, they shall be stored at (23 ± 2) °C and (50 ± 5) % relative humidity (RH) for the time specified in any relevant harmonized product standard, or for a minimum of 6 h.

NOTE 5.7.2 specifies the procedure to be followed to determine the conditioning of specimens to be used in hot box measurements where the emissivity of the facing can be subject to ageing.

In the case of products supplied in compressed form, the material shall be allowed to recover fully before conditioning for the test. This shall be for a minimum of 6 h or longer if recommended by the manufacturer. In cases of dispute, the procedure specified in ISO 29466:2022, Annex A shall be followed.

5.4 Determination of thermal resistance — Outline

Four different methods (A, B, C and D) are defined in this document. Some methods are more appropriate than others for different forms of reflective insulation materials, as described in Clause 4. The actual measured performance using each method gives comparable performance values.

Of the four methods, three, (A, B, C) provide a measurement of thermal resistance as follows:

— Method A

  Guarded hot plate apparatus shall meet the requirements of ISO 8302, EN 1946-2, EN 12664 and EN 12667;

— Method B

  Heat flow meter apparatus shall meet the requirements of ISO 8301, EN 1946-3, EN 12664 and EN 12667;

— Method C

  Hot box apparatus shall meet the requirements of ISO 8990 and EN 1946-4

— Method D

  A fourth method provides for measurement of surface emissivity and calculation of airspace thermal resistance.

The method relevant for each product type shall be performed in accordance with 5.5 to 5.8. The correct process for each product type shall be identified through the use of the flow charts in Annex A, Annex B and Annex C. The surface of the material shall be assessed as given in Clause 4 to determine the appropriate product type and test method, which shall be specified in the test report.

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