Calculation procedure for surface condensation

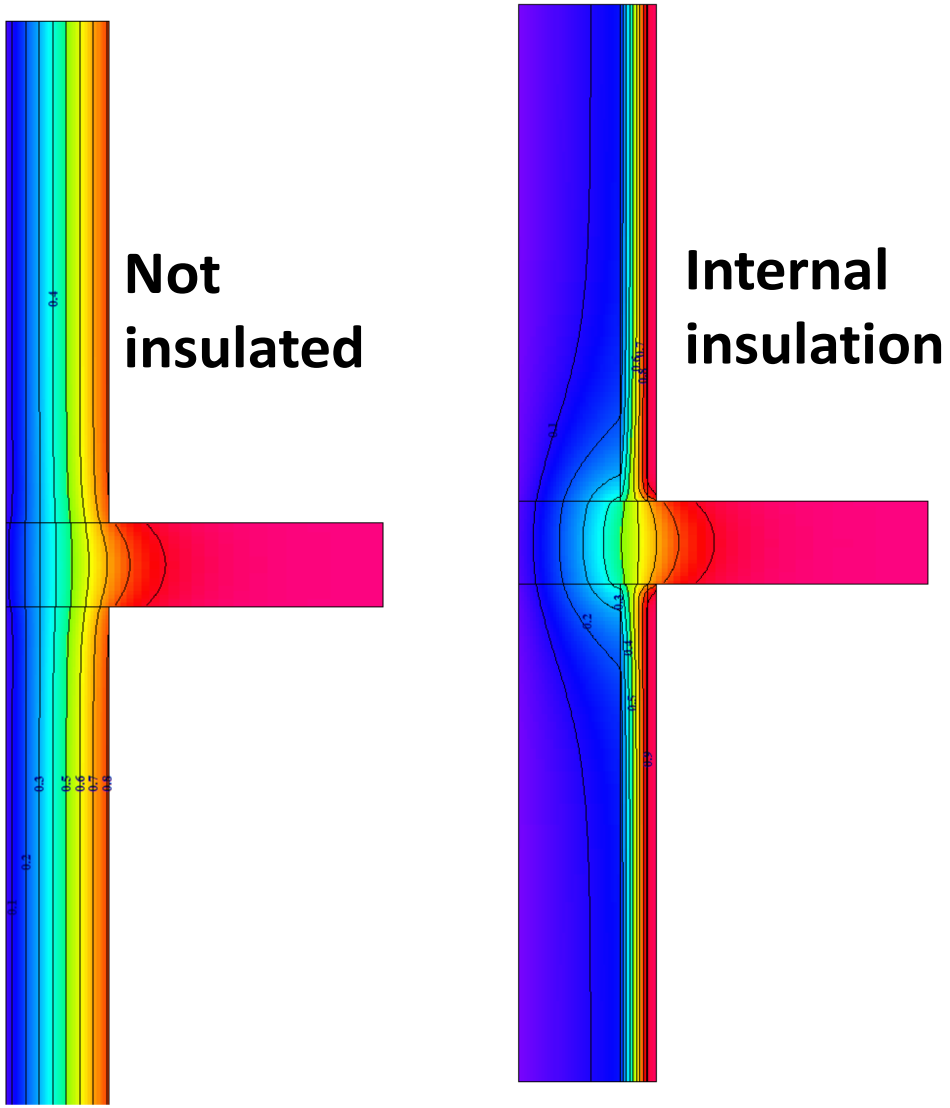
Output of the 2D calculation

The output of the 2D simulation is the temperature factor f_{RSi}.

The picture shows a thermal bridge due to the presence of different materials.

$f_{RSi} = 0.74$

How can we correlate this minimum loical temperature with the surface condensation problems?

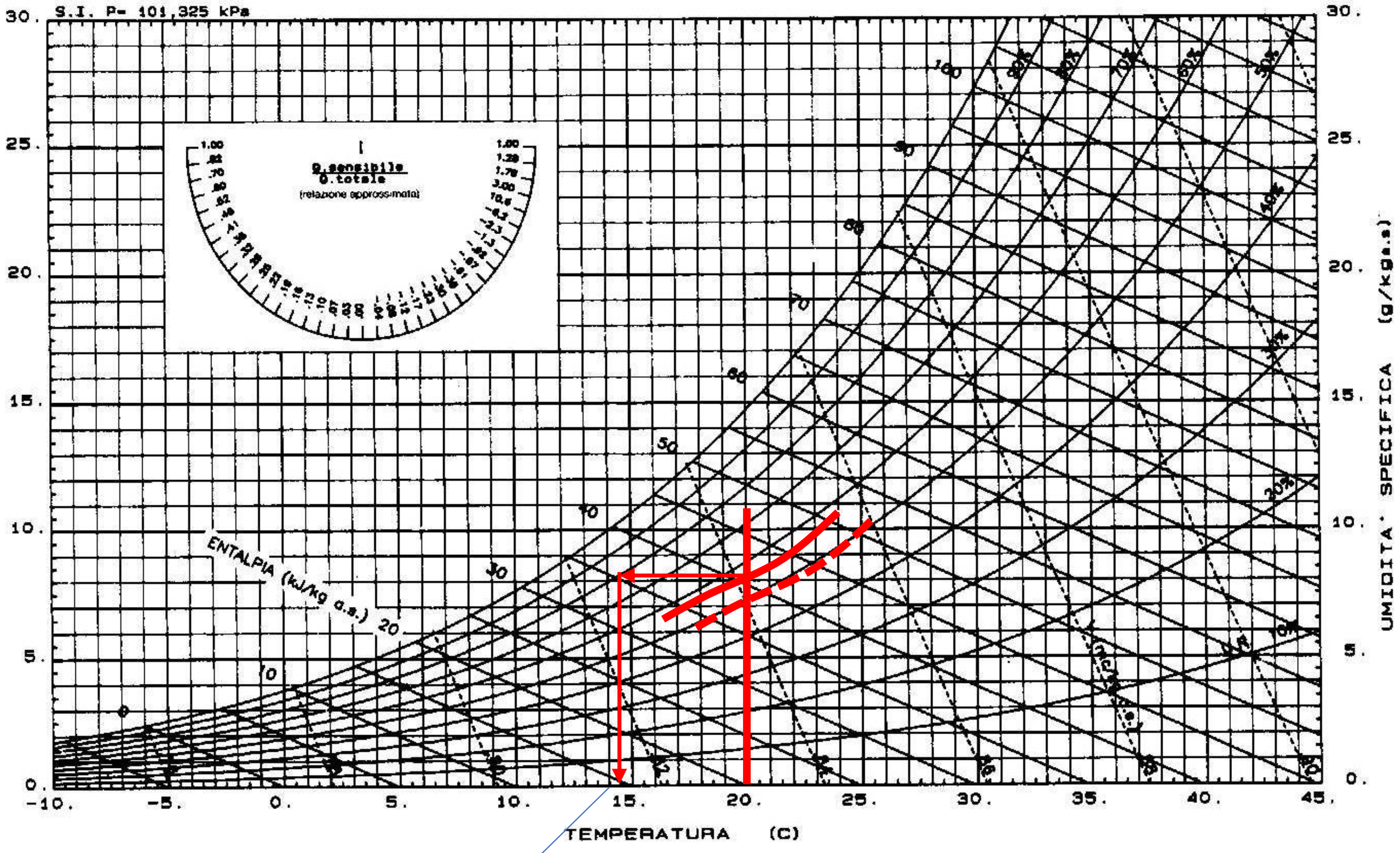


$f_{RSi} = 0.74 = (\theta_{si} - \theta_e) / (\theta_i - \theta_e)$

Let's consider Milan in January with $\theta_{si} = 1.7°C$

$$\theta_{si} = \theta_e + f_{RSi} * (\theta_i - \theta_e)$$

$$\theta_{si} = 1.7 + 0.74 * (20 - 1.7) = 15.2°C$$



$\theta_{si,min} = 14.5°C$

$\theta_{si} > \theta_{si,min}$

Condensation does not occur

Two main observations:

1) Need to evaluate the indoor conditions
2) Need for calculation procedure

ISO EN 13788

Example 1 – Calculation of the temperature factor – Use of the indoor humidity classes - UNI EN ISO 13788

Calculation of f_{RSi} *for January. Location: Milan (climatic data UNI 10349)*

θ_e= 1.7°C; p_v=590 Pa

θ_i = 20°C

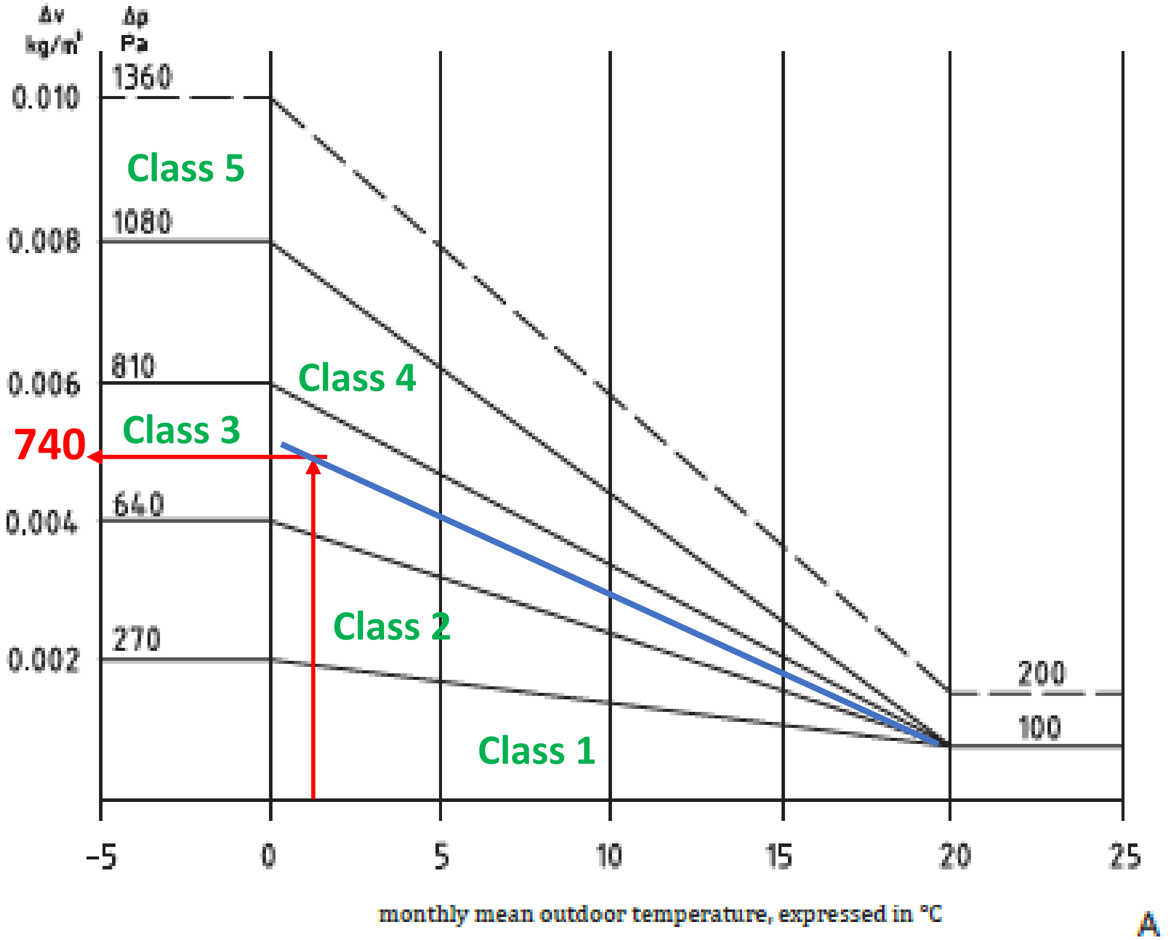
based on UNI EN ISO 13788

$$p_{sat} = 610{,}5\, e^{\frac{17{,}269\,\theta}{237{,}3+\theta}} \qquad \text{per } \theta \geq 0\ °C$$

Calculation of $p_{sat}(\theta_e)$ *= 690 Pa*

ϕ_e=85.6%

Calculation of the indoor pressure p_v (considering Δp for dwellings with low vapour production, class 3/4



Considering Δp and the safety factor 1.1 according to UNI EN ISO 13788 the indoor pressure p_v:

$$p_i = p_e + \Delta p = 590 + 740 * 1.1 = 1404 \text{ Pa}$$

Minimum acceptable value for the saturation pressure and minimum surface temperature referred to local condition φ_{si}=0.8

$$p_{sat}(\theta_{si}) = p_i / 0.8 = 1404 / 0.8 = 1755 \text{ Pa} \rightarrow \theta_{Si,min} = 15.5°C$$

$$\theta = \frac{237{,}3 \log_e\left(\frac{p_{sat}}{610{,}5}\right)}{17{,}269 - \log_e\left(\frac{p_{sat}}{610{,}5}\right)} \qquad \text{per } p_{sat} \geq 610{,}5 \text{ Pa}$$

Calculation of the minimum temperature factor:

$$f_{RSi,min} = (\theta_{Si,min} - \theta_e) / (\theta_i - \theta_e) = (15.5-1.7) / (20-1.7) = \underline{0.754}$$

Example 2 – Calculation of the temperature factor – Use of constant indoor relative humidity - UNI EN ISO 13788

Calculation of f_{RSi} for January. Location: Milan (climatic data UNI 10349)

θ_e= 1.7°C; p_v=590 Pa

θ_i = 20°C; ϕ_i=50%

based on UNI EN ISO 13788

$$p_{sat} = 610{,}5\, e^{\frac{17{,}269\,\theta}{237{,}3+\theta}} \qquad \text{per } \theta \geq 0\ °C$$

Calculation of $p_{sat}(\theta_i)$ = 2337 Pa

Calculation of indoor partial vapour pressure (RH + 0.05 according to UNI EN ISO 13788):

$$p_i = \phi_i\, p_{sat}(\theta_i) = 0.55 * 2337 = 1285 \text{ Pa}$$

Minimum acceptable value for the saturation pressure and minimum surface temperature referred to local condition φ_{si}=0.8

$$p_{sat}(\theta_{si}) = p_i / 0.8 = 1285 / 0.8 = 1606.3 \text{ Pa} \rightarrow \theta_{Si,min} = 14.08°C$$

$$\theta = \frac{237,3 \log_e\left(\frac{p_{sat}}{610,5}\right)}{17,269 - \log_e\left(\frac{p_{sat}}{610,5}\right)} \qquad \text{per } p_{sat} \geq 610,5 \text{ Pa}$$

Calculation of the minimum temperature factor:

$$f_{RSi,min} = (\theta_{Si,min} - \theta_e) / (\theta_i - \theta_e) = (14.08-1.7) / (20-1.7) = \underline{0.677}$$

How to calculate the surface condensation problem:

- Calculate from January to December in an Excel the $f_{Rsi,\ min}$
- Verify whether there is or not condensation in each month $f_{Rsi} > f_{Rsi,\ min}$

	Month	1	2	3	4	5	6	7	8	9	10	11	12
External conditions	**T_e (PD)**	1.7	4	8.4	13	17.1	21.3	23.6	23.1	19.7	13.8	8.2	3.6
	p_e (PD)	590	652	809	1083	1388	1790	1929	1928	1718	1252	934	677
	p_e_sat	**To be calculated**											
	RH_e	**To be calculated**											
Internal conditions	**T_i**	20	20	20	20	20/26	26	26	26	20/26	20	20	20
	delta_p_v	To be evaluated based on the indoor humidity class											
	p_v_i	**To be calculated**											
	p_sat (q_{si})	**p_sat at 80%**											
	$q_{Si,min}$	**To be calculated**											
	$f_{RSi,min}$	**To be calculated**											
Surface condensation check	**f_{RSi}**	**From thermal bridge**											
	Internal condensation	Yes/no	Yes/no	Yes/no	Yes/no	Yes/no	Yes/no	Yes/no	Yes/no	Yes/no	Yes/no	Yes/no	Yes/no