WEEK 9

Tuesday, December 3, 2019 8:55 PM

Politecnico di Milano
MSc. Sustainable Architecture and Landscape Design
Fabiola Anahí Mogrovejo León

Task 1. Use a weather forecast website, and utilize the psychrometric chart and the formula we went through in the class to determine the absolute humidity, the wet-bulb temperature and the mass of water vapor in the air in Classroom A (Aula A) of Piacenza campus in the moment that you are solving this exercise (provide the inputs that you utilized)

Il tempo oggi in Piacenza

Martedì, 03 Dicembre 2019 16:00

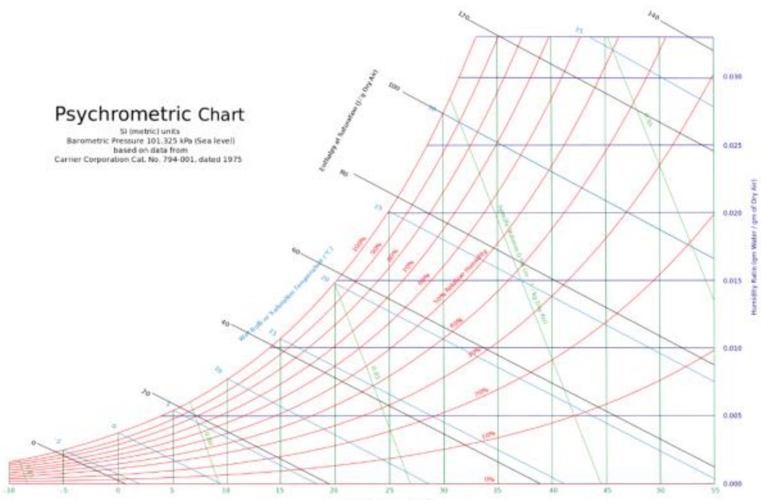
Desde <https://www.meteo-oggi.it/italia/regione-emilia-romagna/tempo-piacenza/>

Umidità: 69%

Pressione atmosferica: 1025 hPa

Air total pressure 102.5 kPa

Temperatura effettiva: 8 °C



Humidity ratio - absolute humidity ω = 0.0048

The web-bulb temperature Twb = 6.5 °C

$$\omega = \frac{0.622P_v}{P - P_v} = 0.0048\frac{Kg_{vapour}}{kg_{dryAir}}$$

If P= 102.5 kPa

P_v= 0.7849 kPa

Now, we can find the mass of the water

We accept the fact that for ideal gases : $m = \frac{PV}{R_{sp.}T}$

So for air : $m_a = \frac{P_a V_a}{R_a T}$ $\quad R_{sp.} = \frac{R_{global}}{M_{gas}}$ $\longrightarrow$ You can also find them in Tables $R_a = 0.287, R_v = 0.4615$

Volume class: 15*6*4

$$m_v = \frac{0.7849 * (15 * 6 * 4)}{0.4615 \ * (273 + 8)} = 2.18\ kg$$

$$\phi = \frac{m_v}{m_g} \quad \longrightarrow m_g \textit{the mass of water at sat condition}$$

$$m_g = \frac{m_v}{\phi} = \frac{2.19}{69\%} = 3.17\ kg$$

Task 2. Utilize the same methodology we went through in the class and determine the sensible and latent load corresponding to internal gains, the ventilation, and the infiltration in a house with a *good* construction quality and with the same geometry as that of the example which is located in Brindisi, Italy.

(height of 2.5 m, considering two occupants and one bed room calculate, and a conditioned floor area of 200 m2 and wall area is 144 m2)

Internal gains
$\dot{Q}ig_{sensible} = 136 + 2.2\ * A_{cf} + 22\ N_{oc} = 136 + 2.2 * 200 + 22 * 2 = 620\ W$
$\dot{Q}ig_{latent} = 20 + 0.22 * A_{cf} + 12\ N_{oc} = 20 + 0.22 * 200 + 12 * 2 = 88\ W$
Infiltration
First I should calculate how much is the maximum flow rate of air
First Let's find the leakage area

$$A_L = A_{es} A_{ul}$$

where

A_{es} = building exposed surface area, m^2
A_{ul} = unit leakage area, cm^2/m^2 (from Table 3)

good quality -> $A_{ul} = 1.4 \frac{cm^2}{m2}$

Exposed surface = Wall area +roof area

$$A_{es} = 200 + 144 = 344\ m^2$$

$$A_L = A_{es} \times A_{ul} = 344 \times 1.4 = 481.6\ cm^2$$

In the table,

$$IDF_{heating} = 0.073 \frac{L}{s.cm^2}$$

$$IDF_{cooling} = 0.033 \frac{L}{s.cm^2}$$

Now I can calculate the volume !

$$\dot{V}_{infiltration_{heating}} = A_L \times IDF = \ 481.6 * 0.073 = 35.16\frac{L}{s}$$

$$\dot{V}_{infiltration_{cooling}} = A_L \times IDF = \ 481.6 * 0.033 = 15.89\frac{L}{s}$$

BRINDISI, Italy WMO#: **163200**

Lat: **40.65N** Long: **17.95E** Elev: **10** StdP: **101.2** Time Zone: **1.00 (EUW)** Period: **86-10** WBAN: **99999**

Annual Heating and Humidification Design Conditions

	Coldest Month	Heating DB		Humidification DP/MCDB and HR						Coldest month WS/MCDB				MCWS/PCWD to 99.6% DB		
				99.6%			99%			0.4%		1%				
		99.6%	99%	DP	HR	MCDB	DP	HR	MCDB	WS	MCDB	WS	MCDB	MCWS	PCWD	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	
(1)	**2**	**2.9**	**4.1**	**-5.1**	**2.5**	**7.2**	**-3.0**	**3.0**	**7.4**	**13.4**	**10.2**	**12.4**	**10.6**	**3.4**	**250**	(1)

Annual Cooling, Dehumidification, and Enthalpy Design Conditions

	Hottest Month	Hottest Month DB Range	Cooling DB/MCWB						Evaporation WB/MCDB						MCWS/PCWD to 0.4% DB		
			0.4%		1%		2%		0.4%		1%		2%				
			DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	WB	MCDB	MCWS	PCWD	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
(2)	**8**	**7.1**	**32.8**	**23.6**	**31.1**	**24.3**	**29.9**	**24.3**	**27.2**	**29.7**	**26.3**	**29.0**	**25.6**	**28.3**	**4.2**	**180**	(2)

	Dehumidification DP/MCDB and HR									Enthalpy/MCDB						Hours 8 to 4 & 12.8/20.6	
	0.4%			1%			2%			0.4%		1%		2%			
	DP	HR	MCDB	DP	HR	MCDB	DP	HR	MCDB	Enth	MCDB	Enth	MCDB	Enth	MCDB		
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
(3)	**26.3**	**21.8**	**29.2**	**25.4**	**20.7**	**28.5**	**24.7**	**19.7**	**27.9**	**86.0**	**30.1**	**82.2**	**29.1**	**78.5**	**28.3**	**1236**	(3)

Extreme Annual Design Conditions

	Extreme Annual WS			Extreme Max WB	Extreme Annual DB				n-Year Return Period Values of Extreme DB								
					Mean		Standard deviation		n=5 years		n=10 years		n=20 years		n=50 years		
	1%	2.5%	5%		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
(4)	**11.3**	**9.9**	**8.7**	**31.4**	**0.4**	**37.3**	**1.4**	**3.0**	**-0.6**	**39.4**	**-1.4**	**41.1**	**-2.2**	**42.8**	**-3.2**	**44.9**	(4)

$\dot{V}_{ventilation} = 0.05\ A_{cf} + 3.5\ (N_{br} + 1) =$ *0.05*200+ 3.5* 2 = 17 L/S*

$\dot{V}_{inf-ventilation_{heating}} = 35.16 + 17 = 52.16\ L/s$

$\dot{V}_{inf-ventilation_{cooling}} = 15.89 + 17 = 32.89\frac{L}{s}$

The required miminum whole-building vetilation rate is

in Brindisi, Δ Tcooling=31.1 °C −24 °C=7.1 °C=7.1 K

Δ Theating=21 °C −(−4. 1 °C)=25.1 °C=25.1 K

DR = 7.1 °C =7.1 K

$C_{sensible} = 1.23$, $C_{latent} = 3010$, *ΔωCooling=0.0039*

$$\dot{Q}_{inf-ventilation_{cooling_{sensible}}} = C_{sensible}\dot{V}\Delta T_{Cooling} = 1.23\ * 32.89 * 7.1 = 287.25\ W$$

$$\dot{Q}_{inf-ventilation_{cooling_{latent}}} = \ C_{latent}\dot{V}\Delta\omega_{Cooling} = 3010\ * 32.89\ *\ 0.0039 = 386.13\ W$$

$$\dot{Q}_{inf-ventilation_{heatingg_{sensible}}} = C_{sensible}\dot{V}\Delta T_{heating} = 1.23\ * 52.16 * 25.1 = 1610.34\ W$$