

Week 9_LI, Junkai






2019年12月2日

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 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.

Ans:

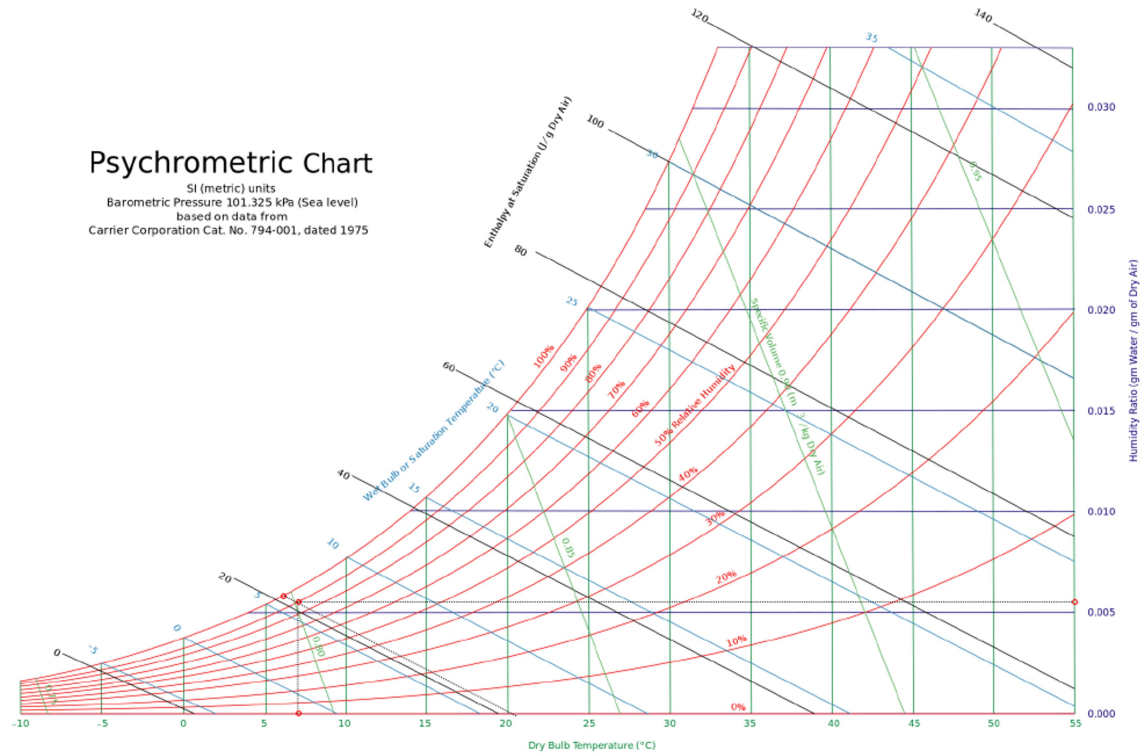
Il tempo oggi in Piacenza Lunedì, 02 Dicembre 2019							
	13:00	14:00	16:00	18:00	20:00	21:00	22:00
	 PartlyCloud	 PartlyCloud	 LightCloud	 LightCloud	 PartlyCloud	 Cloud	 PartlyCloud
Temperatura effettiva	10°C	10°C	9°C	6°C	7°C	7°C	8°C
Temperatura percepita	10°C	10°C	8°C	5°C	7°C	6°C	7°C
Precipitazioni	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm
Umidità	79 %	77 %	89 %	90 %	90 %	92 %	91 %
Pressione atmosferica	1016 hPa	1015 hPa	1016 hPa	1017 hPa	1019 hPa	1019 hPa	1020 hPa

The time now is 20:00, from the data given in the website <https://www.meteo-oggi.it/italia/regione-emilia-romagna/tempo-piacenza/>

umidità: 90%, i.e., the relative humidity $\phi = 90\%$;

pressione atmosferica: 1019 hPa, i.e., the total air pressure $P = 101.9 \text{ kPa}$;

temperatura effettiva: 7 °C, i.e., the temperature in Kelvin temperature scale $T = 230 \text{ K}$



Utilize the psychrometric chart, we can see,

the humidity ratio, i.e., the absolute humidity $\omega = 0.0055$

the web-bulb temperature $T_{wb} = 6^\circ\text{C}$

$\therefore \omega = \frac{0.622P_v}{P_a} = \frac{0.622P_v}{P - P_v} = 0.0055$, introduce $P = 101.9 \text{ kPa}$ into this equation, and solve it,

$$P_v \approx 0.893 \text{ kPa}$$

$$\text{autem, } \phi = \frac{m_v}{m_g} = 90\% \dots \dots (1)$$

for any ideal gas, $m = \frac{PV}{R_{sp}T}$, during the class we were told that for water vapour, $R_{sp} = 0.4615$

introduce the pressure of water vapor $P_v = 0.893 \text{ kPa}$, and define the volume of aula A is V , here we have:

$$m_v = \frac{0.893V}{0.4615 \times 230} \approx 8.41 \times 10^{-3}V$$

subordinate this value to equation (1), calculate the maximum water vapour m_g ,

$$m_g = \frac{m_v}{90\%} \approx 9.34 \times 10^{-3}V$$

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 (height of 2.5 m, considering two occupants and one bed room calculate, and a conditioned floor area of 200 m^2 and wall area is 144 m^2 , 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)
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

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)
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

	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)
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

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)
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

Ans:

Internal gains,

Calculate the sensible cooling load from internal gains,

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

Calculate the latent cooling load from internal gains,

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

Infiltration,

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

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

thus, $A_L = A_{es} * A_{ul} = 344 * 1.4 = 481.6 \text{ cm}^2$

Define the cooling temperature $T_{cooling} = 24 \text{ }^\circ\text{C}$, and heating temperature $T_{heating} = 20 \text{ }^\circ\text{C}$

in Brindisi,

$$\Delta T_{cooling} = 31.1 \text{ }^\circ\text{C} - 24 \text{ }^\circ\text{C} = 7.1 \text{ }^\circ\text{C} = 7.1 \text{ K}$$

$$\Delta T_{heating} = 20^{\circ}\text{C} - (-4.1^{\circ}\text{C}) = 24.1^{\circ}\text{C} = 24.1\text{ K}$$

$$DR = 7.1^{\circ}\text{C} = 7.1\text{ K}$$

$$\text{Given that } IDF_{heating} = 0.073 \frac{L}{s * cm^2},$$

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

Calculate infiltration airflow rate,

$$Q_{i,heating} = A_L * IDF_{heating} = 481.6 * 0.073 \approx 35.157 \frac{L}{s}$$

$$Q_{i,cooling} = A_L * IDF_{cooling} = 481.6 * 0.033 \approx 15.893 \frac{L}{s}$$

The required minimum whole-building ventilation rate is

$$Q_v = 0.05A_{cf} + 3.5(N_{br} + 1) = 0.05 * 200 + 3.5 * (1 + 1) = 17 \frac{L}{s}$$

thus,

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

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

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

$$\dot{q}_{inf-ventilation_{cooling_{sensible}}} = C_{sensible} Q_{i-v,cooling} \Delta T_{cooling} \approx 1.23 * 32.893 * 7.1 \\ \approx 287.25\text{ W}$$

$$\dot{q}_{inf-ventilation_{cooling_{latent}}} = C_{latent} Q_{i-v,cooling} \Delta\omega_{cooling} \approx 3010 * 32.893 * 0.0039 \\ \approx 386.13\text{ W}$$

$$\dot{q}_{inf-ventilation_{heating_{sensible}}} = C_{sensible} Q_{i-v,heating} \Delta T_{heating} \approx 1.23 * 52.157 * 24.1 \\ \approx 1546.09\text{ W}$$