Week assignment 9

Task 1

Question

Use a weather forecast website, and utilize the psychrometric chart and the formula we went through in the class to determine the absoloute humidity, the wet-bulb temperature and the mass of water vapour 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)

Umidità: **Relative humidity**, Pressione atmosferica: **Air total pressure** (1 hPa: 0.1 kPa), Temperatura effettiva: **temperature to be utilized.**

Answer

Il tempo oggi in Piacenza
Martedì, 03 Dicembre 2019

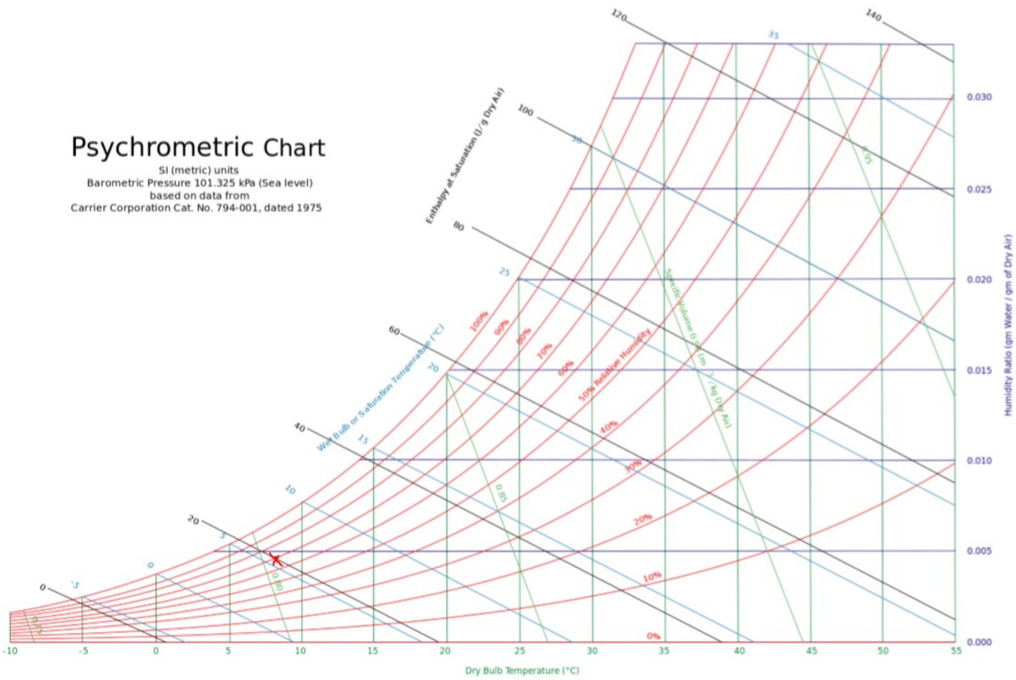
	13:00	14:00	16:00	18:00	20:00	21:00	22:00
	LightCloud	LightCloud	PartlyCloud	LightCloud	Sun	Sun	Sun
Temperatura effettiva	9°C	10°C	8°C	6°C	4°C	2°C	2°C
Temperatura percepita	7°C	10°C	6°C	4°C	2°C	0°C	0°C
Precipitazioni	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm
Umidità	67 %	65 %	69 %	70 %	75 %	83 %	87 %
Pressione atmosferica	1025 hPa	1025 hPa	1025 hPa	1026 hPa	1027 hPa	1027 hPa	1028 hPa

The time now is 18:00, from the data given in the website **https://www.meteo-oggi.it/italia/regione-emilia-romagna/tempo-piacenza/**

umidità: 70%, i.e., the relative humidity ϕ =70%;

pressione atmosferica: 1026 hPa, i.e., the total air pressure P =102.6 kPa;

temperatura efftiva: 6 °C ; the temperature in Kelvin temperature scale T =279.15 K



Utilize the psychrometric chart, we can see,

the humidity ratio, i.e., the absolute humidity m = 0.0045

The web-bulb temperature Twb = 8 °C

$\omega = \frac{0.622Pv}{Pa} = \frac{0.622Pv}{P-Pv}$, $\omega = 0.0045$

introduce P = 102.6 kPa into this equation and solve it:

$P_v = 0.737$ kPa

autem, $\phi = \frac{mv}{mg} = 70\%$ (1)

ideal gas $m= \frac{PV}{Rsp\ T}$

from class water vapour - $R_{sp} = 0.4615$, introduce the pressure of water 0.737 kPa and define the volume of aula A is V, than we have :

$m_v = \frac{0.737V}{0.4615 * 279,15} = \frac{0.737V}{128,83} = 0.00572\ V = 5.72 \times 10^{-3}\ V$

put this volume to equation(1) and calculate the maximum water vapour

$m_g = \frac{mv}{70\%} = 0,00817\ V = 8,17 \times 10^{-3}\ V$

Task 2

Question

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 (height of 2.5 m, considering two occupants and one bed room calculate, and a conditioned floor area of 200 N2 and wall area is 144 N2, calculate the internal gains, infiltration, and ventilation loads) as that of the example which is located in Brindisi, Italy.

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)

Answer

- Internal gains,

Calculate the sensibile cooling load from internal gains,

$q_{ig,s}$= 136 + 2.2A_{cf} + 22N_{oc} = 136 + 2.2 × 200 + 22 × 2 = 620 W

Calculate the latent cooling load from internal gains,

$q_{ig,l}$ = 20 + 0.22A_{cf} + 12N_{oc} = 20 + 0.22 × 200 + 12 × 2 = 88 W

- Infiltration,

for a house with a good construction quality, unit leakage area A_{ul} = 1.4cm^2/m^2

and the exposed surface A_{es} = A_{wall} + A_{roof} = 200 + 144 = 344 m^2

A_L = A_{es} × A_{ul} = 344 × 1.4 = 481.6 cm^2

- Define the cooling temperature $T_{cooling}$ =24 °C, and heating temperature $T_{heating}$ =20 °C in Brindisi

$\Delta T_{cooling}$ = 31.1 °C — 24 °C = 7.1 °C = 7.1 K

$\Delta T_{heating}$ = 20 °C — (—4. 1 °C) = 24.1 °C = 24.1 K

DR = 7.1 °C = 7.1 K

- Given that

$IDF_{heating} = 0.073 \frac{L}{S * cm2}$

$IDF_{cooling} = 0.033 \frac{L}{S * cm2}$

- Calculate infiltration airflow rate,

$Q_{i,heating} = A_L \times IDF_{heating} = 481.6 \times 0.073 = 35.157 \frac{L}{S}$

$Q_{i,cooling} = A_L \times IDF_{cooling} = 481.6 \times 0.033 = 15.893 \frac{L}{S}$

- The required miminum whole-building vetilation rate is

$Qv = 0.05Acf + 3.5(N_{br}+1) = 0.05 \times 200 + 3.5 \times (1 + 1) = 17 \frac{L}{S}$

$Q_{i-v,heating} = Q_{i,heating} + Q_v = 35.157 + 17 = 52.157 \frac{L}{S}$

$Q_{i-v,cooling} = Q_{i,cooling} + Q_v = 15.893 + 17 = 32.893 \frac{L}{S}$

- Given that $C_{sensible}$ = 1.23 , C_{latent} = 3010, $\Delta\ \omega_{Cooling}$ = 0.0039

$\dot{q}inf_{ventilation_{cooling_{sensible}}} = C_{sensible} Q_{i-v,cooling}\ \Delta\ T_{Cooling} = 1.23 \times 32.893 \times 7.1 = 287.25\ W$

$\dot{q}inf_{ventilation_{cooling_{latent}}} = C_{latent} Q_{i-v,cooling}\ \Delta\ \omega_{Cooling} = 3010 \times 32.893 \times 0.0039 = 287.25\ W$

$\dot{q}inf_{ventilation_{heati\ \ sensible}} = C_{sensible} Q_{i-v,heating}\ \Delta\ T_{heating} = 1.23 \times 52.157 \times 24.1 = 1546.09\ W$