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Heat, Air and Moisture Transfer Terminology

Parameters and Concepts

International Council
for Research and Innovation
in Building and Construction

HEAT, AIR AND MOISTURE TRANSFER TERMINOLOGY

PARAMETERS AND CONCEPTS

CIB – W040
HEAT AND MOISTURE TRANSFER IN BUILDINGS

EDITED BY

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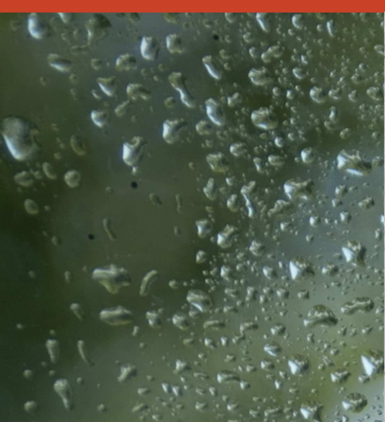


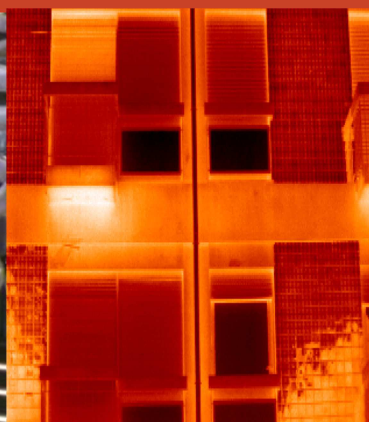

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CIB W040

Heat and Moisture Transfer in Buildings

CIB

HEAT, AIR AND MOISTURE TRANSFER TERMINOLOGY – PARAMETERS AND CONCEPTS

2012

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SUMMARY

This publication compiles the heat, air and moisture transfer terminology existing in books, standards and other reference documents. A small introduction is provided in Chapter 1 to present the CIB Commission W040 – Heat and Moisture Transfer in Buildings and to summarise the Commission activities since its formation in 1969. Chapter 2 indicates the guidelines for the use of this document. In Chapter 3 both parameters and concepts are presented, their definition according to the literature and the symbol(s) and unit(s) that are commonly used to describe it. Finally, Chapter 4 lists all the reference documents that were taken into consideration to develop this document.

CONTENT

CHAPTER 1

INTRODUCTION

THE CIB W040 – HEAT AND MOISTURE TRANSFER IN BUILDINGS

CIB is the acronym of INTERNATIONAL COUNCIL FOR RESEARCH AND INNOVATION IN BUILDING AND CONSTRUCTION. CIB was established in 1953 as an Association whose objectives were to stimulate and facilitate international cooperation and information exchange between governmental research institutes in the building and construction sector, with an emphasis on those institutes engaged in technical fields of research.

CIB has since developed into a worldwide network of over 5000 experts from about 500 member organizations with a research, university, industry or government background, who collectively are active in all aspects of research and innovation for building and construction. A CIB Commission is a worldwide network of experts in a defined scientific area who meet regularly and exchange information on a voluntary basis. The scope, objectives and work programme of each Commission are defined by its members and officially approved by the CIB Programme Committee. All the Commissions have at least one Coordinator, who is appointed by its members and by the CIB Programme Committee.

The Commission W040 – Heat and Moisture Transfer in Buildings is one of the CIBs oldest groups and was officially created in 1969 when the first meeting occurred, in Berlin, Germany. By that time the Coordinator was Bob Vos from the Netherlands. In 1983, during Leuven meeting Bob Vos resigned and Hugo Hens from Belgium was elected. At the Sopron meeting, in 1993, Ingemar Samuelson from Sweden became the new coordinator. Since 2008, after the Copenhagen meeting, the Coordinator of W040 – Heat and Moisture Transfer in Buildings is Vasco Peixoto de Freitas from University of Porto, Portugal.

ACTIVITIES OF CIB W040

SCOPE

The Commission W040 is essentially concerned with the phenomena related with heat and moisture transfer in buildings and encouraging the systematic application of that knowledge to the design, construction and management of buildings. Researchers are invited to present their work at the meetings, where the information is discussed and after the meeting it is spread to the participants’ institutions and countries.

The main objectives of W040 are:

- to explore the phenomena of heat, moisture, air and salts transfer in buildings, components and materials;
- to define, measure and discuss the hygrothermal properties of materials and building components;
- to discuss the hygrothermal advanced models;
- to analyse case studies.

MEMBERS

The Commission W040 has, at the moment, around 60 members from Austria, Belgium, Canada, Chile, Denmark, Estonia, Finland, Germany, India, Iran, Israel, Italy, Lithuania, Netherlands, New Zealand, Nigeria, Poland, Portugal, Romania, Slovakia, Sudan, Sweden, Switzerland, United Arab Emirates and United Kingdom.

Members of this Working Commission have to be either a Representative of a CIB Member Organisation or an Individual CIB Member. They are elected by the working party at the ordinary meetings. All members must participate actively in W040's meetings, present their own research and take part in discussions. In addition, members must provide information on the work of W040 in their home countries and also keep W040 informed of current research in those countries.

Since the CIB W040 was created, several personalities can be distinguished by their enormous contribution given to the Commission activities, namely, Bob Vos, Hugo Hens, Mark Bomberg and Arne Elmroth. Their actions as coordinators or members were, and still are, essential to increase the working group and to achieve the proposed objectives along the years.

PUBLICATIONS

The last publications are the following:

YEAR	TITLE	TYPE OF PUBLICATION
1975	Quantities, symbols and units for the description of heat and moisture transfer in buildings: Conversion factors, 1975	Report
1989	Proceedings of the W040 Meeting, Victoria BC, Canada,1989	Proceedings

YEAR	TITLE	TYPE OF PUBLICATION
1991	Proceedings of the W040 Meeting, Lund, Sweden, 1991	Proceedings
1993	Proceedings of the W040 Meeting, Sopron, Hungary, 1993	Proceedings
1995	Moisture Problems in Building, Proceedings of the International Symposium in Porto, Portugal, 1995	Proceedings
1997	Heat and Moisture Transfer in Buildings - Minutes and Proceedings of W040 Meeting in Kyoto, Japan, 1997	Proceedings
1999	Heat and Moisture Transfer in Building – Papers of W040 Meeting in Prague, Czech Republic, 1999	Proceedings
2004	CIB W040 Conference – Papers of W040 Meeting in Glasgow, United Kingdom, 2004	Proceedings

MEETINGS / CONFERENCES

Since 1969, the CIB W040 commission organized the following meetings / conferences in different places all over the world:

YEAR	EVENT	LOCATION
1969	CIB Commission Meeting on Heat and Moisture Transfer in Buildings	Berlin – Germany
1971	CIB Commission Meeting on Heat and Moisture Transfer in Buildings	Lund – Sweden
1972	CIB Commission Meeting on Heat and Moisture Transfer in Buildings	Holzkirchen – Germany
1973	CIB Commission Meeting on Heat and Moisture Transfer in Buildings	Birmingham – United Kingdom
1974	CIB Commission Meeting on Heat and Moisture Transfer in Buildings, in conjunction with the 2nd Symposium on Moisture Problems in Buildings	Rotterdam – Netherlands
1976	CIB Commission Meeting on Heat and Moisture Transfer in Buildings	Washington – United States
1978	CIB Commission Meeting on Heat and Moisture Transfer in Buildings	Trondheim – Norway

YEAR	EVENT	LOCATION
1981	CIB Commission Meeting on Heat and Moisture Transfer in Buildings	Horsholm – Denmark
1983	CIB Commission Meeting on Heat and Moisture Transfer in Buildings	Leuven – Belgium
1985	CIB Commission Meeting on Heat and Moisture Transfer in Buildings	Holzkirchen – Germany
1987	CIB Commission Meeting on Heat and Moisture Transfer in Buildings	Borås – Sweden
1989	CIB Commission Meeting on Heat and Moisture Transfer in Buildings	Victoria – Canada
1991	CIB Commission Meeting on Heat and Moisture Transfer in Buildings	Lund – Sweden
1993	CIB Commission Meeting on Heat and Moisture Transfer in Buildings	Sopron – Hungary
1995	CIB Commission Meeting on Heat and Moisture Transfer in Buildings, in conjunction with the Symposium on Moisture Problems in Building Walls	Porto – Portugal
1997	CIB Commission Meeting on Heat and Moisture Transfer in Buildings	Kyoto – Japan
1999	CIB Commission Meeting on Heat and Moisture Transfer in Buildings	Prague – Czech Republic
2001	CIB Commission Meeting on Heat and Moisture Transfer in Buildings, in conjunction with the 15th CIB World Building Congress	Wellington – New Zealand
2004	CIB Commission Meeting on Heat and Moisture Transfer in Buildings	Glasgow – United Kingdom
2006	CIB Commission Meeting on Heat and Moisture Transfer in Buildings, in conjunction with the 2006 Building Science Forum	Syracuse – United States
2008	CIB Commission Meeting on Heat and Moisture Transfer in Buildings, in conjunction with the 8th Nordic Symposium on Building Physics	Copenhagen – Denmark
2009	CIB Commission Meeting on Heat and Moisture Transfer in Buildings, in conjunction with the 4th International Building Physics Conference	Istanbul – Turkey

YEAR	EVENT	LOCATION
2010	CIB Commission Meeting on Heat and Moisture Transfer in Buildings, in conjunction with the Conference Buildings XI - Thermal Performance of Exterior Envelopes of Whole Buildings	Clearwater Beach, Florida – United States
2011	CIB Commission Meeting on Heat and Moisture Transfer in Buildings, in conjunction with the 9th Nordic Symposium on Building Physics	Tampere – Finland
2012	CIB Commission Meeting on Heat and Moisture Transfer in Buildings, in conjunction with the 5th International Building Physics Conference	Kyoto – Japan

CHAPTER 2

STRUCTURE OF THE DOCUMENT

The CIB W040 commission started in 2009 (Istanbul meeting) to develop a document which compiled all heat, air and moisture transfer terminology existing in books, standards and other reference documents. This new "Heat, Air and Moisture Transfer Terminology – Parameters and Concepts" is systematized with the following structure:

- 1st column – the parameter or concept is indicated by alphabetic order;
- 2nd column – the definition of the parameter / concept is presented;
- 3rd column – the symbol(s) that are commonly used is(are) displayed;
- 4th column – the unit(s) that are commonly used is(are) displayed;
- 5th column – the reference documents are indicated.

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
Water vapour partial pressure	Part of the total atmospheric pressure exerted by water vapour.	p_v	Pa	[3], [5], [8], [15]
	Vapour saturation pressure – Pressure resulting from the presence of the maximum possible water vapour content in air. Vapour saturation pressure is a function of temperature. In pores it also becomes a function of the equivalent pore diameter.	$p_{v,sat}$	Pa	[7], [8]

It is expected that this document may be a valid contribution for the systematization of knowledge on heat, air and moisture transfer terminology.

CHAPTER 3

PARAMETERS AND CONCEPTS

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
Absorptance	Fraction of the incident radiant energy that is absorbed: $\alpha = \frac{\Phi_a}{\Phi_i}$ where Φ_i is the radiant heat flow rate incident in W and Φ_a is the radiant heat flow rate absorbed in W.	α	-	[1], [3], [7], [8], [11]
Absorption coefficient of water	It is a coefficient that quantifies the amount of water entry into a porous material due to absorption when its surface is in direct contact with liquid water. Absorption coefficient of water is defined by the following relation: $m_s = A_w \cdot \sqrt{t}$ where m_s is the mass of sorbed moisture from a water surface per unit of contact area in kg/m^2 and t is the time in s.	A_w	$kg/(m^2 \cdot s^{1/2})$	[2], [7], [15]
Air barrier	A material layer or system that stops air flow across it under air pressure gradient.			[8]
Air change rate / Ventilation rate	Air flow rate divided by the indoor air volume of the domain: $n = \frac{R_a}{V}$ where R_a is the air flow rate in m^3/s or m^3/h and V is the volume in m^3. $n = 1\ h^{-1}$ means that an air volume equivalent to the indoor air volume is exchanged with fresh outdoor air each hour.	n	s^{-1}; h^{-1}	[1], [7], [9]
Air flow rate	Mass or volume of air transferred to or from a system / domain, per unit time, that is induced by an air pressure difference, caused by wind, stack effect or mechanical systems.	R_a ; $\dot{V}$ M_a ; $\dot{M}$	m^3/s; m^3/h kg/s	[1], [7], [15]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	Density of air flow rate / Air flux – Air flow rate per unit area. Mass of air transported per unit of time across a unit of surface perpendicular to the direction of the flow. Air flow rate density is a vector.	r_a ; $\dot{V}$ m_a ; $\dot{m}$	$m^3/(m^2{\cdot}s)$ $m^3/(m^2{\cdot}h)$ $kg/(m^2{\cdot}s)$	[1], [15], [16]
Air flow resistance	Reciprocal of air permeance: $S_a = \frac{1}{K_a}$ The air flow resistance of a specific material layer can also be derived from the equation: $S_a = \frac{d}{k_a}$ where d is the thickness of the layer in m and k_a is its air permeability in kg/(m·s·Pa).	S_a	$m^2{\cdot}s{\cdot}Pa/m^3$ $m^2{\cdot}s{\cdot}Pa/kg$	[15]
Air permeability	The density of air flow rate per one unit gradient of air pressure in the direction of the flow.	k_a	kg/(m·s·Pa) $m^3/(m{\cdot}s{\cdot}Pa)$	[1], [16]
Air permeance	Ratio between the density of air flow rate and the pressure difference across the bounding surfaces under 1-D steady state conditions. Defined by the following relation: $r_a = K_a \cdot (p_1 - p_2)$ where r_a is the density of air flow rate either in $m^3/(m^2{\cdot}s)$·or in $kg/(m^2{\cdot}s)$ and p_1 and p_2 are the air pressures on each side of the layers in Pa. - For a leak - For a meter of joint and crack - For unit surface of a flat layer	K_a	 $m^3/(s{\cdot}Pa)$ or kg/(s·Pa) $m^3/(m{\cdot}s{\cdot}Pa)$ or kg/(m·s·Pa) $m^3/(m^2{\cdot}s{\cdot}Pa)$ or $kg/(m^2{\cdot}s{\cdot}Pa)$	[1], [15], [16]
Air saturation degree	Ratio between the current air content and the maximum possible air content.	S_a	% ; -	[8]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
Black body	Ideal body that absorbs all incident radiation independent of wavelength, direction and polarization. At given temperature, a black body emits the maximum thermal energy for each wavelength (maximum spectral excitance).			[7], [8], [11]
Black body exitance	Expressed by the Stefan-Boltzmann law: $M^o = \sigma \cdot T^4$ where σ is the Stefan-Boltzmann constant (σ = 5.67 x 10^{-8} W/($m^2 \cdot K^4$)) and T is the absolute temperature of the black body in K.	M^o	W/m^2	[11]
	Black body spectral exitance - Expressed by Planck's law which relates M^o_λ to wave length and absolute temperature of the black body: $M^o_\lambda = \dfrac{C_1 \cdot \lambda^{-5}}{\exp\left(\dfrac{C_2}{\lambda \cdot T}\right) - 1}$ where $C_1 = 2 \cdot \pi \cdot h \cdot C_0^2 = 3.741 \cdot 10^{-16}\ W/m^2$ $C_2 = \dfrac{h \cdot C_0}{k} = 0.014388\ m \cdot K$ h - Planck constant k - Boltzmann constant C_0 - speed of electromagnetic waves in vacuum. A curve $M^o_\lambda = f(\lambda)$ with a maximum at λ_{max} can be drawn for each temperature. λ_{max} is a function of temperature, but the product $\lambda_{max} \cdot T$ is constant (Wien's "displacement law"): $\lambda_{max} \cdot T = 2.898 \cdot 10^{-3}\ m \cdot K$ M^o and M^o_λ are hemispherical terms. The emission of a black body is by definition diffuse, i.e., L^o and L^o_λ are	M^o_λ	W/m^3 $W/(m^2 \cdot \mu m)$	[11]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	independent of the direction (Lambert's law). The total and the spectral radiance of a black body are expressed as: $L^o = \frac{M^o}{\pi}$ $L^o_\lambda = \frac{M^o_\lambda}{\pi}$			
Building envelope	A building element (e.g. walls, roofs) that separates the indoor environment from the outdoor environment.			[8]
Bulk density	Mass divided by volume occupied by the material.	ρ	kg/m^3	[2], [8], [10], [14]
	Bulk density of dry material - Mass of 1 m^3 of the dry material. "Dry material" does not necessarily mean "oven dry". For each class of material it may be necessary to adopt prescribed standard conditions of drying at specified temperature or temperature and RH.	ρ_0	kg/m^3	[16]
Capillary suction	The difference between the mean pressure of pore water and the pressure at the free water table under identical temperature and atmospheric pressure when both water quantities have identical salinity and other components of chemical potential.	s	Pa	[3], [15]
Classification of materials in relation with radiative transfer	**Opaque medium**: Medium which does not transmit any fraction of the incident radiation through it. The absorption, emission, reflection of radiation can be handled as surface phenomena. **Semi-transparent medium**: medium in which the incident radiation is progressively attenuated inside the material by absorption or scattering or both. The absorption, scattering and emission of radiation are bulk (volume) phenomena. The radiative properties of an opaque or semi-transparent medium are			[11]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	generally a function of the incident radiation's spectral and directional distribution of temperature. Some opaque and semi-transparent mediums are homogenous (i.e. isotropic) and some are heterogeneous (i.e. non-isotropic).			
Coloured bodies	For coloured bodies, the emissivity, absorptivity and reflectivity depend on wavelength (which is function of temperature) and direction. For each temperature and direction, Kirchoff's law ($\varepsilon = \alpha$) applies. Lambert's law, however, is no longer applicable since it requires an emission independent from direction. Per wavelength, the spectral emittance differs from a black body. The average emissivity at a temperature T follows from the ratio between the emittance of the coloured body and that of a black body at the same temperature. To simplify things, coloured bodies are considered as grey bodies, but with temperature dependent emissivity. For the emittance and irradiance at strongly different temperatures, Kirchoff's law no longer applies. This is the case for ambient radiation and solar radiation. Therefore, $\alpha_S \neq \varepsilon_L$, with α_S the short wave absorptivity for sunlight and ε_L the long wave emissivity for ambient radiation.			[8]
Condensation	Phase change of water vapour into liquid water where the humidity by volume of air reaches the humidity by volume at saturation (ϕ = 100%). **Interstitial condensation** – Refers to the condensation of moisture on surfaces between material layers inside the building component. **Surface condensation** – Refers to vapour condensation on the surface of the building component.			[7], [8]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
Degree of saturation	The ratio between the moisture content in a porous material and its maximum moisture content. Can also be defined as the fraction of open pores filled with moisture against those accessible for moisture.	S_w	% ; -	[2], [8], [15], [16]
Dew point temperature	The temperature at which moist air becomes saturated at atmospheric pressure. Condensation occurs at any temperature below the dew point.	θ_d T_d	ºC K	[1], [5]
Dry bulb temperature	Air temperature measured in a thermometer shielded for radiation.	θ T	ºC K	[5]
Dynamic viscosity	The ratio of viscous shear stress and the velocity gradient in the normal flow.	η	N·s/m^2	[2], [8]
Emission	Process in which heat (from molecular agitation in gases or atomic agitation in solids, etc.) is transformed into electromagnetic waves. The evaluation of the emission properties of real materials is made relative to the black body placed in the same conditions of temperature. In general, these properties depend on the nature and surface aspect of the body and vary with wavelength, direction of emission and surface temperature.			[11]
Emissivity	Real surfaces can not emit the same amount of energy as a black body surface. The ratio between the real exitance of a surface, M in W/m^2, and the total exitance of a black body, M^o in W/m^2, at the same temperature defines emissivity: $\varepsilon = \frac{M}{M^o}$	ε	-	[1], [7], [11]
Energy	Energy exists in many forms such as work, internal energy, enthalpy.	U	J	[2], [8]
	Specific energy – Energy divided by the mass of the system (e.g. specific work, specific internal energy, specific enthalpy). In any system, the energy is	u	J/kg	[8]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	conservative according to the first law of thermodynamic.			
	Primary energy – Energy capacity of the row fuels or renewable sources.			
	Final energy – Energy received by the beneficiary.			
Enthalpy	Thermodynamic property that includes internal energy and flow work and is defined as: $H = U + P \cdot V$ where U is the internal energy in J, P is the pressure in Pa and V the volume in m^3.	H	J	[2], [8]
	Specific enthalpy – enthalpy per unit of mass.	h	J/kg	[1], [8]
	Free enthalpy	G	J	[2], [8]
	Specific free enthalpy	g	J/kg	[8]
	Specific enthalpy of evaporation/condensation or melting/fusion – Energy per unit mass released or absorbed during evaporation / condensation or melting / solidifying without a change in temperature.	l	J/kg	[8]
Exitance	Radiant heat flow rate emitted by a surface per unit area of the emitting surface: $M = \frac{\partial \Phi}{\partial A}$	M	W/m^2	[7], [8], [11]
Gas diffusion coefficient	Rate of gas diffusion density through a material per unit gradient of its concentration.	D	m^2/s	[15]
Gas permeability	Product of the gas permeance and the perpendicular distance between the surfaces of a flat layer of material.	k	kg/(m·s·Pa) m^3/(m·s·Pa)	[15]
Gas permeability coefficient	Product of the diffusion coefficient and the solubility coefficient.	δ_c	m^2/(s·Pa)	[15]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
Gas permeance	Mass of gas passing through a flat layer of material per unit of time, area and pressure difference. This property is used for heterogeneous materials and layered systems.	K	$kg/(m^2·s·Pa)$ $m^3/(m^2·s·Pa)$	[15]
Grey body	Thermal radiator whose emissivity is independent of wavelength.			[8], [11]
HAM	Combined **H**eat, **A**ir and **M**ass transfer.			
Heat	Quantity which indicates the energy in the form of heat. Heat is a scalar.	Q	J	[1], [2], [8], [9]
Heat capacity	The heat capacity equals the value dQ/dT when the temperature of a volume of material changes by a value dT in K as a result of adding or removing a quantity of heat dQ in J: $C = \frac{dQ}{dT}$	C	J/K	[2], [9]
	Specific heat capacity of dry material – Heat added or removed when changing the temperature of unit mass of dry material by 1 K.	c_0	J/(kg·K)	[1], [8], [9], [16]
	Specific heat capacity – If the material is wet, the specific heat capacity is calculated as: $c = c_0 + 4187 \cdot \left(\frac{w}{\rho_0}\right)$ where w is the moisture content in kg/m^3 and ρ_0 is the bulk density of dry material in kg/m^3. The above relation assumes that the specific heat capacity of water is a constant equal to 4187 J/(kg·K).	c	J/(kg·K)	
	Specific heat capacity at constant pressure – For an ideal gas is given as: $c_p = \frac{\gamma \cdot R}{\gamma - 1}$ where R is the gas constant in J/(kg·K) and γ is the specific heat ratio.	c_p	J/(kg·K)	[9], [14]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	Specific heat capacity at constant volume – For an ideal gas is given as: $c_v = \frac{R}{\gamma - 1}$ where R is the gas constant and γ is the specific heat ratio.	c_v	J/(kg·K)	[9]
	Volumetric heat capacity of dry material – Defined as the heat (energy) required to change the temperature of a unit volume of dry material by 1 K.	$\rho_0 \cdot c_0$	J/(m³·K)	[16]
	Volumetric heat capacity – If the material is wet, the volumetric heat capacity is calculated as: $\rho_0 \cdot c = \rho_0 \cdot c_0 + 4187 \cdot w$ where w is the moisture content in kg/m³ and ρ_0 is the bulk density of dry material in kg/m³. The above relation assumes that the specific heat capacity of water is a constant equal to 4187 J/(kg·K).	$\rho_0 \cdot c$	J/(m³·K)	
Heat flow rate	Quantity of heat transferred to or from a system per unit time: $\Phi = \frac{dQ}{dt}$ Heat flow rate is a scalar.	Φ	W	[7], [8], [9], [11]
	Radiant heat flow rate – The amount of radiant heat per unit of time: $\Phi_r = \frac{dQ_r}{dt}$	Φ_r	W	[8]
	Density of heat flow rate or Heat flux – Quantity of heat transported per unit of time across a unit of surface perpendicular to the flow direction. It may also be defined as the derivative to the area of the heat flow rate: $q = \frac{d\Phi}{dA}$ Heat flow rate density is a vector.	q	W/m²	[1], [7], [8], [9], [16]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	Density of linear heat flow rate – Heat flow rate per unit length: $q_l = \frac{d\Phi}{dl}$	q_l	W/m	[9]
	Density of radiant heat flow rate – The radiant heat flow per unit of surface area: $q_r = \frac{d\Phi_r}{dA}$	q_r	W/m^2	[8]
Heat transfer	Energy transfer by conduction, convection, radiation and enthalpy flow, or a combination of these. **Conduction** – Energy transferred when vibrating atoms collide and free electrons move collectively. Heat is transferred by conduction between solids at different temperature in contact with each other, between points at a different temperature within the same solid, within fluids and in the contact between fluids. Conduction occurs from higher to lower temperatures, needs a medium and there is no observable macroscopic movement linked to it. **Convection** – Energy transferred by the displacement of molecule groups at different temperature. It is by nature a consequence of movement and occurs close to the contact between fluids and solids. Convection can be defined as forced, natural and mixed depending on whether the movement is caused by an external force, a difference in fluid density or both. In forced convection an exterior source may compel heat to flow from low to high temperatures. Convection needs a medium and in liquids and gases includes conduction, as heat transfer between the molecules occurs by conduction. **Radiation** – Heat transfer caused by the emission and absorption of electromagnetic waves. Every surface at a temperature above 0 K emits			[1], [3], [7], [8], [9], [11]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	electromagnetic energy. If surfaces have different temperatures heat exchanges occurs. Heat transfer trough radiation does not need a medium and follows physical laws which diverge strongly from conduction and convection. **Enthalpy flow** – Heat transfer linked to convection but considers the heat transported by a gas or fluid, permeating a medium.			
Humidity by mass / Humidity ratio	Mass of water vapour within a unit mass of dry air. At saturation, the notation x_{sat} is used.	x	kg/kg	[8], [15]
Humidity by volume / Vapour concentration	Mass of water vapour within a unit volume of the gaseous mixture. Humidity by volume is the same as the partial mass density of water vapour ρ_v . At saturation, the notations v_{sat} and $\rho_{v,sat}$ are used.	v	kg/m^3	[8], [15], [16]
Hygroscopic range	Is the range of relative humidity in a material between 0 and 98% RH.			[7], [8]
Hygroscopicity	Refers to the property of a porous material to adsorb moisture from the air and to desorb it back into air. The more hygroscopic a material is the higher its moisture capacity is.			[7], [8]
Hygrothermics	Domain of building physics / building science concerning the heat, air and mass transfer in buildings and their components.			[7], [8]
Ideal gas law	Both air and vapour are considered to follow the ideal gas law, which is given as: $P \cdot v = R \cdot T$ where P is the pressure of the gas in Pa, v is the molar volume of the gas in m^3/mol, T is the absolute temperature in K and R is the gas constant (R = 8.3143 J/(mol·K)).			[1]
Internal moisture excess	Under steady state conditions: Rate of moisture production in a space, G in kg/s, divided by the air change rate, n in s^{-1}, and the volume of the	Δv	kg/m^3	[3]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	space, V in m^3: $\Delta v = v_i - v_e = \frac{G}{n \cdot V}$ where v_i and v_e are the humidities by volume of a building's indoor air and outdoor air.			
Intrinsic permeability of a porous medium	Is defined by the following relation: $\vec{r}_a = \frac{k}{\eta} \cdot grad\ p$ where $\vec{r}_a$ is the vector density of air flow rate in $m^3/(m^2 \cdot s)$, p is pressure in Pa and η is the dynamic viscosity of air in $N \cdot s/m^2$.	k	m^2	[15]
Irradiance / Irradiation	Radiant heat flow rate received by a surface per unit area: $E = \frac{\partial \Phi}{\partial A}$	E	W/m^2	[7], [8], [11]
Kinematic viscosity	The dynamic viscosity of a fluid divided by its density.	ν	m^2/s	[2], [8]
Long wave (terrestrial) radiation	Radiation with wavelength greater than 3 μm from terrestrial surfaces and the atmosphere. The exchange of long wave radiation occurs permanently between buildings, the terrestrial environment and the atmosphere.			[5]
Luminosity	The ratio between the radiant heat flow rate in a direction and the apparent surface, seen from that direction. L is a vector. The luminosity describes how a receiving surface sees an emitting surface. $L = \frac{d^2\phi_R}{\cos(\phi) \cdot dA \cdot d\omega}$	L	$W/(m^2 \cdot rad)$	[8]
Mass flow rate	The quantity of mass, which migrates per unit of time. Mass flow rate is a scalar.	M	kg/s	[8]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	Density of mass flow rate / Mass flux – The quantity of mass flowing per unit of time through a unit of surface perpendicular to the flow direction. Mass flow rate density is a vector.	m	kg/(m²·s)	[8], [15]
Mass transfer	Transport of mass (especially moisture or air) by various mechanisms.			[15]
Medium classification	**Anisotropic medium** – Relevant properties are a function of direction. **Heterogeneous medium** – Relevant properties are a function of the position in the medium due to the presence of dissimilar constituents. **Homogeneous medium** – Relevant properties are not a function of the position in the medium but may be a function of time, temperature, etc. **Homogeneous porous medium** – Local porosity is independent of position in the medium. **Isotropic medium** – Relevant properties are not a function of direction but may be a function of position in the medium, of time, temperature, etc. **Porous medium** – Heterogeneous medium due to the presence of finely distributed voids in the solid phase. This medium may be considered as homogeneous for hygrothermal modelling. **Stable medium** – Relevant properties are not a function of time, but may be a function of coordinates, direction, temperature, etc. Porous media can be subdivided according to the geometry of their structure: **Fibrous porous medium** – Made of a continuous gas phase with solid inclusions having their length as dominant dimension. **Granular loose fill medium** – Made			[10]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	of a continuous gas phase with solid inclusions whose shape does not have a predominant dimension. **Cellular porous medium** –Made of a continuous solid phase with more or less gas filled spherical inclusions. **Interconnected porous medium** – Made of a continuous solid phase containing cavities that are interconnected in a way the gaseous phase is also continuous.			
Moisture	Water in the gaseous, liquid or solid phase.			[15]
Moisture capacity	**Specific moisture capacity –** The increase in the mass of moisture in unit mass of the material that follows from a unit increase in capillary suction.	ξ	kg/(kg·Pa)	[1], [8], [16]
	Volumetric moisture capacity – Change in the moisture content per unit volume of material that follows from a unit change in capillary suction.	$\rho_0 \cdot \xi$	kg/(m^3·Pa)	[1], [16]
Moisture conductivity curve	Relation between moisture conductivity of a porous material and the relative humidity of the ambient air at equilibrium obtained at precisely controlled temperature and relative humidity.			
Moisture diffusivity	Within the hygroscopic range moisture diffusivity stands for the ratio between vapour permeability and volumetric moisture capacity. Beyond the hygroscopic range moisture diffusivity stands for the ratio between moisture permeability and volumetric moisture capacity. Moisture diffusivity is defined by the following relation: $\vec{g} = -D_w \cdot grad\ w$ where $\vec{g}$ is the vector density of moisture flow rate and w is the moisture content mass per volume. At the low RH e.g. that measured by	D_w	m^2/s	[2], [15], [16]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	dry cup water vapour transmission (about 25% RH) moisture diffusivity represents pure vapour flow at the upper end, at the capillary saturation it represents pure liquid transfer and anywhere in between it represents a mixture of liquid and air that includes vapour with varying fraction of liquid water.			
Moisture flow rate	Mass of moisture transferred to or from a system per unit of time. Moisture flow rate is a scalar and may relate to water vapour only, liquid water only, or both together.	G	kg/s	[7], [15]
	Density of moisture flow rate / moisture mass flux – Mass of moisture transported per unit of time across a unit area perpendicular to the flow direction: $g = \frac{dG}{dA}$ where G is the moisture flow rate and A is the area. Density of moisture flow rate is a vector and may relate to water vapour only, liquid water only or both together.	g m_m	kg/(m^2·s)	[7], [15], [16]
Moisture in an open-porous material	The presence of moisture in an open-porous material is defined as:			[1], [2], [3], [15], [16]
	Moisture content – mass of water present in the open pores divided by the volume of dry material.	w	kg/m^3	
	Moisture ratio – mass of water present in the open pores divided by the dry mass of the material.	u	kg/kg	
	Moisture ratio by volume – volume of water present in the open pores divided by the volume of dry material.	ψ	m^3/m^3	
	In porous materials the moisture content may vary between dry state and fully saturated state when the open pores are completely filled with water.			

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	Maximum moisture content – moisture content that corresponds to the saturation state. This maximum moisture content can only be obtained experimentally if the process is carried out in vacuum (index: $_{max}$). **Capillary saturation moisture content** – Moisture content that corresponds to the saturation state obtained under 1-D process of free water intake under standard temperature and air atmospheric pressure conditions with evaporation shield on the opposite side of the test specimen (index: $_{cap}$). **Critical moisture content** – Moisture content that corresponds to the lowest moisture content necessary to initiate moisture transport in the liquid phase. Below this level, moisture is transported only in the vapour phase (index: $_{cr}$). **Equilibrium moisture content** – The balance of moisture content of a porous material with ambient air humidity at steady-state condition. **Maximum hygroscopic moisture content** – Moisture content that corresponds to the maximum amount of water in material captured from the ambient humid air under isothermal conditions. The relative humidity value, which corresponds this moisture content, is approximately 98% RH (index: $_{hygr}$).			
Moisture permeability / Moisture conductivity	Ratio between the density of moisture flow rate and the suction gradient in the direction of the moisture flow. Suction includes capillary, gravity, electro-osmotic, freezing and external pressure components. In experimental determination of material characteristics components other than capillary suction are eliminated to simplify the process of testing. It is defined by the following relation:	k_w	kg/(m·s·Pa)	[15], [16]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	$\vec{g} = -k_w \cdot grad\ s$ Where $\vec{g}$ is the vector density of moisture flow rate in kg/(m^2·s) and s is the total suction in Pa. Moisture permeability/ conductivity is primarily used to describe liquid transfer, though also vapour is included.			
Moisture transfer	Moisture can be transported both in vapour and liquid phase. The moisture transfer is caused by: **Diffusion** occurs due to a difference in vapour concentration, which results in a net transfer of water molecules to the region with the lowest concentration. **Convection** is caused by air flows due to a difference in total pressure. Moving air always carries water vapour and may drag along water droplets or snow crystals. **Wind pressure** can force liquid water through cracks in the building envelope. **Capillary suction** is the result of differences in pore water pressure. **Gravity** induces downwards flows of liquid water.			[7], [8], [15]
Mould index	Describes the visible mould growth intensity on the surface of a material. The higher the index, the more mould growth on the surface.	M		
Porosity	Total volume of voids in unit volume of porous material. Porosity can be defined by the expression: $\xi = 1 - \frac{\rho - \rho_g}{\rho_s - \rho_g}$ where ρ is the apparent density of the material, ρ_s is the density of the solid matrix and ρ_g is the density of the gas in the voids.	ξ ψ	- % m^3/m^3	[8], [10]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	Local porosity – Porosity at a point in a material for an elementary volume enclosing that point large enough to define a meaningful average.	ξ_p	- % m^3/m^3	[10]
	Open porosity – Volume of open pores per volume-unit material. What fraction of the porous system is "open" depends on the fluid migrating through the material. In general, open porosity is smaller than total porosity.	ψ_o	- % m^3/m^3	[8], [16]
Psychrometric chart	Psychrometric chart is a practical tool that graphically approximates the properties of moist air (saturation moisture ratio or partial vapour pressure and relative humidity) as a function of its temperature.			[1]
Radiance	Radiant heat flow rate per unit solid angle around the direction $\vec{\Delta}$ and the projected area normal to this direction: $L_\Omega = \frac{\partial^2\Phi}{\partial\Omega \cdot \partial(A \cdot \cos\theta)}$	L_Ω	$W/(m^2 \cdot sr)$	[11]
Radiation intensity	Radiant heat flow rate per unit solid angle around the direction $\vec{\Delta}$: $I_\Omega = \frac{d\Phi}{d\Omega}$ Intensity is a vector.	I_Ω	W/sr	[8], [11]
Radiosity	Radiant heat flow rate emitted and reflected by an opaque surface per unit of its area: $J = \frac{\partial\Phi}{\partial A}$ where Φ is the radiant heat flow rate emitted and reflected in W and A is the area in m^2.	J	W/m^2	[7], [11]
Reference year	A year-long set of hourly values of appropriate meteorological parameters representative for the severe or mean local climate over a long period of time (f.e. 30 years). TRY: test reference year			[5]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	TMY: typical meteorological year DRY: design reference year MRY: moisture reference year			
Reflectance	Fraction of the incident radiant energy that is reflected: $\rho = \frac{\Phi_r}{\Phi_i}$ where Φ_i is the radiant heat flow rate incident in W and Φ_r is the radiant heat flow rate reflected in W.	ρ	-	[1], [3], [7], [8], [11]
Relative humidity	Actual water vapour partial pressure at a given temperature divided by vapour pressure at saturation at the same temperature: $\varphi = \frac{p_v}{p_{v,sat}}$ or $RH = \frac{p_v}{p_{v,sat}} \cdot 100$ where p_v is the water vapour partial pressure in Pa and $p_{v,sat}$ is the vapour saturation pressure in Pa. Assuming ideal gas behaviour that relation may also be written as: $\varphi = \frac{v}{v_{sat}}$ where v is the humidity by volume of air in kg/m^3 and v_{sat} is the humidity by volume at saturation evaluated at the same temperature, in kg/m^3.	φ ; ϕ ; RH	- ; %	[2], [3], [5], [7], [8], [15]
Solar irradiance	Radiation power per unit area on a plane of any slope and orientation generated by the incident solar radiation. The following special quantities can be distinguished according to the conditions of reception:	G_s	W/m^2	[5]
	Global solar irradiance – Irradiance on a surface by solar radiation from the full hemisphere. On a horizontal surface global solar irradiance contains as well beam as diffuse solar radiation. On tilted surfaces also a portion of the ground reflected global solar radiation is included.	$G_{s,g}$	W/m^2	[5]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	Direct solar irradiance – Irradiance on a surface by directional solar radiation from the visible solar disk.	$G_{s,b}$	W/m^2	[5]
	Beam solar irradiance – Irradiance on a surface perpendicular to the solar beam.	$G_{s,b}$	W/m^2	[5]
	Diffuse solar irradiance – Irradiance on a surface by that part of the solar radiation that is scattered over the celestial hemisphere.	$G_{s,d}$	W/m^2	[5]
	Reflected solar irradiance – Irradiance on tilted surface by solar radiation reflected globally by all surrounding surfaces and the surfaces beneath. The ratio between reflected and global solar irradiance is called the albedo.	$G_{s,r}$	W/m^2	[5]
Solar irradiation	Radiant energy per unit of area received by a surface of given inclination and orientation during a period of time. The same components as indicated for solar irradiance intervene.	H_s	MJ/m^2	[5]
Sorption curve	Relation between moisture content in a porous material and the relative humidity of the ambient air at equilibrium obtained at precisely controlled temperature and relative humidity. Sorption curve is a part of Moisture retention curve. The sorption curve differs from desorption. Measuring difficulties limits experimental determination to a relative humidity at 95 % to 98 %.			[1], [3], [8], [15], [16]
Steady state	Condition for which all relevant parameters do not vary with time.			[10]
Suction curve / Moisture retention curve	Relation between the moisture content in a porous material and suction (negative difference between atmospheric pressure and pore pressure) in pore water. This relation includes hygroscopic region (sorption curves) and above hygroscopic region. Generally there are curves for sorption (wetting from a dry material) and for desorption (drying from			[15]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	moisture content above the capillary saturation).			
Surface coefficient of heat loss or gain	Heat flow rate from or to a surface per unit area and per unit difference of temperature between the indoor and outdoor environments: $F_s = \frac{\Phi}{A \cdot \Delta T}$ where Φ is the heat flow rate in W, A is the area in m^2 and ΔT is the difference of temperature between the indoor and outdoor environments. The heat flow rate may include heat transmission, enthalpy flow, solar radiation, etc. The area could be the whole envelope, the floor area, etc.	F_s	W/(m²·K)	[9]
Surface film coefficient for vapour diffusion	Describes the effect of a laminar air layer that sticks to each surface and only allows vapour diffusion as transport mode. The surface film coefficients for diffusion β_v and β_p are defined by the following relations: a) $g_v = \beta_v \cdot (v_a - v_s)$ b) $g_v = \beta_p \cdot (p_{v,a} - p_{v,s})$ where g_v is density of vapour flow rate in kg/(m²·s), v_a and v_s are the humidities by volume in the ambient air and at the surface in kg/m³ and $p_{v,a}$ and $p_{v,s}$ are the water vapour partial pressures in the ambient air and at the surface in Pa. If the Lewis relation with the convective surface film coefficient for heat transfer (h_c) holds, than the surface film coefficients for diffusion can be written as: $\beta_p = 7.7 \cdot 10^{-9} \cdot h_c$	β_v β_p	m/s s/m	[2], [7], [8], [15]
Surface film coefficient for heat transfer	Density of heat flow rate at a surface in steady state divided by the temperature difference between that surface and the environment:	h	W/(m²·K)	[1], [2], [7], [8], [9]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	$h = \frac{q}{T_s - T_a}$ where q is the density of heat flow rate at a surface in W/m^2, T_s is surface temperature in K and T_a the operative temperature in the environment seen by the surface in K.			
	Convective surface film coefficient for heat transfer – Defined by the following relation: $q_c = h_c \cdot (T_s - T_a)$ where q_c is the density of convective heat flow rate at the surface in W/m^2, T_s is the surface temperature in K and T_a is the temperature of a well chosen spot in the ambient air in K.	h_c	W/(m^2·K)	
	Radiative surface film coefficient for heat transfer – Defined by the following relation: $q_r = h_r \cdot (T_s - T_r)$ where q_r is the density of radiant heat flow rate at the surface in W/m^2, T_s the is surface temperature in K and T_r the radiant temperature of the environment as seen by the surface in K.	h_r	W/(m^2·K)	
Surface film resistance for vapour diffusion	The reciprocal of the surface film coefficient for vapour diffusion, β_p.	Z_s	m/s	[2], [7], [8]
Surface film resistance for heat transfer	The reciprocal of the surface film coefficient for heat transfer.	R_s	m^2·K/W	[1], [2]
Temperature	Potential that determines heat transfer. There are two scales for temperature in the SI-system:			[1], [2], [8]
	Empirical: Degree Celsius, where 0 ºC is the triple point of water and 100 ºC is the boiling point of water at 1 atmosphere.	θ t	ºC	
	Thermodynamic: Kelvin, where 0 K is the absolute zero and 273.15 K is the triple point of water. T = θ + 273.15	T	K	

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	Operative temperature – Temperature of an imaginary environment in which, with equal wall (enclosing areas) and ambient air temperatures and some standard rate of air motion, the human body would lose the same amount of heat by radiation and convection as it would in some actual environment at unequal wall and air temperatures and for some other rate of air motion. Operative temperature can be calculated using the following simplification: $\theta_{op} = \dfrac{\theta_i + \theta_r}{2}$ where θ_i is interior air temperature in ºC and θ_r is radiant temperature in ºC.	θ_{op}	ºC	[4]
Temperature factor	Difference between the temperature of a surface indoors, θ_{si} in ºC, and the external air temperature, θ_e in ºC, divided by the difference between the air temperature indoors, θ_i in ºC, and the air temperature outdoors, θ_e in ºC: $f_{si} = \dfrac{\theta_{si} - \theta_e}{\theta_i - \theta_e}$	f_{si}	-	[3], [8]
Thermal bridges	Refers to spots on the envelope where 2-D or 3-D heat transfer exists and causes loss or gain different from that in adjacent locations. There are two types of thermal bridges: **Geometric thermal bridges** – A consequence of the three dimensional character of a building: angles and corners, inner and outer reveals around windows, etc. **Structural thermal bridges** – A consequence of construction details, for example for reasons of structural integrity: steel or concrete girders and columns penetrating the envelope, discontinuities in the thermal insulation, etc.			[7], [8]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
Thermal conductance	Thermal conductance is the heat flux through a flat body induced by a unit temperature difference between the surfaces of that body. It is the reciprocal of thermal resistance from surface to surface under conditions of uniform density of heat flow rate: $K = \frac{1}{R}$	K	W/(m²·K)	[1], [7], [9]
	Linear thermal conductance – Reciprocal of linear thermal resistance from surface to surface under conditions of uniform density of linear heat flow rate: $K_l = \frac{1}{R_l}$	K_l	W/(m·K)	[9]
Thermal conductivity	The thermal conductivity of a material is the density of heat flow rate per one unit of the thermal gradient in the direction of the flow. That definition stems from Fourier's law for heat conduction: $\vec{q} = -\lambda \cdot grad\ T$ Thermal conductivity is a scalar for isotropic materials and a tensor for anisotropic materials. Its value depends on density, temperature, moisture content and sometimes age (as an indicator of changes in the material structure or composition) of the layer considered.	λ	W/(m·K)	[1], [2], [9], [16]
Thermal diffusivity	The ratio between the thermal conductivity in W/(m·K) and the volumetric heat capacity of a material in J/(m³·K): $a = \frac{\lambda}{\rho_0 \cdot c}$ The thermal diffusivity stands for how fast temperature changes are propagating in a material.	a	m²/s	[1], [7], [8], [9], [16]
Thermal effusivity	Square root of the product of thermal conductivity in W/(m·K) and volumetric heat capacity in J/(m³·K):	b	J/(m²·s^1/2·K) W·s^1/2/(m²·K)	[7], [9]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	$b = \sqrt{\lambda \cdot \rho_0 \cdot c}$ Thermal effusivity reflects the ability of a material to absorb heat.			
Thermal expansion coefficient	The thermal expansion coefficient is a thermodynamic property of a material. It relates the change in temperature to the change in a material's linear dimensions. It is the fractional change in length per degree of temperature change.	α	K^{-1}	[2], [8]
Thermal moisture diffusion coefficient	The thermal moisture diffusion coefficient is the density of moisture flow rate, in kg/(m²·s), per one unit of the temperature gradient, in K. That definition stems from the following equation: $\vec{g} = -D_T \cdot grad\ T$ (at uniform moisture content).	D_T	kg/(m·s·K)	[15]
Thermal resistance	Temperature difference in K divided by the density of heat flow rate, in W/m², in the steady state condition: $R = \frac{T_1 - T_2}{q}$ For a plane layer for which the concept of thermal conductivity applies and when this property is constant or linear with temperature: $R = \frac{d}{\lambda}$ where *d* is the thickness of the layer in m.	R	$m^2 \cdot K/W$	[1], [7], [8], [9], [16]
	Linear thermal resistance – Temperature difference in K divided by the linear density of heat flow rate, in W/m, in the steady state condition: $R_l = \frac{T_1 - T_2}{q_l}$	R_l	m·K/W	[9]
Thermal transmittance	Density of heat flow rate across a flat assembly, in W/m², at a temperature difference of 1 K between the surroundings of both surfaces.	U	$W/(m^2 \cdot K)$	[1], [8], [9], [16]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	$U = \frac{\Phi}{(T_1 - T_2) \cdot A}$ The reciprocal of the thermal transmittance is the total thermal resistance between the surroundings on each side of the assembly.			
	Linear thermal transmittance – Density of linear heat flow rate, in W/m, at a temperature difference of 1 K between the surroundings on each side of the assembly. $U_l = \frac{\Phi}{(T_1 - T_2) \cdot l}$ The reciprocal of the linear thermal transmittance is the total linear thermal resistance between the surroundings on each side of the assembly.	U_l ψ	W/(m·K)	[8], [9], [13], [16]
Total pressure	According to Dalton's law, the total pressure is the sum of partial pressures of different species in a mixture.	P	Pa	[8], [16]
Transmittance	Fraction of the incident radiant energy that is transmitted by a surface: $\tau = \frac{\Phi_t}{\Phi_i}$ where Φ_i is the radiant heat flow rate incident in W and Φ_t is the radiant heat flow rate transmitted in W.	τ	-	[1], [3], [7], [8], [11]
Vapour barrier/retarder	Material layer whose main function is to prevent/retard harmful diffusion of water vapour into or within a building component. The vapour barrier/retarder can also function as an air barrier/retarder.			
Volume coefficient of heat loss	Heat flow rate from a building, in W, divided by its volume, in m^3, and the difference in loss-weighted mean temperature inside and the mean temperature outside, in K: $F_v = \frac{\Phi}{V \cdot \Delta T}$	F_v	W/(m^3·K)	[9]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
Volumetric thermal expansion coefficient	The volumetric coefficient of thermal expansion is given by: $\beta = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_p$	β	K^{-1}	[8]
Water penetration coefficient	Defined by the following relation: $x = B_w \cdot \sqrt{t}$ where x is the penetration depth of the water front during capillary suction from a water surface in m and t is the time in s.	B_w	$m/s^{1/2}$	[2], [7], [15]
Water vapour	Moisture in the gaseous phase.			[15]
Water vapour diffusion coefficient in the air	Defined by the following relation: $\vec{g}_v = -D_a \cdot grad\ v$ where $\vec{g}_v$ is the vector density of water vapour flow rate in air in $kg/(m^2{\cdot}s)$ and ν is the vapour concentration in the air in kg/m^3.	D_a	m^2/s	[15]
Water vapour diffusion equivalent air layer thickness	Thickness of a motionless air layer which has the same water vapour diffusion resistance as the material layer: $s_d = \mu \cdot d$ where μ is the water vapour resistance factor and d is the thickness of the layer of material in m.	s_d	m	[3], [15]
Water vapour flow rate	The time rate of water vapour transfer. Water vapour flow rate is a scalar.	G_v M_v	kg/s	[1]
	Density of water vapour flow rate – Defined as the mass of vapour transported per unit of time through a unit of area perpendicular to the flow direction.	g_v m_v	$kg/(m^2{\cdot}s)$	[3], [16]
Water vapour partial pressure	Part of the total atmospheric pressure exerted by water vapour.	p_v	Pa	[3], [5], [8], [15]
	Vapour saturation pressure – Pressure resulting from the presence of the maximum possible water vapour content in air. Vapour saturation pressure is a function of temperature. In pores it also	$p_{v,sat}$	Pa	[7], [8]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	becomes a function of the equivalent pore diameter.			
Water vapour permeability	Density of vapour flow rate per one unit of the vapour concentration gradient (δ_v) or vapour pressure gradient (δ_p) in the direction of the flow. The two properties are defined by the following equations:			[15], [16]
	a) permeability with regard to humidity by volume $\vec{g}_v = -\delta_v \cdot grad\ v$	δ_v	m^2/s	
	b) permeability with regard to partial water vapour pressure $\vec{g}_v = -\delta_p \cdot grad\ p_v$	δ_p	kg/(m·s·Pa)	
	where $\vec{g}_v$ is the vector density of water vapour flow rate in kg/(m^2·s), v is the water vapour concentration in kg/m^3 and p_v is the water vapour partial pressure in the pores in Pa.			
Water vapour permeability in the air	Defined by the following relation: $\vec{g}_v = -\delta_{p,a} \cdot grad\ p_v$ where $\vec{g}_v$ is the vector density of water vapour flow rate in air in kg/(m^2·s) and p_v is the water vapour partial pressure in the air in Pa.	$\delta_{p,a}$	kg/(m·s·Pa)	[15], [16]
Water vapour permeance	Density of vapour flow rate across a layer per one unit of the vapour concentration or vapour pressure difference across the two parallel bounding surfaces under steady state conditions. The quantities W_v and W_p are defined by the following relations:			[15], [16]
	a) permeance with regard to water vapour concentration $g_v = W_v \cdot (v_1 - v_2)$	W_v	m/s	
	b) permeance with regard to water vapour partial pressures $g_v = W_p \cdot (p_{v,1} - p_{v,2})$	W_p	kg/(m^2·s·Pa)	
	where g_v is the density of water vapour flow rate perpendicular to the			

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
	surfaces of the layer in kg/(m²·s), v_1 and v_2 are the vapour concentrations in kg/m³ and $p_{v,1}$, $p_{v,2}$ are the water vapour partial pressures at both sides of the layer in Pa.			
Water vapour resistance	Inverse of water vapour permeance.			[15], [16]
	a) water vapour resistance with regard to vapour concentration $Z_v = \frac{1}{W_v}$; $g_v = \frac{v_1 - v_2}{Z_v}$	Z_v	s/m	
	b) water vapour resistance with regard to water vapour partial pressure $Z_p = \frac{1}{W_p}$; $g_v = \frac{p_{v,1} - p_{v,2}}{Z_p}$	Z_p	m²·s·Pa /kg	
Water vapour resistance factor	Water vapour diffusion coefficient in air (D_a in m²/s) divided by the water vapour permeability (δ_v in m²/s) of a porous material: $\mu = \frac{D_a}{\delta_v}$ It can also be defined as: $\mu = \frac{\delta_{p,a}}{\delta_p}$ where $\delta_{p,a}$ is the water vapour permeability in the air in kg/(m·s·Pa) and δ_p is the water vapour permeability with regard to partial water vapour pressure in kg/(m·s·Pa). The water vapour resistance factor indicates how much larger the resistance of a porous material is against diffusion compared to an equally thick layer of stagnant air at a same temperature.	μ	-	[2], [8], [15], [16]
Water vapour transfer	The water vapour flow induced by a partial vapour concentration/water vapour pressure difference or by moving humid air.			[1]

PARAMETER / CONCEPT	DEFINITION	SYMBOL(S)	UNIT(S)	REFERENCE
Wind-driven rain	Rain falling on a vertical surface.			[17]
	Wind-driven rain intensity – It is the component of the rain intensity vector causing rain flux through a vertical plane. WDR intensity can be expressed as: $R_{wdr} = R_h \frac{U}{V_t}$ where R_h is the intensity of rainfall falling through a horizontal plane in m^3/m^2, U is the wind speed in m/s and V_t is the raindrop terminal velocity of fall in m/s.	R_{wdr}	$m^3/(m^2 \cdot s)$	
	Wind-driven rain amount	S_{wdr}	m^3/m^2	
	Wind-driven rain coefficient	α	s/m	
	Free wind-driven rain coefficient	k	s/m	

CHAPTER 4

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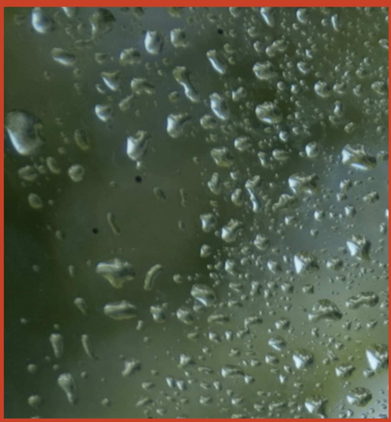

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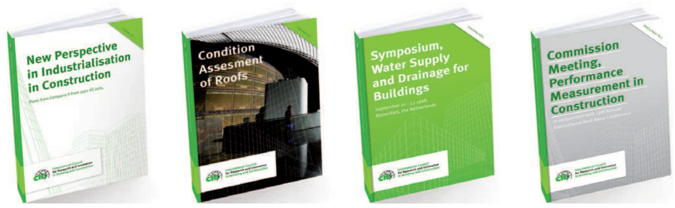

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