BASIC HYGRO-THERMAL EVALUATION OF THE BUILDING CONSTRUCTION (1D HEAT AND MOISTURE TRANSFER)

according to EN ISO 13788, EN ISO 6946 and CSN 730540

Teplo 2014

Project name : **HALL EXTENSION**
User : ALESSIO AMODIO
Order :
Date : 06.01.2020

ASSEMBLY OF THE CONSTRUCTION AND BOUNDARY CONDITIONS:

Type of analysed construction : Roof, ceiling - heat flow upwards
Correction of U-value dU : 0.050 W/m2K

Assembly of the construction (from interior) :

No.	Name	D [m]	Lambda [W/(m.K)]	C [J/(kg.K)]	Ro [kg/m3]	Mi [-]	Ma [kg/m2]
1	TR SHEET	0,1600	0,0670	1010,0	1,2	1,0	0.0000
2	PE foil	0,0002	0,3500	1470,0	900,0	144000,0	0.0000
3	MINERAL WOOL	0,0300	0,0490	1150,0	150,0	5,0	0.0000
4	MINERAL WOOL	0,0300	0,0490	1150,0	150,0	5,0	0.0000
5	EPS 150 S	0,0600	0,0350	1270,0	25,0	30,0	0.0000
6	EPS 100 S	0,1200	0,0370	1270,0	20,0	30,0	0.0000
7	mPVC FOIL	0,0150	0,1700	1400,0	1200,0	1000,0	0.0000

Note: D is thickness of layer, Lambda is design thermal conductivity of layer, C is specific thermal capacity, Ro is bulk density of layer, Mi is vapor resistance factor of layer and Ma is initial built-in moisture in layer.

No.	Complete name of layer	Internal calculation of thermal conductivity
1	TR SHEET	---
2	PE foil	---
3	MINERAL WOOL	---
4	MINERAL WOOL	---
5	EPS 150 S	---
6	EPS 100 S	---
7	mPVC FOIL	---

Calculation will be executed using moisture redistribution.

Assembly of the construction (from interior) :

No.	Name	Coefficient K [W/(m.K)]	u,23/80 [%]	W,c [kg/m2]	W,m [kg/m2]	Redistribution
1	TR SHEET	---	0.00	0.00	0.00	NO
2	PE foil	---	0.00	0.00	0.00	NO
3	MINERAL WOOL	---	0.00	0.00	0.00	NO
4	MINERAL WOOL	---	0.00	0.00	0.00	NO
5	EPS 150 S	---	0.00	0.00	0.00	NO
6	EPS 100 S	---	0.00	0.00	0.00	NO
7	mPVC FOIL	---	0.00	0.00	0.00	NO

Note: Lambda,m is th.conductivity of layer fully saturated by moisture, u23/80 is character. gravimetric moisture content, W,c is critical moisture content (limit for beginning of liquid phase transport), W,m is max.possible amout of moisture and redistribution indicates the liquid phase transport possibility.

Boundary conditions :

Internal surface thermal resistance Rsi : 0.10 m2K/W
dtto for calculation of temperature factor Rsi : 0.25 m2K/W
External surface thermal resistance Rse : 0.04 m2K/W
dtto for calculation of temperature factor Rse : 0.04 m2K/W

Design external temperature Te : -15.0 C
Design internal air temperature Tai : 21.0 C

Design relative humidity of external air RHe : 84.0 %
Design relative humidity of internal air RHi : 55.0 %

Month	Dur.[days]	Ti[C]	RHi[%]	Pi[Pa]	Te[C]	RHe[%]	Pe[Pa]
1	31	21.0	53.8	1337.2	-4.5	81.3	340.4
2	28	21.0	56.9	1414.3	-2.3	80.5	405.9
3	31	21.0	57.7	1434.2	1.8	79.2	550.6
4	30	21.0	60.2	1496.3	7.0	76.8	769.0
5	31	21.0	64.7	1608.2	11.9	73.6	1024.9
6	30	21.0	68.5	1702.6	15.0	70.9	1208.4
7	31	21.0	70.5	1752.3	16.5	69.3	1300.2
8	31	21.0	70.0	1739.9	16.1	69.8	1276.6
9	30	21.0	65.2	1620.6	12.3	73.3	1048.0
10	31	21.0	60.2	1496.3	7.1	76.7	773.3
11	30	21.0	57.6	1431.7	1.5	79.3	539.6
12	31	21.0	56.5	1404.4	-2.6	80.7	396.8

Note: Tai, RHi and Pi are mean monthly parameters of internal air (temperature, rel. humidity and partial vapor pressure) anf Te, RHe and Pe are mean monthly parameters in environment on external side (temperatur, rel. humidity and partial vapor pressure).

Mean monthly external temperature Te was decreased by 2 C according to EN ISO 13788 (influence of radiation heat exchange between roof and sky vault).

To increase the safety, internal relative humidity was increased for: 5.0 %

The first month of calculation was determined according to EN ISO 13788.
Number of calculated years : 1

RESULTS OF CALCULATION :

Thermal resistance and thermal transmittance according to EN ISO 6946 :

Thermal resistance of construction R : 5.971 m2K/W
Thermal transmittance of construction U : **0.164 W/m2K**

U-value of built-in construction U,kc : 0.18 / 0.21 / 0.26 / 0.36 W/m2K
These informational values are valid for various design level of thermal bridges expressed by means of increment according to clause B.9.2 in ČSN 730540-4.

Diffusion resistance and thermal accumulation:

Vapor diffusion resistance of construction ZpT : 2.6E+0011 m/s

Decrement factor of construction Ny* : 176.6
Time shift of temperature oscillation Psi* : 6.3 h

Internal surface temperature and temperature factor according to EN ISO 13788 :

Internal surface temperature for design conditions Tsi,p : 19.56 C
Temperature factor in design conditions f,Rsi,p : **0.960**

Month no.	Minimum required values for max. internal surface relative humidity				Calculated values		
	--------- 80% ---------		-------- 100% ---------				
	Tsi,m[C]	f,Rsi,m	Tsi,m[C]	f,Rsi,m	Tsi[C]	f,Rsi	RHsi[%]
1	14.7	0.753	11.3	0.619	20.0	0.960	57.3
2	15.6	0.767	12.1	0.620	20.1	0.960	60.3
3	15.8	0.728	12.3	0.549	20.2	0.960	60.5
4	16.5	0.675	13.0	0.428	20.4	0.960	62.3
5	17.6	0.625	14.1	0.242	20.6	0.960	66.2
6	18.5	0.583	15.0	------	20.8	0.960	69.5
7	19.0	0.546	15.4	------	20.8	0.960	71.3
8	18.8	0.560	15.3	------	20.8	0.960	70.8
9	17.7	0.622	14.2	0.221	20.7	0.960	66.6
10	16.5	0.673	13.0	0.424	20.4	0.960	62.3
11	15.8	0.731	12.3	0.555	20.2	0.960	60.4
12	15.5	0.765	12.0	0.620	20.1	0.960	59.9

Note: RHsi is relative humidity at the internal surface, Tsi is int.surface temperature and f,Rsi is temp.factor.

Vapor diffusion in design conditions and annual balance according to CSN 730540:

(without influence of built-in moisture and sun radiation)

Pressure and temperature distribution in design conditions:

interface:	i	1-2	2-3	3-4	4-5	5-6	6-7	e

theta[C]:	20.6	10.8	10.8	8.3	5.8	-1.2	-14.5	-14.8
p [Pa]:	1367	1363	651	647	643	599	510	138
p,sat [Pa]:	2424	1296	1296	1095	922	553	173	167

Note: theta is temperature on interfaces of layers, p is expected partial vapor pressure on interfaces of layers and p,sat is saturated partial vapor pressure on interfaces.

Interstitial condensation occurs in the design conditions.

Cond.zone no.	Cond.zone boundary left	[m]	right	Vapor condensation rate [kg/m2s]
1	0.1600		0.1600	8.180E-0008
2	0.4002		0.4002	6.052E-0009

Annual moisture balance:

Amount of condensated water vapor Mc,a: **0.0797 kg/(m2.rok)**
Amount of evaporable water vapor Mev,a: **0.1355 kg/(m2.rok)**
Condensation occurs if external temperature is lower than 10.0 C.

Annual moisture balance according to EN ISO 13788:

Annual cycle no. 1

Interstitial condensation occurs in construction during the model year.

Condensation zone no. 1

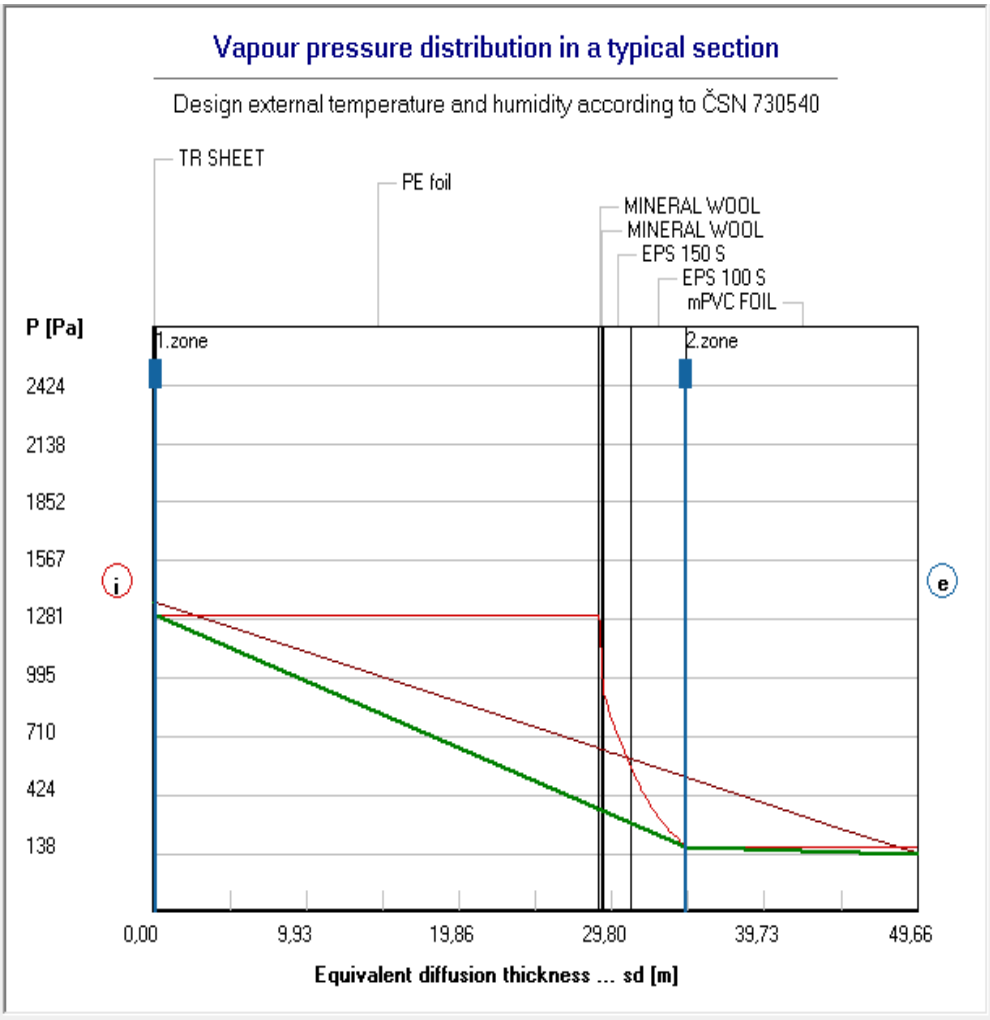
Month	Cond.zone boundary left	[m]	right	Act.cond./evap. Gc [kg/m2s]	Accum.moisture Ma [kg/m2]
11	0.4002		0.4002	2.19E-0009	0.0057
12	0.4002		0.4052	3.07E-0009	0.0139
1	0.4002		0.4052	3.45E-0009	0.0231
2	0.4002		0.4052	2.98E-0009	0.0303
3	0.4002		0.4052	1.07E-0009	0.0332
4	0.4002		0.4052	-2.08E-0009	0.0278
5	0.4002		0.4052	-6.35E-0009	0.0108
6	---		---	-1.01E-0008	0.0000
7	---		---	---	---
8	---		---	---	---
9	---		---	---	---
10	---		---	---	---

Maximum amount of condensated water vapor Mc,a: **0.0332 kg/m2**
Annual amount of evaporable vapor Mev,a is at least: **0.0332 kg/m2**

The zone is dry at the end of the model year (i.e. Mc,a < Mev,a).

Note: Calculation of water vapor diffusion was performed with the assumption of 1D vapor flow through prevailing assembly of the construction. The result is just informational for components with significant thermal bridges. More exact values can be obtained using 2D analysis.

STOP, Teplo 2014



LEGEND:

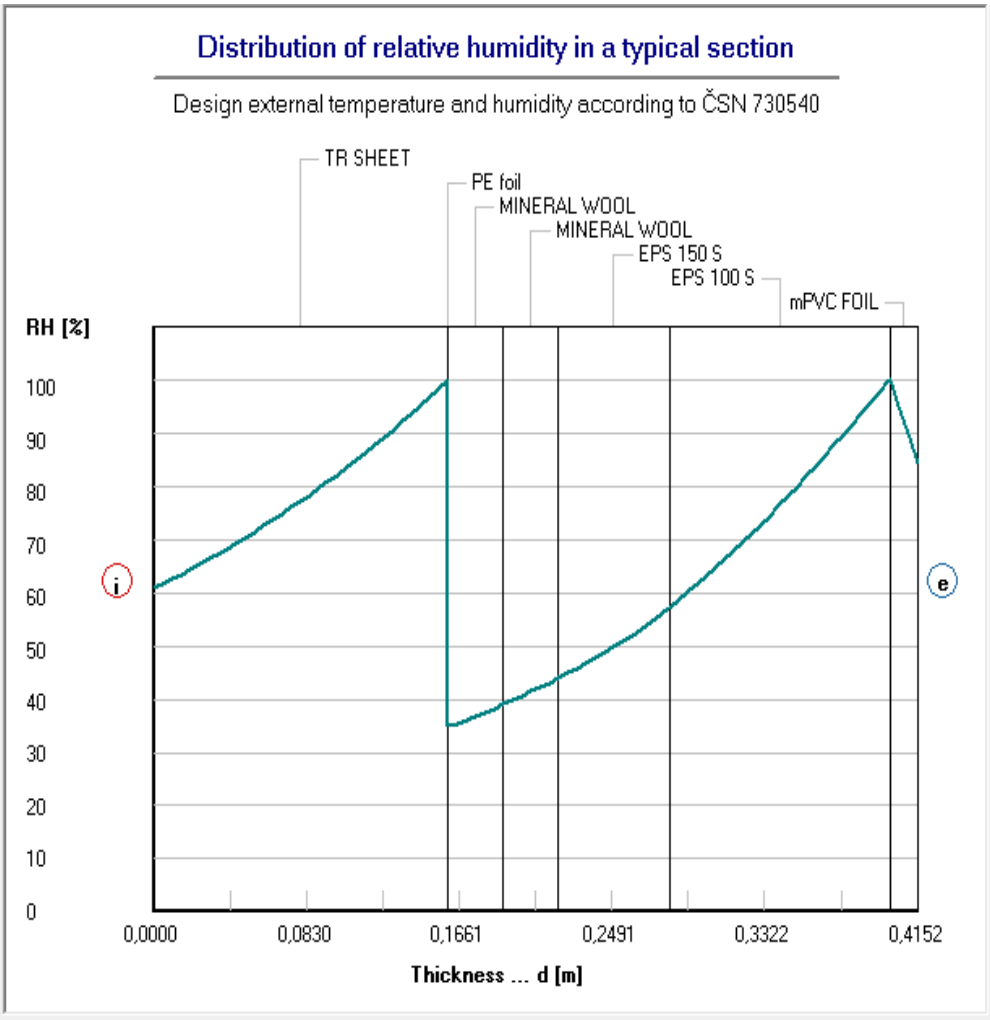
HALL EXTENSION

Vapour pressures:

Bound.conditions:

Interior	21,0 C
	55,0 %
Exterior	-15,0 C
	84,0 %

satur. pressure
theor. pressure
real pressure
condens. zone



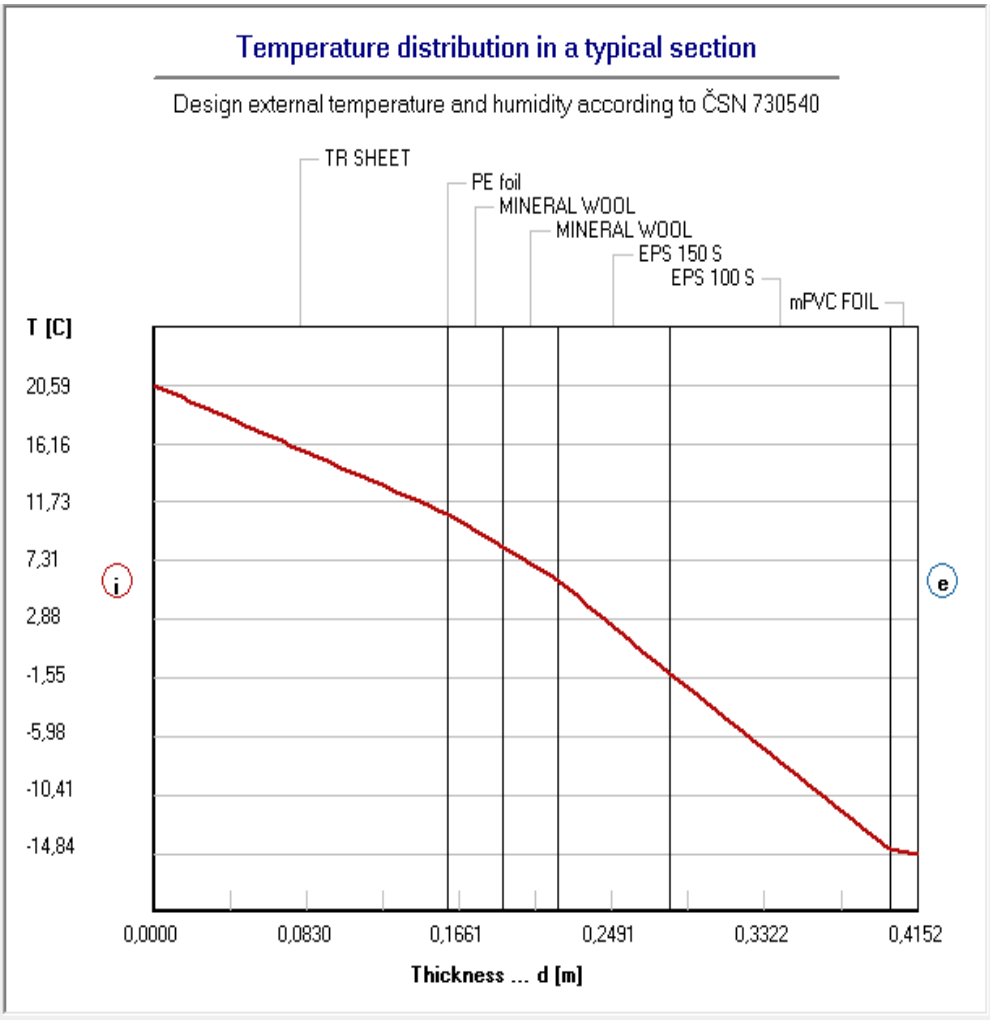
LEGEND:

HALL EXTENSION

Rel.humidity distribution:

Bound.conditions:

Interior	21,0 C
	55,0 %
Exterior	-15,0 C
	84,0 %



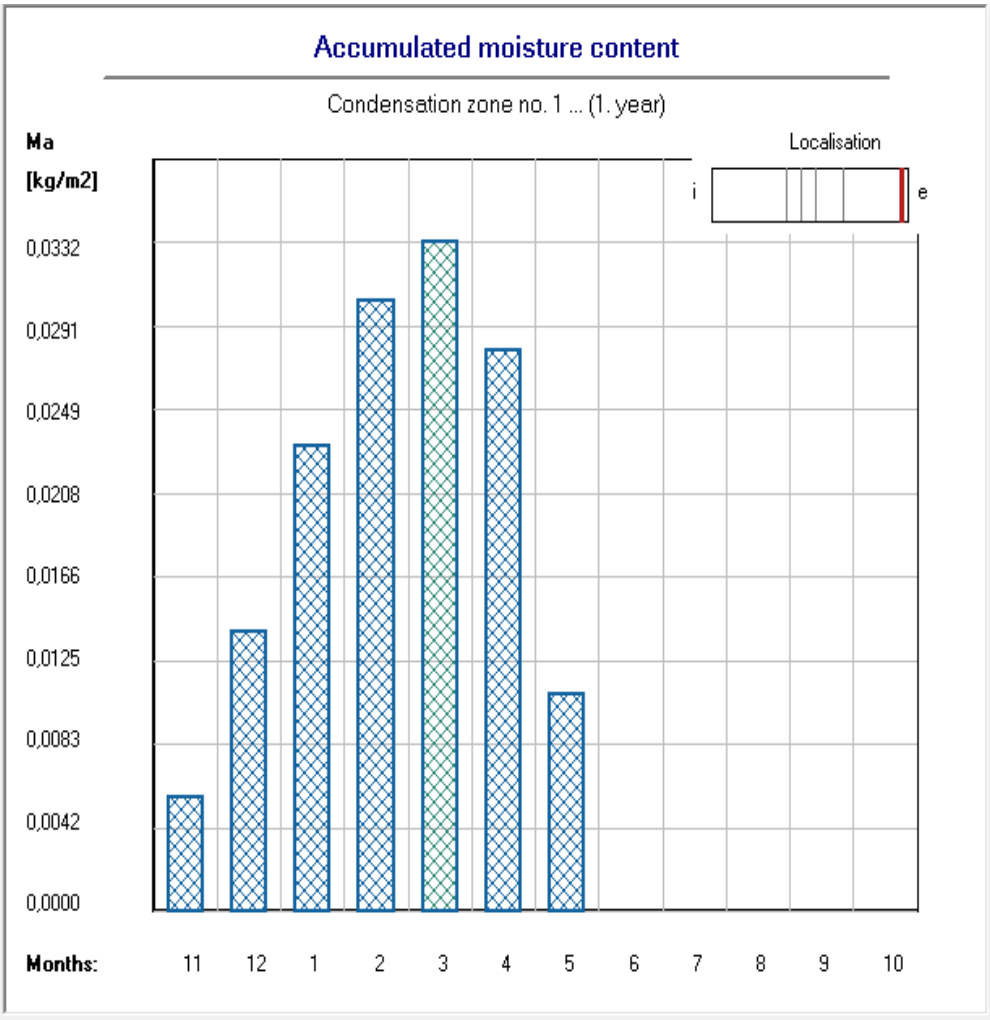
LEGEND:

HALL EXTENSION

Temperatures:

Bound.conditions:

Interior	21,0 C 55,0 %
Exterior	-15,0 C 84,0 %



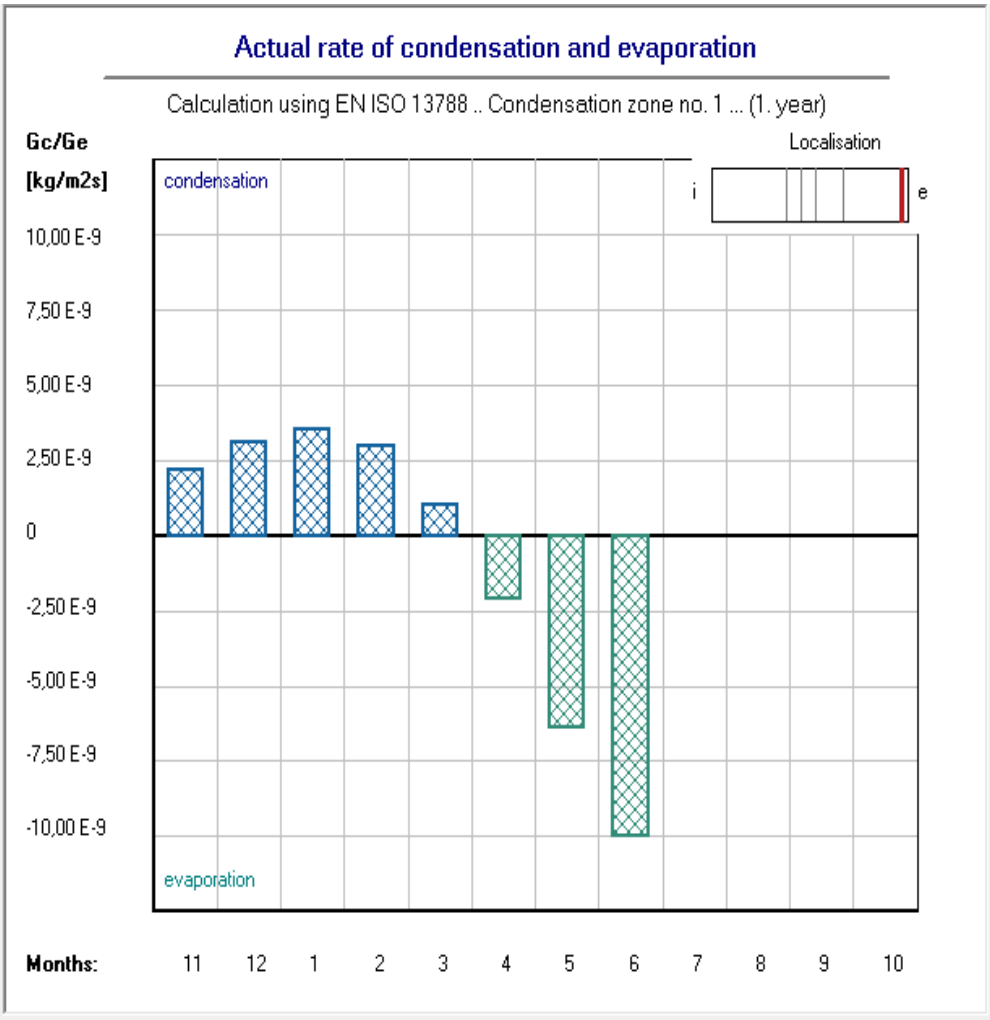
LEGEND:

HALL EXTENSION

Accumulated moisture:

Calculation year no. 1
Condensation zone no. 1

At the end of a model year, the zone is dry.



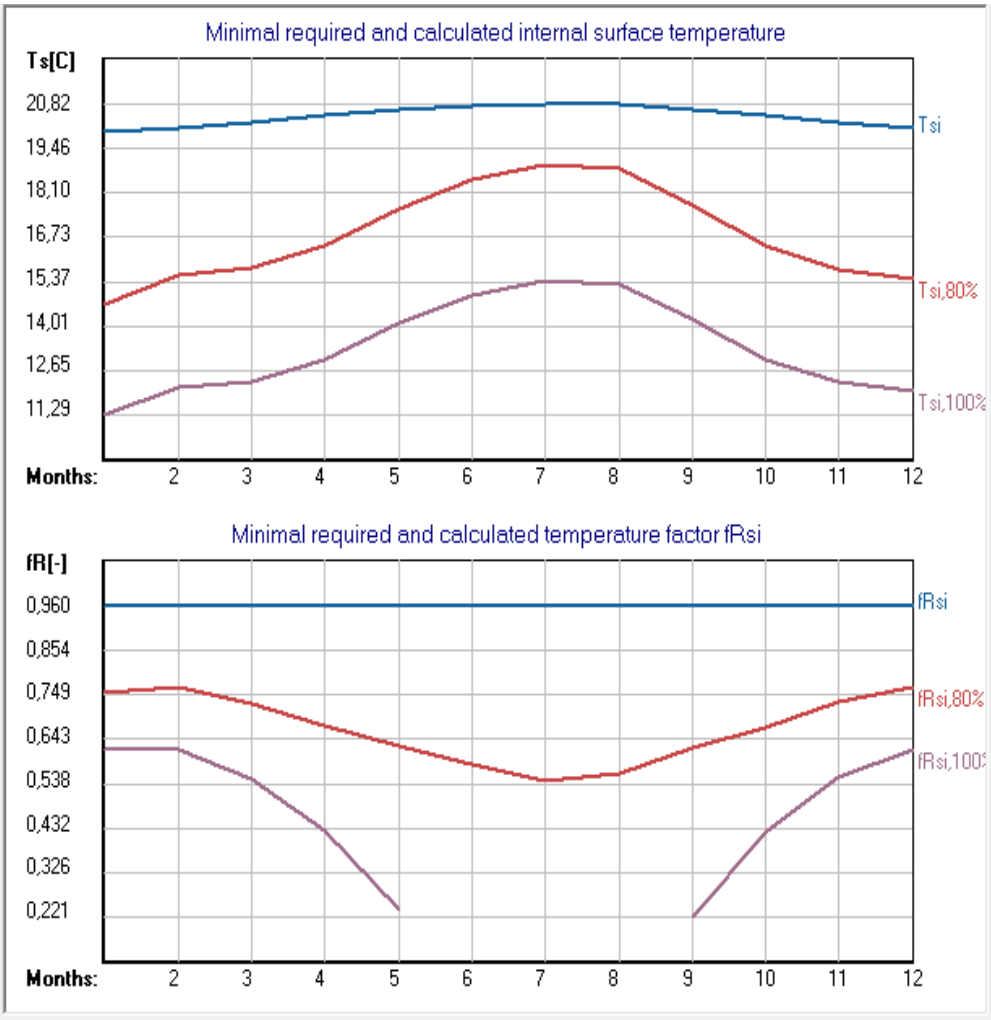
LEGEND:

HALL EXTENSION

Actual rate of condensation + evaporation:

Calculation year no. 1
Condensation zone no. 1

At the end of a model year, the zone is dry.



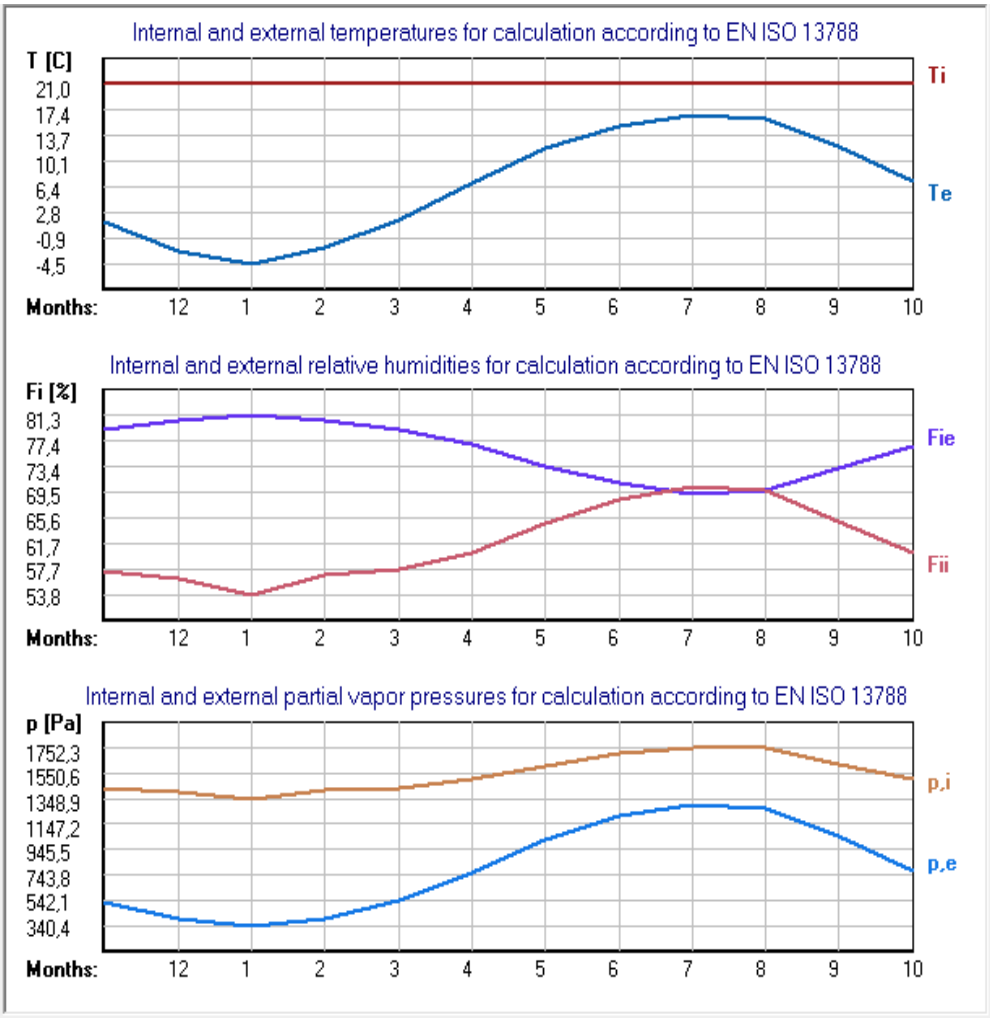
LEGEND:

HALL EXTENSION

Surf.temperatures and temp. factor:

Values for maximum surface relative humidity:

- 80% (preventing mould growth)
- 99% (preventing surface condensation)
- Calculated values



LEGEND:

HALL EXTENSION

Bound.conditions:

Number of years: 1
Starting month: 11