Week 9 Assignment

Wednesday, December 4, 2019   12:19 PM

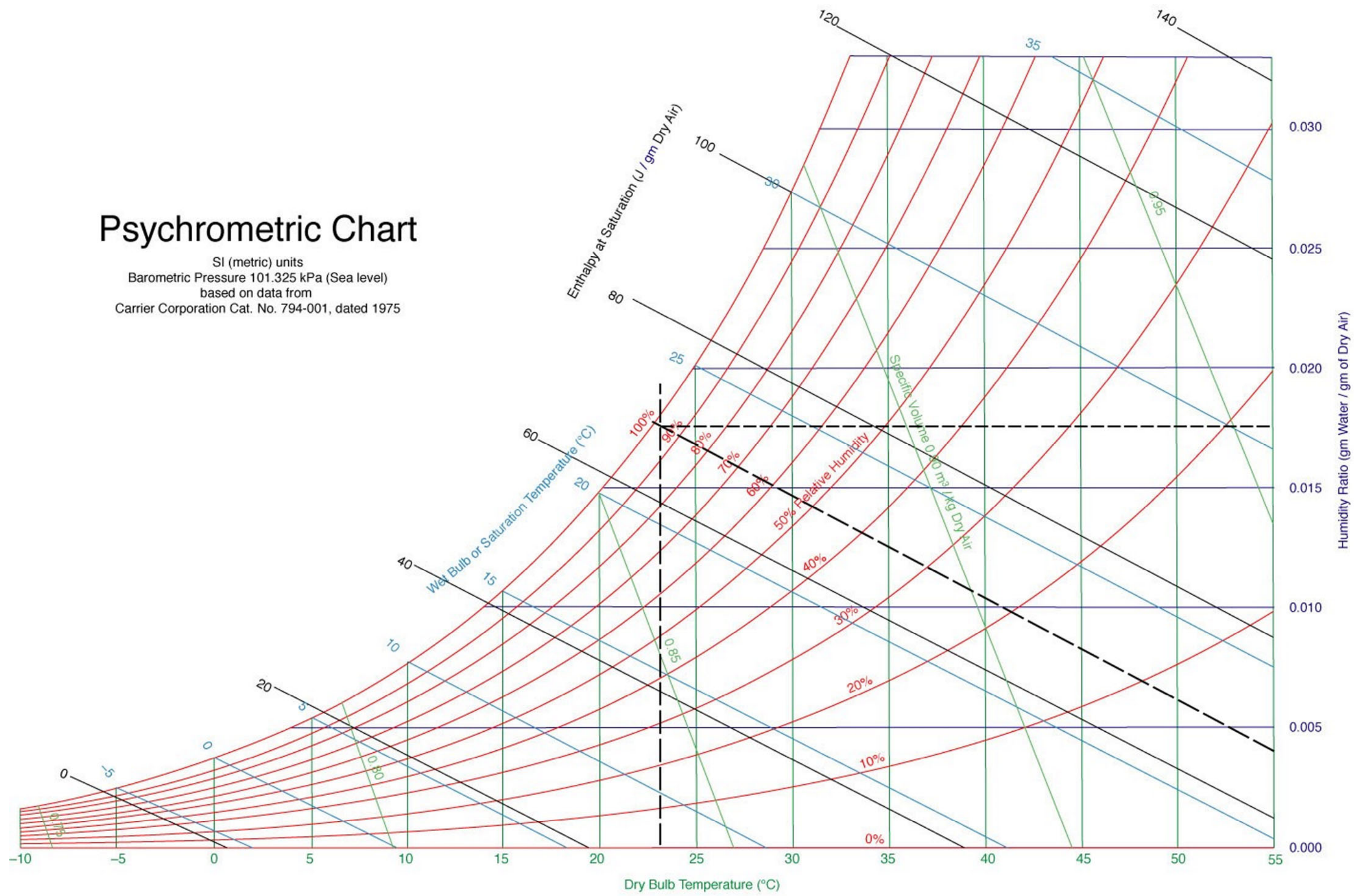
Task one:

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 Class Room 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
Lunedi, 16 Dicembre 2019

	17:00	18:00	19:00	20:00	21:00	22:00	23:00
	Cloud	Cloud	Cloud	Cloud	Drizzle	LightRain	LightRain
Temperatura effettiva	7°C	7°C	6°C	6°C	6°C	6°C	7°C
Temperatura percepita	7°C	7°C	6°C	5°C	6°C	6°C	7°C
Precipitazioni	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm
Umidità	95 %	95 %	97 %	98 %	96 %	96 %	95 %
Pressione atmosferica	1021 hPa	1021 hPa	1021 hPa	1021 hPa	1021 hPa	1021 hPa	1020 hPa
Intensità del vento	3 km/h	3 km/h	4 km/h	5 km/h	4 km/h	3 km/h	2 km/h
Direzione del vento	NO	O	O	O	O	O	O
Probabilità di nebbia	0 %	0 %	0 %	0 %	0 %	0 %	0 %
Punto di rugiada	6°C	6°C	6°C	5°C	6°C	6°C	6°C
Nuvole	100 %	95 %	98 %	99 %	100 %	100 %	100 %
Nuvole basse	99 %	67 %	73 %	89 %	100 %	100 %	100 %
Nuvole medie	75 %	53 %	19 %	19 %	99 %	99 %	92 %
Nuvole alte	91 %	88 %	89 %	95 %	95 %	95 %	100 %

Umidita: Relative humidity, Atmospheric Pressure : Air total pressure (1 hPa: 0.1 kPa} Effective
Temperature: temperature to be utilized.
Chosen time : 19:00   Relative humidity Φ = 97%
Total air pressure = 1021hPa = 102.1kPa Temperature =6°C
Aula A= 10m x 5m x 4m = 200 m3



From the chart with the weather data we can get:

The absolute humidity ω= 0.0175
Wet bulb temp T wb: 22.5

Therefore ω= $\frac{0.622pv}{pa} = \frac{0.622pv}{p-pv} = 0.0175$

P=102.1 Kpa then, 0.0175 = $\frac{0.622pv}{102.2-pv}$

Then P$v = 2.8\ Kpa$

For any ideal gas, m =$\frac{p\ x\ v}{RSpT}$

And Rsp= 0.4615 , Volume of aula A=200 m3

mv= $\frac{2.8x200}{0.4615x(273+6)} = 4.35$

Autem, Φ=$\frac{mv}{mg}$= $\frac{pv}{pg} = 97\%$

0.97 x mg = mv

Mg = $\frac{4.35}{0.97} = 4.48\ \ kg$

<u>Task 2:</u>

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%			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

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

	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

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

Height= 2.5 m; Floor area= 200 m^2; Wall area= 144 m^2

Internal Gains:

Sensible cooling load from internal gains,

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

Latent cooling load from internal gains,

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

Infiltration:

Unit leakage area A_{ul}= 1.4 cm^2/m^2

Exposed surface A_L= A(wall)+ A(roof)= 200+144= 344m^2

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

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

$\triangle$T cooling = 31.1– 24 = 7.1°C = 7.1 k

$\triangle$T heating = 20 °C – (- 4.1°C) = 24.1 °C = 24.1 k

DR = 7.1 °C = 7.1 k

Given: IDF (heating) = 0.073 $\frac{L}{s*cm2}$

IDF (cooling) = 0.033$\frac{L}{s*cm2}$

Calculate infiltration airflow rate.

ΔT heating = 20 °C – (- 4.1°C) = 24.1 °C = 24.1 k

DR = 7.1 °C = 7.1 k

Given: IDF (heating) = 0.073 $\frac{L}{s*cm2}$

IDF (cooling) = 0.033 $\frac{L}{s*cm2}$

Calculate infiltration airflow rate,

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

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

The required minimum whole building ventilation rate is

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

Thus,

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

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

Given that $C_{sensible} = 1.23$, $C_{talent} = 3010$, $\Delta\omega$ cooling = 0.0039

$\dot{q}_{\text{inf-ventilation (cooling sensible)}} = C_{sensible}\, Q_{i\text{-}v,cooling}\, \Delta T cooling = 1.23 * 32.893 * 7.1 = 287.25$ W

$\dot{q}_{\text{inf-ventilation (cooling talent)}} = C_{talent}\, Q_{i\text{-}v,cooling}\, \Delta\omega cooling = 3010 * 32.893 * 0.0039 = 386.13$ W

$\dot{q}_{\text{inf-ventilation (heating sensible)}} = C_{sensible}\, Q_{i\text{-}v,cooling}\, \Delta T heating = 1.23 * 52.157 * 24.1 = 1546.09$W