NOMENCLATURE

1. PERFORMANCES

$\dot{M}_a$	Air mass flow rate	*kg/s*
$\dot{M}_{CO2}$	CO_2 mass flow rate	*kg/s*
MM	Molar mass	*kg/kmol*
X_{CO2}	Air CO_2 concentration	-
$dM/dtau_{CO2,in}$	Variation of room indoor CO_2 mass	*kg/s*
V_{in}	Room indoor volume	m^3
v_a	Moist air specific volume	m^3/kg_{dryair}
$\dot{L}$	Thermal imbalance of the human body	*W*
$\dot{Q}_m$	Metabolism not converted in work and dissipated as heat	*W*
$\dot{Q}_a$	Heat flow dissipated to ambiance through breathing and skin	*W*
$\dot{E}_m$	Metabolism	*W*
η	Mechanical efficiency	-
$\dot{H}_R$	Enthalpy taken away by the breathing air	*W*
$\dot{H}_{persp}$	Perspiration i.e. steam diffusion through skin	*W*
$\dot{H}_{sweat}$	Sweating steam diffusion	*W*
$\dot{Q}_{cl}$	Heat flow through clothing	*W*
$\dot{Q}_{rad}$	Radiation heat exchange with ambiance	*W*
$\dot{Q}_{conv}$	Convection heat exchange with ambiance	*W*
A_{sk}	Human body skin area	m^2
C	Occupant *susceptibility*	-
PMV	Predicted Mean Vote	-
PPD	Predicted Percentage of Dissatisfied	*%*
$f_{comfort,profile}$	Factor equal to 1 when comfort is required, 0 when it isn't	-
$t_{set,occ}$	Temperature set point during occupancy period	*°C*
t_{in}	Indoor temperature	*°C*
τ	Time	*s*
dd	Degree-days	*K.day*
t_a	Moist air dry temperature	*°C*
W	Moist air humidity ratio	kg_{water}/kg_{dryair}
$\dot{M}_w$	Water mass flow rate	*kg/s*
$F_{w,in}$	Fictitious surcharge of indoor moisture capacity	-
p_w	Water vapor partial pressure of moist air total pressure	*Pa*
$p_{w,s}$	Water vapor partial pressure of saturated moist air	*Pa*
RH	Relative humidity of moist air	-
η	System efficiency	-
COP	System coefficient of performance	-

2. SOLAR HEAT GAINS AND SKY RADIATION

$q_{b,w}$	Heat gains from direct solar intensity through windows	*W*
SF	Window solar factor	-
g	Glazing solar factor	-
f_{fr}	Ratio of frame area in the whole window area	-
I_b	Direct solar intensity on a plane of a given slope and azimuth	W/m^2
A_w	Window area including glazing and frame	m^2
I_{bh}	Direct solar intensity measured on a horizontal plane	*W/m2*
θ	Angle between sum beams and normal direction to a given wall	*rad*
θ_z	Angle between sum beams and vertical direction	*rad*
$A_{eq,w}$	Window equivalent solar area including glazing and frame	m^2
p	Wall slope (*0* for horizontal position; $\pi/2$ for vertical)	*rad*
γ	Sun azimuth (*0* for sun on south, *>0* for sun on west)	*rad*
γ_p	Wall azimuth (*0* for south facing wall, *>0* for west facing wall)	*rad*
δ	Sun declination	*rad*
φ	Latitude	*rad*
λ	Longitude	*rad*
ω	True solar time	*rad*
λ_h	Longitude expressed in *h*	*h*
ω_h	True solar time expressed in *h*	*h*
UTC	Coordinated Universal Time in *h*	*h*
ET	Equation of Time in *h*	*h*
h_{cw}	Clock time in winter	*h*
h_{cs}	Clock time in summer	*h*
h_{solar}	Solar time of the place under consideration	*h*
$q_{dr,w}$	Heat gains from diffuse and reflected solar intensities through windows	*W*
I_{dr}	Diffuse and reflected solar intensities on a plane of a given slope	W/m^2
I_{dh}	Diffuse solar intensity measured on a horizontal plane	W/m^2
I_{bh}	Direct solar intensity measured on a horizontal plane	W/m^2
I_{th}	Total solar intensity measured on a horizontal plane	W/m^2
ρ	Surrounding ground albedo	-
I_{ir}	Infrared radiation emitted by an area of a given slope	W/m^2
$I_{ir,h}$	Infrared radiation emitted by an horizontal plane	W/m^2
$I_{ir,h,cs}$	Infrared radiation of a horizontal plane for clear sky conditions	W/m^2
$I_{ir,h,cc}$	Infrared radiation of a horizontal plane for covered sky conditions	W/m^2
J	Relative solar intensity at a given time	-
J_{cc}	Relative solar intensity for covered sky conditions $J_{cc} = 0{,}354$	-
J_{cs}	Relative solar intensity for clear sky conditions $J_{cs} = 1$	-
$I_{t,h}$	Total solar intensity on a horizontal plane at a given time	W/m^2
$I_{t,h,cs}$	Total solar intensity on a horizontal plane for clear sky conditions	W/m^2

3. WALL MODEL DEFINITION

$\tilde{t}_1, \tilde{t}_2$	Temperature variations expressed as complex quantities	*°C*
$\tilde{q}_1, \tilde{q}_2$	Heat flow variations expressed as complex quantities	*W/m2*
ω	Pulsation	*rad/s*
d	Thickness	*m*
α	Thermal diffusivity	m^2/s
λ	Thermal conductivity	*W/m.K*
ρ	Mass density	kg/m^3
c	Specific heat	*J/kg.K*
$\tilde{K}_\nu$	Wall transmittance	$W/m^2.K$
$\tilde{A}_\nu$	Wall admittance	$W/m^2.K$
ν	Frequency of a sinusoidal signal	s^{-1}
f_d	Dampening factor of a sinusoidal signal	-
R	Wall heat transfer resistance	$m^2.K/W$
C	Wall heat capacity	$J/m^2.K$
ϕ	Useful proportion of wall overall heat capacity	-
θ	Accessibility of wall overall heat capacity	-
U	Wall overall heat transfer coefficient	$W/m^2.K$

4. BUILDING SIMPLIFIED MODEL DEFINITION

R_1	Heat transfer resistance of a zone light external walls	*K/W*
R_{21}, R_{22}	Heat transfer resistances of a zone massive external walls	*K/W*
C_2	Heat capacity of a zone massive external walls	*J/K*
R_3	Heat transfer resistance of a zone massive internal walls	*K/W*
C_3	Heat capacity of a zone massive internal walls	*J/K*
C_4	Heat capacity associated to a zone indoor node	*J/K*
R_v	Heat transfer resistance modeling zone ventilation heat losses	*K/W*
R_4	Heat transfer resistance of light walls separating zones	*K/W*
$R_{5,z1}, R_{5,z2}$	Heat transfer resistances of massive walls separating zones	*K/W*
C_5	Heat capacity of massive walls separating zones	*J/K*
t_1	Outdoor node temperature	*°C*
t_2	Node temperature associated to C_2 capacity	*°C*
t_3	Node temperature associated to C_3 capacity	*°C*
t_4	Indoor node temperature	*°C*
$\dot{Q}_{vent}$	Ventilation heat exchange between zone and outdoor	*W*
$\dot{Q}_{transm}$	Transmission heat exchange between zone and outdoor	*W*
$\dot{Q}_{heating}$	Emission from zone heating system	*W*
$\dot{Q}_{sol}$	Heat gains from direct solar intensity through windows	*W*
$\dot{Q}_{occ}$	Heat gains from occupants, lighting and appliances	*W*
U_{C4}	Energy stored in C_4 capacity	*J*

5. BUILDING SIMPLIFIED MODEL VALIDATION

Y	Outdoor heat flow response factor for indoor temperature impulse	W/m^2
Z	Indoor heat flow response factor for indoor temperature impulse	W/m^2
Δt	Time step for the computation of walls response factors	s
$\mathbf{N}$	Finite elements temperature interpolation matrix	-
$\mathbf{B}$	Finite elements temperature-gradient interpolation matrix	m^{-1}
$\mathbf{N}_S$	Finite elements surface temperature interpolation matrix	-
$\mathbf{C}$	Finite elements capacity matrix	J/K
$\mathbf{L}$	Finite elements conductivity matrix	W/K
$\mathbf{H}$	Finite elements convection and radiation matrix	W/K
h	Heat transfer coefficient, including convection and radiation	$W/m^2.K$
$\boldsymbol{\theta}$	Finite elements nodal temperatures vector	°C
$\boldsymbol{\theta}_\mathbf{e}$	Finite elements surface nodes temperatures vector	°C
$\dot{Q}_{convol}$	Indoor heat flow from convolution on zone response factors	W
$\dot{Q}_{out,isothermal}$	Indoor heat flow response to outdoor temperature	W
$\dot{Q}_{in,isothermal}$	Indoor heat flow response to indoor temperature for isothermal boundary conditions walls	W
$\dot{Q}_{in,adiabatic}$	Indoor heat flow response to indoor temperature for adiabatic boundary conditions walls	W
$\lambda_{out,isothermal}$	Convolution correction factor for $\dot{Q}_{out,isothermal}$	-
$\lambda_{in,isothermal}$	Convolution correction factor for $\dot{Q}_{in,isothermal}$	-
$\lambda_{in,adiabatic}$	Convolution correction factor for $\dot{Q}_{in,adiabatic}$	-
$\dot{Q}_{heating}$	Emission from zone heating system	W
$\dot{Q}_{heating,max}$	Maximum emission from zone heating system	W
X	Control factor	-
t_{in}	Indoor temperature	°C
t_{set}	Temperature set point	°C
X	Control factor	-
C	Invert of the differential of zone indoor temperature controller	K^{-1}
$t_{in,ref}$	Reference indoor temperature	°C
$\bar{t}_{in}$	Daily mean indoor temperature	°C
Δt_{in}	Daily indoor temperature amplitude	°C
RMS	Root mean square of the error on indoor temperature	°C
dmp	Indoor temperature dampening ratio	-
$\bar{t}_{in,st}$	Daily mean indoor temperature for a static computation	°C
$\Delta t_{in,st}$	Daily indoor temperature amplitude for a static computation	°C
$t_{eq,out}$	Equivalent outdoor temperature	°C
$t_{a,out}$	Outdoor air temperature	°C
α	Shortwave absorption factor	-
ε	Emissivity	-
h_{out}	Outdoor heat transfer coefficient (convection and radiation)	$W/m^2.K$
$\dot{Q}_{sol}$	Solar radiation reaching outdoor wall surface	W/m^2
$\dot{Q}_{sky,ir}$	Sky radiation related to outdoor wall surface	W/m^2

6. VENTILATION MODELS

Δp	Pressure drop through ventilation aperture	*Pa*
$\dot{M}$	Air mass flow rate through ventilation aperture	*kg/s*
n	Air mass flow rate exponent (*0* for laminar, *1* for turbulent flow)	-
K	Constant of ventilation aperture resistance	$Pa.(s/kg)^{1+n}$
Δp_{wind}	Wind pressure	*Pa*
p_c	Wind pressure factor	-
u_{wind}	Wind speed	*m/s*
v_{out}	Outdoor air specific volume	m^3/kg
$\Delta p_{buoyancy}$	Buoyancy pressure	*Pa*
g	Acceleration of gravity	m/s^2
z	Level	*m*
v	Air specific volume	m^3/kg
CSO	Controlled Supply Orifice	
CEO	Controlled Exhaust Orifice	
TO	Transfer Orifice	
$\dot{M}_{ms}$	Mechanical supply air mass flow rate	*kg/s*
$\dot{M}_{me}$	Mechanical exhaust air mass flow rate	*kg/s*
Δp_{duct}	Duct pressure drop	*Pa*
Δp_{unit}	Supply unit pressure drop including pressure balance device	*Pa*
Δp_{AHU}	Pressure drop through Air Handling Unit	*Pa*

7. AIR QUALITY ANALYSIS

X_{CO2}	Air CO_2 concentration	*ppm*
$X_{CO2,set}$	Air CO_2 concentration set point	*ppm*
C	Invert of the differential of indoor CO_2 concentration controller	ppm^{-1}
rpm_{fan}	Fan rotation speed	*rev/min*
$rpm_{fan,nom}$	Nominal fan rotation speed	*rev/min*
$COP_{chiller}$	Chiller coefficient of performance	-
$t_{a,su,cd}$	Chiller condenser air supply temperature	*°C*

8. SUMMER COMFORT ANALYSIS

t_{out}	Outdoor temperature	*°C*
t_{in}	Indoor temperature	*°C*
PPD	Predicted Percentage of Dissatisfied	*%*

9. CONNECTION WITH HEATING OR HVAC SYSTEM

$t_{s,floor}$	Heating floor surface temperature	*°C*
t_{in}	Indoor temperature	*°C*
t_{w}	Water temperature	*°C*
$t_{room,under}$	Temperature of the room under heating floor	*°C*
$R_{floor,in}$	Heat transfer resistance between floor surface and indoor node	*K/W*
$R_{w,floor}$	Heat transfer resistance between water pipes and floor surface	*K/W*
$R_{floor\ losses}$	Heat transfer resistance between water pipes and room under	*K/W*
C_{floor}	Floor heat capacity	*J/K*
$\dot{Q}_{ex,floor}$	Heat flow supplied by the heating floor to the zone	*W*
$\dot{Q}_{su,floor}$	Heat flow supplied by the water to the heating floor	*W*
$\dot{Q}_{floor,storage}$	Heat flow stored in the floor heat capacity	*W*
ε_{floor}	Heating floor heat exchange efficiency	-
$\dot{C}_{w,floor}$	Heating floor water heat capacity rate	*W/K*
$t_{w,su,floor}$	Heating floor water supply temperature	*°C*
$t_{w,ex,floor}$	Heating floor water exhaust temperature	*°C*
$t_{w,su,floor,set}$	Heating floor water supply set point temperature	*°C*
$t_{w,su,floor,nom}$	Heating floor water supply temperature for nominal conditions	*°C*

t_{out}	Outdoor temperature	*°C*
$t_{out,nom}$	Outdoor nominal temperature	*°C*
t_{set}	Indoor set point temperature	*°C*
C_{ff}	Feed-forward proportional action factor	-
C_{fb}	Feed-back proportional action factor	-
C_{w}	Invert of the differential of water supply temperature controller	K^{-1}
C_{in}	Invert of the differential of zone indoor temperature controller	K^{-1}

$t_{c,ground}$	Ground capacity node temperature	*°C*
t_{ground}	Ground temperature	*°C*
$t_{glw,su,ev}$	Brine-water heat pump evaporator brine supply temperature	*°C*
$R_{ground,fluid}$	Heat transfer resistance between ground capacity node and brine	*K/W*
R_{ground}	Ground heat transfer resistance	*K/W*
C_{ground}	Ground heat capacity	*J/K*
$\dot{Q}_{ev}$	Heat flow supplied to the brine-water heat pump evaporator	*W*
$\dot{Q}_{su,ground}$	Heat flow supplied by the ground heat exchanger	*W*
$\dot{Q}_{ground,storage}$	Heat flow stored in the ground heat capacity	*W*

NTU	Heat exchanger number of transfer units	-
AU	Heat exchanger overall heat transfer coefficient	*W/K*
$\dot{C}_{a}$	Heat exchanger air heat capacity rate	*W/K*
$\dot{C}_{w}$	Heat exchanger water heat capacity rate	*W/K*
ε	Heat exchanger efficiency	-

w_a	Moist air humidity ratio	kg_{water} $/kg_{dryair}$
$\dot{M}_a$	Air mass flow rate	kg_{dryair}/s
$\dot{M}_{steam}$	Steam mass flow rate	kg_{water}/s
h_a	Moist air enthalpy	J/kg_{dryair}
h_{steam}	Steam enthalpy	J/kg_{water}
h_{fg0}	Latent heat of vaporization	J/kg_{water}
c_{pg}	Vapor specific heat at constant pressure	$J/kg.K$
c_{pa}	Air specific heat at constant pressure	$J/kg.K$
h_c	Convection heat transfer coefficient	$W/m^2.K$
h_m	Mass transfer conductance	$kg/m^2.s$
w_{sat}	Moist air humidity ratio for saturated air	kg_{water} $/kg_{dryair}$
$h_{sat,tw}$	Enthalpy of saturated air at temperature t_w	J/kg_{dryair}
t_{wb}	Moist air wet bulb temperature	$°C$
R_w	Water side cooling coil thermal resistance	$m^2.K/W$
R_m	Metal cooling coil thermal resistance	$m^2.K/W$
R_a	Air side dry air cooling coil thermal resistance	$m^2.K/W$
R_{sat}	Air side saturated air cooling coil thermal resistance	$m^2.K/W$
AU_c	Wet cooling coil contact heat transfer coefficient	W/K
ε_c	Wet cooling coil contact effectiveness	-
t_c	Wet cooling coil contact temperature	$°C$

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