Homework 9

Tuesday, December 3, 2019 11:39 PM

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)

Aula A = *10m x 5m x 4m*
Temperature = *7°C*
Saturation pressure of water = *1.0021 kPa*
Atmospheric pressure = *102 kPa*
Relative humidity = *84%*
$R_v \ = \ 0.4615$

$$\phi \ = \ \frac{m_v}{m_g} \ = \ \frac{P_v}{P_g}$$

$$P_v \ = \ \phi \ x \ P_g \ = \ 0.84 \ x \ 1.0021 \ = 0.84 \ kPa$$

$$P_a \ = \ P \ - \ P_v \ = \ 102 \ kPa \ - \ 0.84 \ kPa \ = \ 101.16 \ kPa$$

Absolute humidity

$$\omega \ = \ 0.622 \frac{P_v}{P_a} \ = \ 0.622 \frac{0.84}{101.16} \ = \ 0.0052 \frac{kg_{vapour}}{kg_{dryAir}}$$

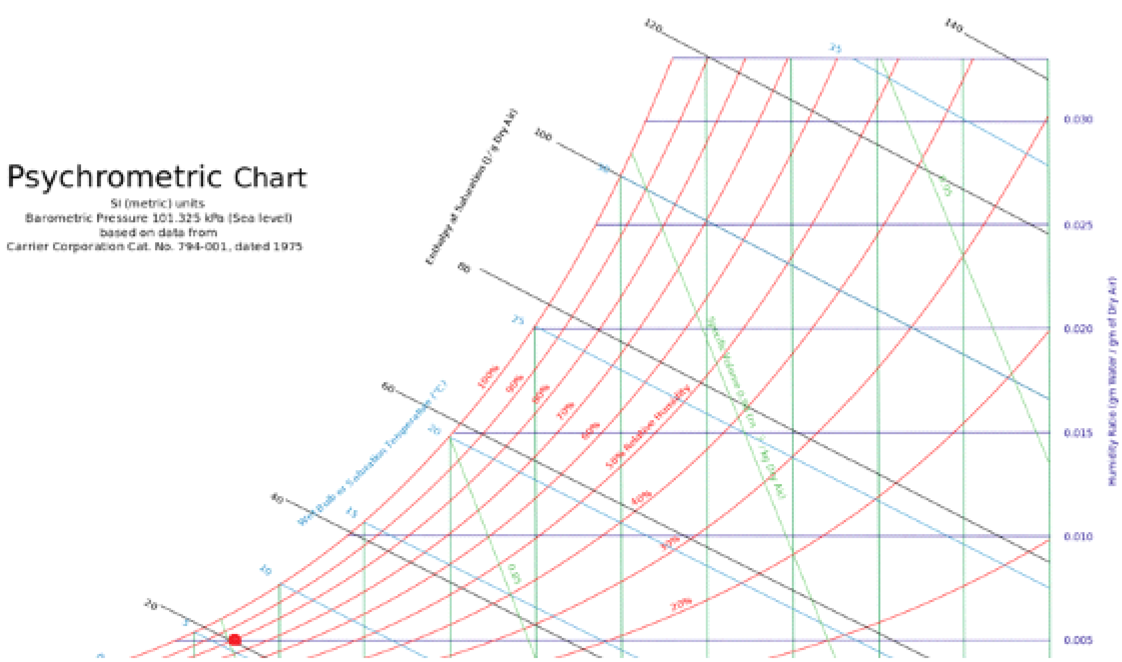
Mass of water vapor

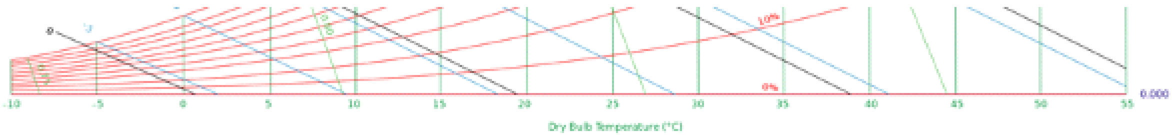
$$m \ = \ \frac{PV}{R_{sp}T} \ ; \ m_v \ = \ \frac{P_v V_v}{R_v T}$$

$$m_v \ = \ \frac{0.84 \ x \ (10 \ x \ 5 \ x \ 4)}{0.4615 \ x (273 + 7)} \ = \ 1.3 \ kg \ water \ vapor$$

Enthalpy

$$h \ = \ h_a \ + \ wh_v \ = \ (1.005 \ x \ 7) + \ 0.0052 \ (2501 \ + \ (1.82 \ x \ 7)) \ = 20.11 \ \frac{kJ}{kg_{dryAir}}$$





Wet-bulb temperature
$\simeq 5.5°C$

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

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%	99.6% DP	99.6% HR	99.6% MCDB	99% DP	99% HR	99% MCDB	0.4% WS	0.4% MCDB	1% WS	1% 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% DB	0.4% MCWB	1% DB	1% MCWB	2% DB	2% MCWB	0.4% WB	0.4% MCDB	1% WB	1% MCDB	2% WB	2% 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% DP	0.4% HR	0.4% MCDB	1% DP	1% HR	1% MCDB	2% DP	2% HR	2% MCDB	0.4% Enth	0.4% MCDB	1% Enth	1% MCDB	2% Enth	2% 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								
	1%	2.5%	5%		Mean Min	Mean Max	Standard deviation Min	Standard deviation Max	n=5 years Min	n=5 years Max	n=10 years Min	n=10 years Max	n=20 years Min	n=20 years Max	n=50 years Min	n=50 years 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)

Building height = 2.5m
Floor area = 200 m^2
Number of occupants = 2
Number of bedrooms = 1
Wall area = 144 m^2

Temperature for cooling and heating

$T_{cooling} = 31.1\ °C$

$T_{heating} = 4.1\ °C$

Temperature difference

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

$\Delta T_{heating} = 20 - 4.1 = 15.9\ °C$

Internal gains

$\dot{Q}_{ig_{sensible}} = 136 + 2.2A_{cf} + 22N_{oc} = 136 + 2.2\ x\ 200 + 22\ x\ 2 = 620\ W$

$\dot{Q}_{ig_{latent}} = 20 + 0.22A_{cf} + 12N_{oc} = 20 + 0.22\ x\ 200 + 12\ x\ 2 = 88\ W$

Infiltration

$A_{ul} = 1.4\ \frac{cm^2}{m^2}$

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

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

$IDF_{heating} = 0.065\ \frac{L}{s.cm^2}$

$IDF_{cooling} = 0.032\ \frac{L}{s.cm^2}$

$\dot{Q}_{i} = A_L\ x\ IDF = 481.6\ x\ 0.065 = 31.30\ \frac{L}{\ }$

$_{heating}$ $\quad s$

$$\dot{Q}_{i_{cooling}} = A_L \; x \; IDF = 481.6 \; x \; 0.032 = 15.41 \; \frac{L}{s}$$

Ventilation

$$\dot{Q}_v = 0.05A_{cf} + 3.5(N_{br} + 1) = 0.05 \; x \; 200 + 3.5 \; x \; 2 = 17 \; \frac{L}{s}$$

$$\dot{Q}_{inf-ventilation_{heating}} = 31.30 + 17 = 48.30 \; \frac{L}{s}$$

$$\dot{Q}_{inf-ventilation_{cooling}} = 15.41 + 17 = 32.41 \; \frac{L}{s}$$

$$\dot{Q}_{inf-ventilation_{cooling_{sensible}}} = C_{sensible}\dot{V}\Delta T_{cooling} = 1.23 \; x \; 32.41 \; x \; 7.1 = 283.04 \; W$$

$$\dot{Q}_{inf-ventilation_{cooling_{latent}}} = C_{latent}\dot{V}\Delta\omega_{cooling} = 3010 \; x \; 32.41 \; x \; 0.0045 = 438.99 \; W$$

$$\dot{Q}_{inf-ventilation_{heating_{sensible}}} = C_{sensible}\dot{V}\Delta T_{heating} = 1.23 \; x \; 48.30 \; x \; 15.9 = 944.60 \; W$$

$$\dot{Q}_{inf-ventilation_{heating_{latent}}} = C_{latent}\dot{V}\Delta\omega_{heating} = 3010 \; x \; 48.30 \; x \; 0.0046 = 668.76 \; W$$