INTERNATIONAL STANDARD

ISO 10456

First edition
1997-08-15

Thermal insulation — Building materials and products — Determination of declared and design thermal values

Isolation thermique — Matériaux et produits du bâtiment — Détermination des valeurs thermiques déclarées et utiles

Reference number
ISO 10456:1997(E)

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Printed in Switzerland

Foreword

ISO (the International Organization for Standardization) is a world-wide 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 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 10456 was prepared by Technical Committee ISO/TC 163, *Thermal insulation*, Subcommittee SC 2, *Calculation methods*.

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

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Thermal insulation — Building materials and products — Determination of declared and design thermal values

1 Scope

This Internatonal Standard specifies methods for the determination of declared and design thermal values for thermally homogeneous building materials and products.

It also gives procedures to convert values obtained under one set of conditions to those valid for another set of conditions. These procedures are valid for design ambient temperatures between –30 °C and +60 °C.

Conversion coefficients for temperature and moisture, valid for mean temperatures between 0 °C and 30 °C, are given in annex A.

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 8301:1991, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Heat flow meter apparatus.*

ISO 8302:1991, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Guarded hot plate apparatus.*

ISO 8990:1994, *Thermal insulation — Determination of steady-state thermal transmission properties —Calibrated and guarded hot box.*

3 Definitions, symbols and units

3.1 Definitions

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

3.1.1 declared thermal value: Expected value of a thermal property of a building material or product

- assessed from measured data converted to reference conditions of temperature and humidity;
- given for a stated fraction and confidence level;
- corresponding to a reasonable expected service life time under normal conditions.

3.1.2 design thermal value: Value of a thermal property of a building material or product under specific external and internal conditions which can be considered as typical of the performance of that material or product when incorporated in a building component.

3.1.3 material: Piece of a product irrespective of its delivery form, shape and dimensions, without any facing or coating.

3.1.4 product: Final form of a material ready for use, of given shape and dimensions and including any facings or coatings.

3.2 Symbols and units

Table 1 - Symbols, quantities and units

Symbol	Quantity	Unit
F_a	ageing conversion factor	
F_m	moisture conversion factor	
F_T	temperature conversion factor	
f_T	temperature conversion coefficient	1/K
f_u f_ψ	moisture conversion coefficient mass by mass moisture conversion coefficient volume by volume	kg/kg m^3/m^3
R	thermal resistance	$m^2 \cdot K/W$
T	temperature	K
λ	thermal conductivity	W/(m·K)
u ψ	moisture content mass by mass moisture content volume by volume	kg/kg m^3/m^3

4 Test methods and test conditions

Measured values from the following methods, or equivalent national methods, shall be used:

- guarded hot plate in accordance with ISO 8302;
- heat flow meter in accordance with ISO 8301;
- hot box in accordance with ISO 8990.

To avoid conversions, it is recommended that measurements be conducted under conditions corresponding to the selected set of conditions given in table 2.

The mean test temperature should be chosen so that application of the temperature coefficients does not introduce a change of more than 2 % from the measured value.

The following test conditions are required:

- measured thickness and density for identification;
- mean test temperature;
- moisture content of the specimen during test;

and for aged materials:

- age of the specimen and conditioning procedures before testing.

5 Determination of declared values

The declared value shall be given under one of the sets of conditions **a** or **b** with reference temperature 10 °C (I) or 23 °C (II) in table 2.

Table 2 - Declared value conditions

Property	Sets of conditions			
	I (10 °C)		II (23°C)	
	a	b	a	b
Reference temperature	10 °C	10 °C	23 °C	23 °C
Moisture	u_{dry}	$u_{23,50}$	u_{dry}	$u_{23,50}$
Ageing	aged	aged	aged	aged
u_{dry} is a low moisture content reached by drying. $u_{23,50}$ is the moisture content when in equilibrium with air at 23 °C and relative humidity of 50 %.				

The declared value shall be determined either at a thickness large enough to neglect the thickness effect, or the declared values for smaller thicknesses shall be based on measurements at those thicknesses.

The data used shall be either

- directly measured values according to the test methods given in clause 4, or

- obtained indirectly by making use of an established correlation with a related property such as density.

When all data have not been measured under the same set of conditions, they shall first be brought to one set of conditions (see clause 7). Then a statistical single value estimate shall be calculated. Annex C refers to International Standards on statistics that can be used.

During calculations no value shall be rounded to less than three significant figures.

The declared value is the estimated value of the statistical single value, rounded according to the following rules:

- for thermal conductivity given in watt per metre kelvin [W/(m·K)]:

$\lambda \leqslant 0,08$:	rounding to nearest higher 0,001 W/(m·K)
$0,08 < \lambda \leqslant 0,20$:	rounding to nearest higher 0,005 W/(m·K)
$0,20 < \lambda \leqslant 2,00$:	rounding to nearest higher 0,01 W/(m·K)
$2,0 < \lambda$	rounding to nearest higher 0,1 W/(m·K)

and/or:

- for thermal resistance given in square metre kelvin per watt ($m^2 \cdot K/W$) as the nearest lower value rounded to not more than two decimals or three significant figures.

6 Determination of design values

Design values can be obtained from a declared value, measured values or standardized tabulated values.

Measured data can be either

- directly measured values according to the test methods given in clause 4, or

- obtained indirectly by making use of an established correlation with a related property such as density.

If the set of conditions for declared, measured or standardized tabulated values can be considered relevant for the actual application, those values can be used directly as design values. Otherwise, conversion of data shall be undertaken according to the procedure given in clause 7.

The design value shall be rounded according the rules given in clause 5:

- for thermal conductivity as the nearest higher value in watt per metre kelvin [W/(m·K)];

- for thermal resistance as the nearest lower value in square metre kelvin per watt (m^2·K/W).

6.1 Design values derived from declared values

When the design value is calculated from the declared value and is based on the same statistical evaluation, the declared value shall be converted to the design conditions.

Information on how to derive design values based on a statistical evaluation other than the one applicable to the declared value is given in annex C.

6.2 Design values derived from measured values

When necessary all data shall first be converted to the design conditions. Then a statistical single value estimate shall be calculated. Annex C refers to International Standards on statistics that can be used.

6.3 Design values derived from tabulated values

Standardized tabulated values can be used when the set of conditions for them are available.

7 Conversion of available data

Conversion coefficients derived from measured values according to the test methods referred to in clause 4 can be used instead of the values given in annex A.

Conversions of thermal values from one set of conditions (λ_1, R_1) to another set of conditions (λ_2, R_2) are carried out according to the following expressions:

$$\lambda_2 = \lambda_1 \cdot F_T \cdot F_m \cdot F_a \qquad \text{....(1)}$$

$$R_2 = \frac{R_1}{F_T \cdot F_m \cdot F_a} \qquad \text{....(2)}$$

7.1 Conversion for temperature

The factor F_T for temperature is determined by:

$$F_T = e^{f_T(T_2 - T_1)} \quad \text{....(3)}$$

where

f_T is the temperature conversion coefficient;
T_1 is the temperature of the first set of conditions;
T_2 is the temperature of the second set of conditions.

7.2 Conversion for moisture

The factor F_m for moisture content is determined as follows.

a) Conversion of moisture content given as mass by mass:

$$F_m = e^{f_u(u_2 - u_1)} \quad \text{....(4)}$$

where

f_u is the moisture content conversion coefficient mass by mass;
u_1 is the moisture content mass by mass of the first set of conditions;
u_2 is the moisture content mass by mass of the second set of conditions.

b) Conversion of moisture content given as volume by volume:

$$F_m = e^{f_\psi(\psi_2 - \psi_1)} \quad \text{....(5)}$$

where

f_ψ is the moisture content conversion coefficient volume by volume;
ψ_1 is the moisture content volume by volume of the first set of conditions;
ψ_2 is the moisture content volume by volume of the second set of conditions.

7.3 Age conversion

The ageing depends upon the material type, facings, structures, the blowing agent, the temperature and the thickness of the material. For a given material the ageing effect can be obtained from theoretical models validated by experimental data. There are no simple rules to correlate ageing over time for a given material.

No conversion is needed when the measured conductivity or resistance already takes account of ageing effects.

If a conversion factor F_a is used, it shall allow the calculation of the aged value of the thermal property corresponding to a time not less than half the working lifetime of the product in the application concerned.

NOTES

1 The working lifetime is often taken as 50 years.

2 No conversion coefficients are given in this International Standard to derive the ageing factor F_a.

Annex A
(normative)

Conversion coefficients

A.1 Use of the values

For conductivities between those given in the tables, use linear interpolation.

Unless otherwise specified the conversion coefficients apply to both factory-made products and loose-fill materials.

Values of thermal conductivity are given as identification parameters only and are not intended for any other purpose.

A.2 Conversion coefficients for temperature

The values in the following tables are valid for mean temperatures between 0 °C and +30 °C.

Table A.1 - Mineral wool

Product type	Conductivity λ W/(m·K)	Conversion coefficient, f_T 1/K
Bats, mats and loose fill	0,035 0,040 0,045 0,050	0,0046 0,0056 0,0062 0,0069
Boards	0,032 0,034 0,036 0,038	0,0038 0,0043 0,0048 0,0053
Rigid boards	0,030 0,033 0,035	0,0035 0,0035 0,0031

Table A.2 - Expanded polystyrene

Thickness d mm	Conductivity λ W/(m·K)	Conversion coefficient, f_T 1/K
$d \leqslant 20$	0,032 0,035 0,040 0,043	0,0031 0,0036 0,0041 0,0044
$20 < d \leqslant 40$	0,032 0,035 0,040	0,0030 0,0034 0,0036
$40 < d \leqslant 100$	0,032 0,035 0,040 0,045 0,050	0,0030 0,0033 0,0036 0,0038 0,0041

Table A.2 - Expanded polystyrene *(concluded)*

Thickness d mm	Conductivity λ W/(m·K)	Conversion coefficient, f_T 1/K
d >100	0,032 0,035 0,040 0,053	0,0030 0,0032 0,0034 0,0037

Table A.3 - Extruded polystyrene

Product type	Conductivity λ W/(m·K)	Conversion coefficient, f_T 1/K
Without skin	0,025 0,030 0,040	0,0046 0,0045 0,0045
With skin, fine cell products without skin	0,025 0,030 0,035	0,0040 0,0036 0,0035
With impermeable cover	0,025 0,030 0,035 0,040	0,0030 0,0028 0,0027 0,0026

Table A.4 - Polyurethane foam

Product type	Conductivity λ W/(m·K)	Conversion coefficient, f_T 1/K
All products	0,025 0,030	0,0055 0,0050

Table A.5 - Phenolic foam

Product type	Conductivity λ W/(m·K)	Conversion coefficient, f_T 1/K
All products	all	0,0029