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Thermal performance of buildings and building components — Physical quantities and definitions

Performance thermique des bâtiments et des matériaux pour le bâtiment — Grandeurs physiques et définitions

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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 on 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 the following URL: 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*.

This third edition of ISO 7345 cancels and replaces the second edition (ISO 7345:1987), which has been technically revised.

This edition includes the following significant changes with respect to the previous edition:

— title of the standard updated from '*Thermal insulation — Physical quantities and definitions*' to '*Thermal performance of buildings and building elements — Physical quantities and definitions*';

— title of ISO/TC 163 corrected (Foreword);

— ISO 31-4 replaced by ISO 80000-5 in the note in the Scope and added to the Bibliography;

— symbols, names and definitions (in 3.3 and 3.4) adapted to current state ($\Lambda \rightarrow L$, $\Lambda_l \rightarrow L_{2D}$, $U_l \rightarrow \Psi$, coefficient of heat loss → heat transfer coefficient);

— "areal" used instead of "surface" in quantity names (Clause 3) where "surface" was meant to distinguish between a length-related quantity ("linear") and an area-related quantity (now "areal") with similar name;

— Formula in 3.1.4 corrected;

— subscript l added in 3.4;

— added a Note 1 to entry in 3.1.11 and a Note 3 to entry in 3.1.13;

— H' added in 3.2.2 as an alternative name for F_S;

— added "for homogeneous solids" to A.1 in Annex A.

Introduction

This document is intended to be used in conjunction with other vocabularies related to thermal insulation. These include:

— ISO 7945, *Thermal insulation — Physical quantities and definitions*

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

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

— ISO 9229, *Thermal insulation — Thermal insulating materials and products — Vocabulary*

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

NOTE Annex A provides an explanation of the concept of thermal conductivity.

Thermal performance of buildings and building components — Physical quantities and definitions

1 Scope

This document defines physical quantities used in the thermal performance of buildings and building elements, and gives the corresponding symbols and units.

NOTE Because the scope of this document is restricted to thermal performance and energy use in the built environment, some of the definitions it contains differ from those given ISO 80000-5.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

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

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

3.1 Physical quantities and definitions

3.1.1
heat
quantity of heat
Q
Note 1 to entry: Unit: J.

3.1.2
heat flow rate
Φ
quantity of heat transferred to or from a system divided by time

$$\Phi = \frac{dQ}{dt}$$

Note 1 to entry: Unit: W.

3.1.3
density of heat flow rate
q
heat flow rate divided by area

$$q = \frac{d\Phi}{dA}$$

Note 1 to entry: The word “density” should be replaced by “areal density” when it may be confused with *linear density* (3.1.4).

Note 2 to entry: Unit: W/m^2.

3.1.4
linear density of heat flow rate

q_l

heat flow rate divided by length:

$$q_l = \frac{d\Phi}{dl}$$

Note 1 to entry: Unit: W/m.

3.1.5
thermal conductivity

λ

quantity defined by the following relation:

$$\vec{q} = -\lambda \operatorname{grad} T$$

Note 1 to entry: A rigorous treatment of the concept of thermal conductivity is given in the annex, which also deals with the application of the concept of thermal conductivity to porous isotropic or anisotropic materials and the influence of temperature and test conditions.

Note 2 to entry: Unit: W/(m·K).

3.1.6
thermal resistivity

r

quantity defined by the following relation:

$$\operatorname{grad} T = -r\,\vec{q}$$

Note 1 to entry: A rigorous treatment of the concept of thermal resistivity is given in Annex A.

Note 2 to entry: Unit: (m·K)/W.

3.1.7
thermal resistance

R

temperature difference divided by the density of heat flow rate in the steady state condition:

$$R = \frac{T_1 - T_2}{q}$$

Note 1 to entry: For a plane layer for which the concept of thermal conductivity applies, and when this property is constant or linear with temperature (see Annex A):

$$R = \frac{d}{\lambda}$$

Note 2 to entry: where d is the thickness of the layer.

Note 3 to entry: These definitions assume the definition of two reference temperatures, T_1 and T_2, and the area through which the density of heat flow rate is uniform.

Note 4 to entry: Thermal resistance can be related either to the material, structure or surface. If either T_1 or T_2 is not the temperature of a solid surface, but that of a fluid, a reference temperature must be defined in each specific case (with reference to free or forced convection and radiation from surrounding surfaces, etc.).

Note 5 to entry: When quoting values of thermal resistance, T_1 and T_2 must be stated.

Note 6 to entry: "Thermal resistance" should be replaced by "areal thermal resistance" when it may be confused with *linear thermal resistance* (3.1.8).

Note 7 to entry: Unit: $(m^2 \cdot K)/W$.

3.1.8
linear thermal resistance
R_l
temperature difference divided by the linear density of heat flow rate in the steady state condition:

$$R_l = \frac{T_1 - T_2}{q_l}$$

Note 1 to entry: This assumes the definition of two reference temperatures, T_1 and T_2, and the length along which the linear density of heat flow rate is uniform.

Note 2 to entry: If within the system either T_1 or T_2 is not the temperature of a solid surface, but that of a fluid, a reference temperature must be defined in each specific case (with reference to free or forced convection and radiation from surrounding surfaces, etc.).

Note 3 to entry: When quoting values of linear thermal resistance, T_1 and T_2 must be stated.

Note 4 to entry: Unit: $(m \cdot K)/W$.

3.1.9
surface coefficient of heat transfer
h
density of heat flow rate at a surface in the steady state divided by the temperature difference between that surface and the surroundings:

$$h = \frac{q}{T_s + T_a}$$

Note 1 to entry: This assumes the definition of the surface through which the heat is transferred, the temperature of the surface, T_s, and the ambient temperature, T_a (with reference to free or forced convection and radiation from surrounding surfaces. etc.). The surface us usually denoted by an index *e* for external and *i* for internal surface.

Note 2 to entry: Unit: $W/(m^2 \cdot K)$.

3.1.10
thermal conductance
L
reciprocal of thermal resistance from surface to surface under conditions of uniform density of heat flow rate:

$$L = \frac{1}{R}$$

Note 1 to entry: "Thermal conductance" should be replaced by "areal thermal conductance" when it may be confused with *linear thermal conductance* (3.1.11)

Note 2 to entry: Unit: $W/(m^2 \cdot K)$.

3.1.11
linear thermal conductance
L_l
W/(m·K)
reciprocal of linear thermal resistance from surface to surface under conditions of uniform linear density of heat flow rate:

$$L_l = \frac{1}{R_l}$$

Note 1 to entry: Unit: W/(m·K).

3.1.12
thermal transmittance
U
heat flow rate in the steady state divided by area and by the temperature difference between the surroundings on both sides of a flat uniform system:

$$U = \frac{\Phi}{(T_1 - T_2)A}$$

Note 1 to entry: This assumes the definition of the system, the two reference temperatures, T_1 and T_2, and other boundary conditions.

Note 2 to entry: “Thermal transmittance” should be replaced by “areal thermal transmittance” when it may be confused with *linear thermal transmittance* (3.1.13).

Note 3 to entry: The reciprocal of the thermal transmittance is the total thermal resistance between the surroundings on both sides of the flat uniform system.

Note 4 to entry: Unit: W/(m^2·K).

3.1.13
linear thermal transmittance
Ψ
heat flow rate in the steady state divided by length and by the temperature difference between the surroundings on each side of a system:

$$\Psi = \frac{\Phi}{(T_1 - T_2)l}$$

Note 1 to entry: This assumes the definition of the system, the two reference temperatures, T_1 and T_2, and other boundary conditions.

Note 2 to entry: The reciprocal of the linear thermal transmittance is the total linear thermal resistance between the surroundings on each side of the system.

Note 3 to entry: When Ψ is used to characterize linear thermal bridges in the building envelope Ψ is not the *total* but the *additional* heat transfer due to the thermal bridge [i.e. additional to the heat transfer taken into account by the (areal) thermal transmittance U].

Note 4 to entry: Unit: W/(m·K).

3.1.14
heat capacity
C
quantity defined by the formula:

$$C = \frac{dQ}{dT}$$

Note 1 to entry: When the temperature of a system is increased by dT as a result of the addition of a small quantity of heat dQ, the quantity dQ / dT is the heat capacity.

Note 2 to entry: Unit: J/K.

3.1.15
specific heat capacity
c
heat capacity divided by mass:

$$c = \frac{C}{m}$$

Note 1 to entry: Unit: J/(kg·K).

3.1.15.1
specific heat capacity at constant pressure
c_p

$$c_p = \frac{C}{m}$$

Note 1 to entry: Unit: J/(kg·K).

3.1.15.2
specific heat capacity at constant volume
c_v

$$c_v = \frac{C}{m}$$

Note 1 to entry: Unit: J/(kg·K).

3.1.16
thermal diffusivity
a
thermal conductivity divided by the density and the specific heat capacity:

$$a = \frac{\lambda}{\varrho \quad c}$$

Note 1 to entry: For fluids the appropriate specific heat capacity is c_p.

Note 2 to entry: The definition assumes that the medium is homogeneous and opaque.

Note 3 to entry: The thermal diffusivity is relevant to the non-steady-state and may be measured directly or calculated from separately measured quantities by the above formula.

Note 4 to entry: Among others, thermal diffusivity accounts for the response of the temperature at a location inside a material to a change of temperature at the surface. The higher the thermal diffusivity of the material, the more sensitive the interior temperature is to changes of the surface temperature.

Note 5 to entry: Unit: m^2/s.

3.1.17
thermal effusivity
b
square root of the product of thermal conductivity, density and specific heat capacity:

$$b = \sqrt{\lambda \quad \varrho \quad c}$$

Note 1 to entry: For fluids the appropriate specific heat capacity is c_p.