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Thermal insulation — Heat transfer by radiation — Vocabulary

Isolation thermique — Transfert de chaleur par rayonnement — Vocabulaire

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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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This document was prepared by Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, 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).

This second edition cancels and replaces the first edition (ISO 9288:1989), which has been technically revised.

The main changes are as follows:

— deleted the unit where two units existed (4.5, 4.6, 4.8, 4.9, 4.10, 5.3, 5.6, 6.2, 6.4);

— added the mean of d and d_∞ (7.15);

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

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

— ISO 7345

— ISO 9229

— ISO 9251

— ISO 9346

Thermal insulation — Heat transfer by radiation — Vocabulary

1 Scope

This document defines physical quantities and other terms in the field of thermal insulation relating to heat transfer by radiation.

2 Normative references

There are no normative references in this document.

3 Terms and definitions (General terms)

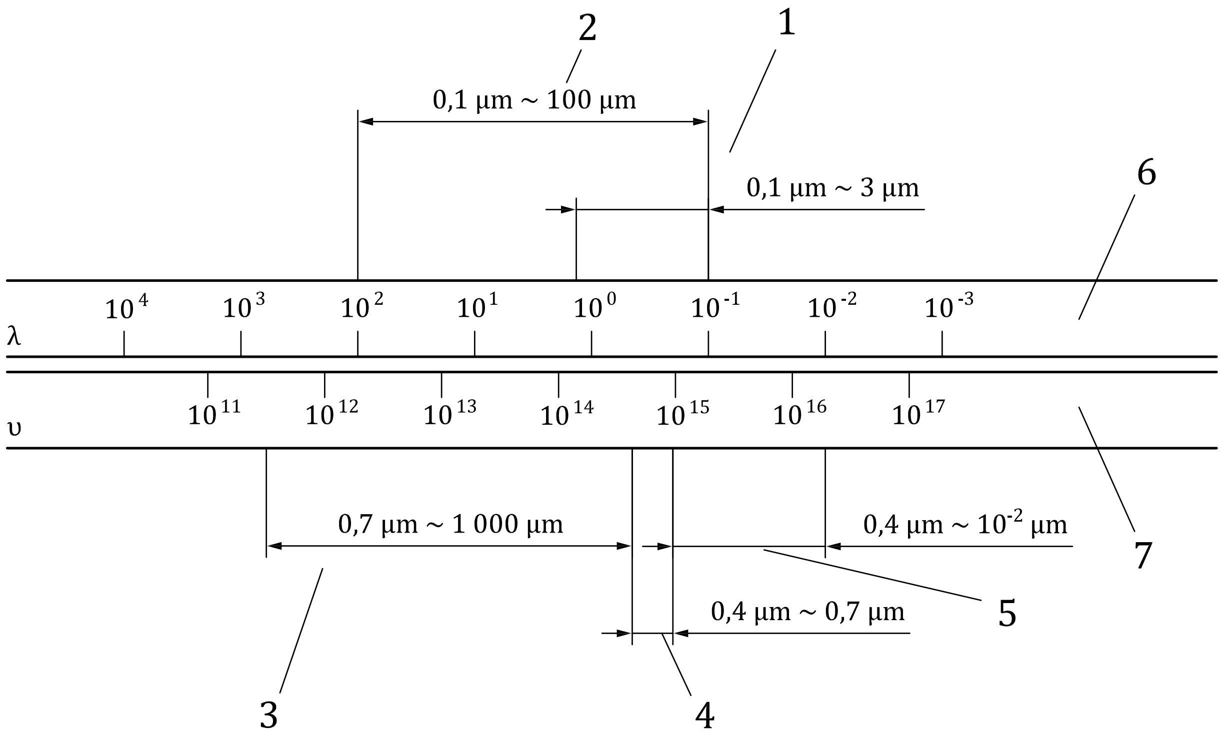
ISO and IEC maintain terminology databases for use in standardization at the following addresses:

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

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

3.1
thermal radiation
electromagnetic radiation emitted at the surface of an opaque body or inside an element of a semi-transparent volume

Note 1 to entry: The thermal radiation is governed by the temperature of the emitting body and its radiative characteristics. It is interesting from a thermal viewpoint when the wavelength range falls between 0, l µm and 100 µm (see Figure 1).



Key

1 solar radiation
2 thermal radiation
3 infrared
4 visible
5 ultraviolet
6 wavelength µm
7 frequency s^{-1}

Figure 1 — Electromagnetic wave spectrum

3.2
heat transfer by radiation
energy exchanged between bodies by means of electromagnetic waves

Note 1 to entry: These exchanges can occur when the bodies are separated from one another by vacuum or by a transparent or a semi-transparent medium. To evaluate these radiation heat exchanges it is necessary to know how opaque and semi-transparent bodies emit, absorb and transmit radiation as a function of their nature, relative position and temperature.

3.3
total radiation
entire spectrum of thermal radiation

3.4
spectral radiation
monochromatic radiation
spectral interval centred on the wavelength λ of thermal radiation, according to spectral distribution

3.5
hemispherical radiation
all directions of thermal radiation along which a surface element can emit or receive radiation, according to spatial distribution (directional)

3.6
directional radiation
thermal radiation whose directions of propagation are defined by a solid angle around the defined direction, according to spatial distribution

3.7
opaque medium
medium, which does not transmit any fraction of the incident radiation

Note 1 to entry: The absorption, *emission* (5.1) and reflection of radiation can be handled as surface phenomena

3.8
semi-transparent medium
medium, in which the incident radiation is progressively attenuated inside the material by absorption or scattering, or both

Note 1 to entry: The absorption, scattering and *emission* (5.1) of radiation are bulk (volume) phenomena.

Note 2 to entry: The radiative properties of an opaque or semi-transparent medium are generally a function of the spectral and directional distribution of incident radiation and of the temperature of the medium.

Note 3 to entry: Thermal insulating materials are generally semi-transparent media.

4 Terms related to surfaces either receiving, transferring or emitting a thermal radiation

4.1
radiant heat flow rate
radiant flux
Φ
heat flow rate emitted, transferred or received by a system in form of electromagnetic waves

Note 1 to entry: This is a total hemispherical quantity. See Table 1.

Note 2 to entry: Expressed in W.

4.2
total intensity
I_Ω
radiant heat flow rate (4.1) divided by the solid angle around the direction $\vec{\Delta}$:

$$I_\Omega = \frac{d\phi}{d\Omega}$$

Note 1 to entry: Expressed in W/sr.

4.3
total radiance
L_Ω
radiant heat flow rate (4.1) divided by the solid angle around the direction $\vec{\Delta}$ and the projected area normal to this direction:

$$L_\Omega = \frac{d^2\Phi}{d\Omega d(A\cos\theta)}$$

Note 1 to entry: Expressed in $\mathrm{W}/\left(\mathrm{m}^2 \cdot \mathrm{sr}\right)$.

4.4
spectral radiant heat flow rate
Φ_λ
radiant heat flow rate (4.1) divided by the spectral interval centred on the wavelength λ:

$$\phi_\lambda = \frac{d\phi}{d\lambda}$$

Note 1 to entry: Expressed in W/m.

4.5
spectral intensity
$I_{\Omega\lambda}$
total intensity (4.2) divided by the spectral interval centred on the wavelength λ:

$$I_{\Omega\lambda} = \frac{dI_\Omega}{d\lambda}$$

Note 1 to entry: Expressed in $\mathrm{W/(sr \cdot m)}$.

4.6
spectral radiance
$L_{\Omega\lambda}$
total radiance (4.3) divided by the spectral interval centred on the wavelength λ:

$$L_{\Omega\lambda} = \frac{dL_\Omega}{d\lambda}$$

Note 1 to entry: Expressed in $\mathrm{W/\left(m^3 \cdot sr\right)}$.

Note 2 to entry: Each spectral term A_λ is related to the corresponding total term A by a relation of the type

$$A_\lambda = \frac{dA}{d\lambda} \; or \; A = \int_0^\infty A_\lambda \, d\lambda$$

Note 3 to entry: Each directional term A_Ω is related to the corresponding hemispherical term A by a relation of the type

$$A_\Omega = \frac{dA}{d\Omega} \; or \; A = \int_{\Omega=4\pi} A_\Omega \, d\Omega$$

and

$$A_{\Omega\lambda} = \frac{d^2 A}{d\Omega d\lambda} \; or \; A = \int_{\Omega=4\pi} \int_0^\infty A_{\Omega\lambda} \, d\lambda d\Omega$$

Note 4 to entry: Total radiance and spectral radiance are oriented quantities (vectors) defined in each point of space where radiation exists (see Figure 3), moreover their values are independent of the particular surface used to define them. Sources which radiate with constant L_Ω (see 4.3) are called isotropic or diffuse.

Note 5 to entry: Intensities are oriented quantities too, but belong to a surface (see Figure 2).

Note 6 to entry: Radiant flows (total or spectral) are not oriented quantities and belong to a surface.

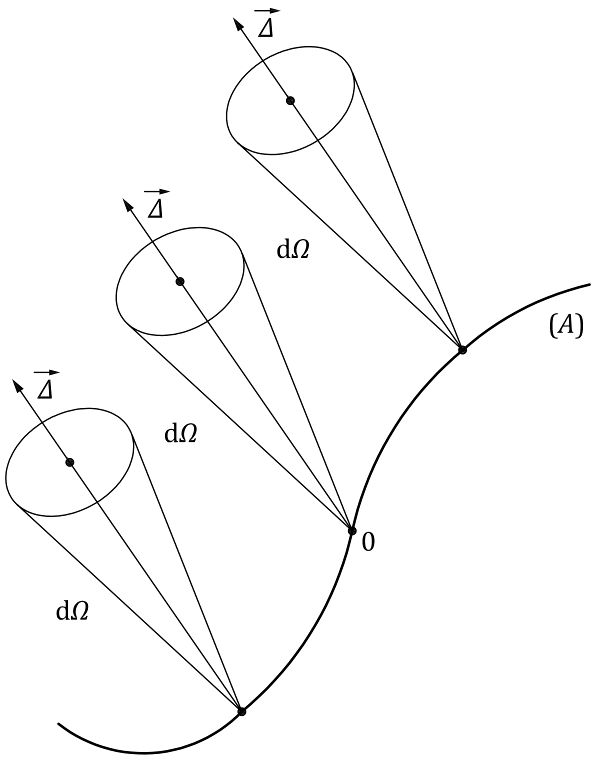


Figure 2 — Definition of the intensity

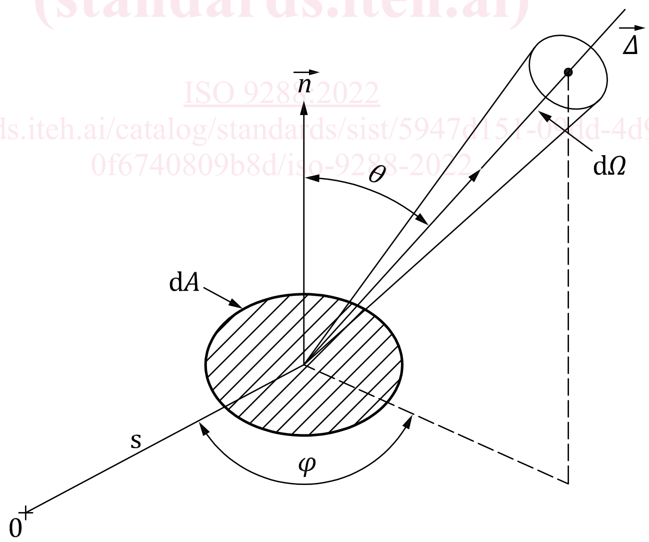


Figure 3 — Definition of the radiance

4.7
spectral radiant density of heat flow rate vector

$\overrightarrow{q_{r,\lambda}}$

$$\overrightarrow{q_{r,\lambda}} = \int_{\Omega=4\pi} L_{\Omega\lambda} \vec{\Delta} d\Omega$$

where

$L_{\Omega\lambda}$ is the *spectral radiance* (4.6);

$\vec{\Delta}$ is the solid angle around the direction.

Note 1 to entry: Expressed in W/m^3.

4.8
total radiant density of heat flow rate vector
$\overrightarrow{q_r}$

$$\overrightarrow{q_r} = \int_0^{\infty} \int_{\Omega=4\pi} L_{\Omega\lambda} \vec{\Delta} d\Omega d\lambda$$

where

$L_{\Omega\lambda}$ is the *spectral radiance* (4.6);

$\vec{\Delta}$ is the solid angle around the direction;

λ is the wavelength.

Note 1 to entry: Expressed in W/m^3.

4.9
spectral radiant density of heat flow rate
$q_{r,\lambda n}$

$$q_{r,\lambda n} = \vec{n} \cdot \overrightarrow{q_{r,\lambda}} = \int_{\Omega=4\pi} L_{\Omega\lambda} \vec{\Delta} \cdot \vec{n} d\Omega$$

where

$L_{\Omega\lambda}$ is the *spectral radiance* (4.6);

$\vec{\Delta}$ is the solid angle around the direction;

$\vec{n}$ is the heat flow rate in the direction.

Note 1 to entry: Expressed in W/m^3.

Note 2 to entry: Heat flow rate in the direction $\vec{n}$.

4.10
forward component of the spectral radiant density of heat flow rate
$q^{+}_{r,\lambda n}$

$$q^{+}_{r,\lambda n} = \vec{n} \cdot \overrightarrow{q_{r,\lambda}} = \int_{\Omega=2\pi} L_{\Omega\lambda} \vec{\Delta} \cdot \vec{n} d\Omega$$

where

$L_{\Omega\lambda}$ is the *spectral radiance* (4.6);

$\vec{\Delta}$ is the solid angle around the direction;

$\vec{n}$ is the heat flow rate in the direction.

Note 1 to entry: Expressed in W/m^3.