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МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

Thermal insulation — Mass transfer — Physical quantities and definitions

Isolation thermique — Transfert de masse — Grandeurs physiques et définitions

Reference number
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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

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Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Thermal insulation — Mass transfer — Physical quantities and definitions

0 Introduction

This International Standard forms part of a series of vocabularies related to thermal insulation.

The series will include

ISO 7345, *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.*[1)]

ISO 9288, *Thermal insulation — Heat transfer by radiation — Physical quantities and definitions.*[1)]

1 Scope and field of application

This International Standard defines physical quantities and other terms in the field of mass transfer relevant to thermal insulation systems, and gives the corresponding symbols and units.

2 General terms

2.1 mass transfer : Transmission of mass (especially moisture or air) by various mechanisms.

2.2 moisture : Water in gaseous, liquid or solid phase.

2.3 water vapour : Moisture in the gaseous phase.

2.4 water vapour diffusion : Movement of water vapour molecules in a gas mixture tending to equalize the vapour content in the air or the partial pressure of the vapour, with the total pressure being constant.

2.5 water vapour convection : Transfer of water vapour in a gas mixture by movement of the whole gas mixture due to a difference in total pressure.

2.6 hygroscopic sorption curve : Relation between moisture content in a porous material and the relative humidity of the ambient air at equilibrium.

NOTE — There are curves for sorption and for desorption. Because of measuring difficulties there is an upper limit for the relative humidity at 95 % to 98 %.

2.7 suction curve : Relation between the equalized moisture content in a porous material and the suction (negative pore pressure) in the pore water.

NOTE — Generally there are curves for sorption and for desorption. Theoretically the suction curve covers the whole moisture range, from absolute dryness to full saturation.

1) At present at the stage of draft.

3 Physical quantities and definitions

Definition	Symbol	Unit
3.1 humidity by volume : Mass of water vapour divided by the volume of the gaseous mixture.	v	kg/m^3
NOTES 1 Humidity by volume is the same as the partial mass density of water vapour, ϱ_v. 2 At saturation the notations v_{sat} and $\varrho_{v,sat}$ are used.		
3.2 humidity by mass : Mass of water vapour divided by the mass of dry air.	x	kg/kg
NOTE — At saturation the notation x_{sat} is used.		
3.3 partial water vapour pressure : Partial pressure of water vapour in a gaseous mixture.	p_v	Pa
NOTE — At saturation the notation p_{sat} is used.		
3.4 relative humidity : Actual humidity by volume divided by humidity by volume at saturation at the same temperature : $\phi = \frac{v}{v_{sat}}$	ϕ	
NOTE — Assuming an ideal gas behaviour $\phi = \frac{p_v}{p_{v,sat}}$		
3.5 specific enthalpy : Enthalpy divided by mass.	h	J/kg
3.5.1 specific latent enthalpy of evaporation or condensation	h_e	J/kg
3.5.2 specific latent enthalpy of melting (or freezing)	h_m	J/kg
3.6 moisture content mass by volume : Mass of evaporable water divided by volume of material.	w	kg/m^3
NOTE — Volume of material can either be that of wet state or dry state and shall be specified when quoting moisture content. The method of evaporating water from a moist material must be stated.		
3.7 moisture content volume by volume : Volume of evaporable water divided by volume of material.	ψ	m^3/m^3
NOTE — Volume of material can either be that of wet state or dry state and shall be specified when quoting moisture content. The method of evaporating water from a moist material must be stated.		
3.8 moisture content mass by mass : Mass of evaporable water divided by mass of material.	u	kg/kg
NOTE — Mass of material can either be that of wet state or dry state and shall be specified when quoting moisture content. The method of evaporating water from a moist material must be stated.		
3.9 degree of saturation : Mass of water in a porous body divided by the mass of water at saturation.	S	
NOTE — The method of reaching saturation must be stated.		
3.10 suction : The pressure difference between the pore water pressure and the ambient total pressure.	s	Pa

	Symbol	Unit
3.11 moisture flow rate : Mass of moisture transferred to or from a system divided by time.	G	kg/s
3.12 density of moisture flow rate : Moisture flow rate divided by area.	g	kg/(m²·s)
3.13 water vapour diffusion coefficient in the air : Quantity defined by the following relation :	D	m²/s
$\vec{g} = -D \text{ grad } v$		
where		
$\vec{g}$ is the vector density of water vapour flow rate in air;		
v is the humidity by volume.		
NOTE — Fick's law describes water vapour diffusion in air.		
3.14 moisture permeability : Quantities defined by the following relations :		
a) permeability with regard to humidity by volume		
$\vec{g} = -\delta_v \text{ grad } v$	δ_v	m²/s
b) permeability with regard to partial vapour pressure		
$\vec{g} = -\delta_p \text{ grad } p_v$	δ_p	kg/(m·s·Pa)
where		
$\vec{g}$ is the vector density of moisture flow rate;		
v is the humidity by volume in the pores;		
p_v is the partial vapour pressure in the pores.		
NOTE — Water vapour transmission through porous materials can be related to different driving mechanisms. Humidity by volume or partial vapour pressure are commonly used.		
The word diffusion should not be used in this context, as part of the moisture flow is in liquid phase.		
The transfer coefficients are dependent on the level of the corresponding relative humidity or moisture content of the material.		
3.15 moisture permeance : Quantities defined by the following relations :		
a) permeance with regard to humidity by volume		
$g = W_v (v_1 - v_2)$	W_v	m/s
b) permeance with regard to partial vapour pressure		
$g = W_p (p_1 - p_2)$	W_p	kg/(m²·s·Pa)
where		
g is the density of moisture flow rate perpendicular to the surfaces of a layer;		
v_1 and v_2 are the ambient humidities by volume of air;		
p_1 and p_2 are ambient partial vapour pressures.		

	Symbol	Unit
3.16 moisture resistance : The inverse of moisture permeance :		
a) moisture resistance with regard to humidity to volume		
$Z_v = \frac{1}{W_v}; \left(g = \frac{v_1 - v_2}{Z_v}\right)$	Z_v	s/m
b) moisture resistance with regard to partial vapour pressure		
$Z_p = \frac{1}{W_p}; \left(g = \frac{p_1 - p_2}{Z_p}\right)$	Z_p	$m^2 \cdot s \cdot Pa/kg$
3.17 moisture resistance factor : Water vapour diffusion coefficient in air, D, divided by the moisture permeability, δ_v, of a porous material.	μ	
3.18 moisture diffusivity : Quantity defined by the following relation :	D_w	m^2/s
$\vec{g} = D_w \operatorname{grad} w$		
where		
$\vec{g}$ is the vector density of moisture flow rate;		
w is the moisture content mass by volume.		
NOTE — Moisture diffusivity and moisture conductivity are principally used to describe moisture transfer in the liquid phase, but they include also the gaseous phase.		
3.19 moisture conductivity : Quantity defined by the following relation :	λ_m	$kg/(m \cdot s \cdot Pa)$
$\vec{g} = \lambda_m \operatorname{grad} s$		
where		
$\vec{g}$ is the vector density of moisture flow rate;		
s is the suction.		
NOTE — Moisture diffusivity and moisture conductivity are principally used to describe moisture transfer in the liquid phase, but they include also the gaseous phase.		
3.20 surface coefficient of water vapour transfer : Quantity defined by the following relations :		
a) $g = \beta_v (v_a - v_s)$	β_v	m/s
b) $g = \beta_p (p_{va} - p_{vs})$	β_p	$kg/(m^2 \cdot s \cdot Pa)$
where		
g is the density of moisture flow rate;		
v_a and v_s are the humidities by volume of ambient air and at the surface respectively;		
p_{va} and p_{vs} are the partial vapour pressures of ambient air and at the surface respectively.		

	Symbol	Unit
3.21 moisture differential capacity : Quantity defined by the following relation : $\xi = \frac{dw}{d\phi}$	ξ	kg/m^3

where

w is the moisture content mass by volume;

ϕ is the relative humidity.

NOTE — This value indicates the tangent of the hygroscopic sorption curve.

	Symbol	Unit
3.22 thermal diffusion coefficient of moisture : Quantity defined by the following relation : $\vec{g} = D_T \operatorname{grad} T$	D_T	kg/(m·s·K)

where

$\vec{g}$ is the vector density of moisture flow rate;

T is the temperature.

NOTE — The thermal diffusion coefficient is dependent on how the flow related to moisture gradients is described.

	Symbol	Unit
3.23 water sorption coefficient : Quantity defined by the following relation : $m_s = A\sqrt{t}$	A	kg/(m^2·s$^{1/2}$)

where

m_s is the mass divided by area of sorbed water from a water surface;

t is time.

	Symbol	Unit
3.24 water penetration coefficient : Quantity defined by the following relation : $x = B\sqrt{t}$	B	m/s$^{1/2}$

where

x is the penetration depth of the water front during sorption from a water surface;

t is time.

	Symbol	Unit
3.25 air flow rate : Volume of air transferred to or from a system divided by time.	R	m^3/s
3.26 density of air flow rate : Air flow rate divided by area.	r	m^3/(m^2·s)
3.27 permeability of a porous medium : Quantity defined by the following relation : $\vec{r} = -\frac{k}{\eta} \operatorname{grad} p$	k	m^2

where

$\vec{r}$ is the vector density of flow rate in a porous medium;

p is the fluid pressure;

η is the dynamic viscosity of the fluid at constant temperature.

	Symbol	Unit
3.28 air permeance : Quantity defined by the following relation : $r = K(p_1 - p_2)$ where r is the density of air flow rate through a layer; p_1 and p_2 are the ambient air pressure. NOTE — The term K for air permeance includes the effect of the viscosity of air at constant temperature.	K	$m^3/(m^2 \cdot s \cdot Pa)$
3.29 air resistance : Reciprocal of air permeance : $S = \frac{1}{K}; r = \frac{p_1 - p_2}{S}$	S	$m^2 \cdot s \cdot Pa/m^3$

4 Subscripts

v vapour

w water, liquid

sat saturation

a ambient

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Descriptors : thermal insulation, quantities, units of measurement, symbols, definitions.

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