Week 9_Qureshi, Nahid

QUESTION 1

Use a weather forecast website, and utilize the psychometric 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)

The weather today in Piacenza

Sunday, December 08 2019

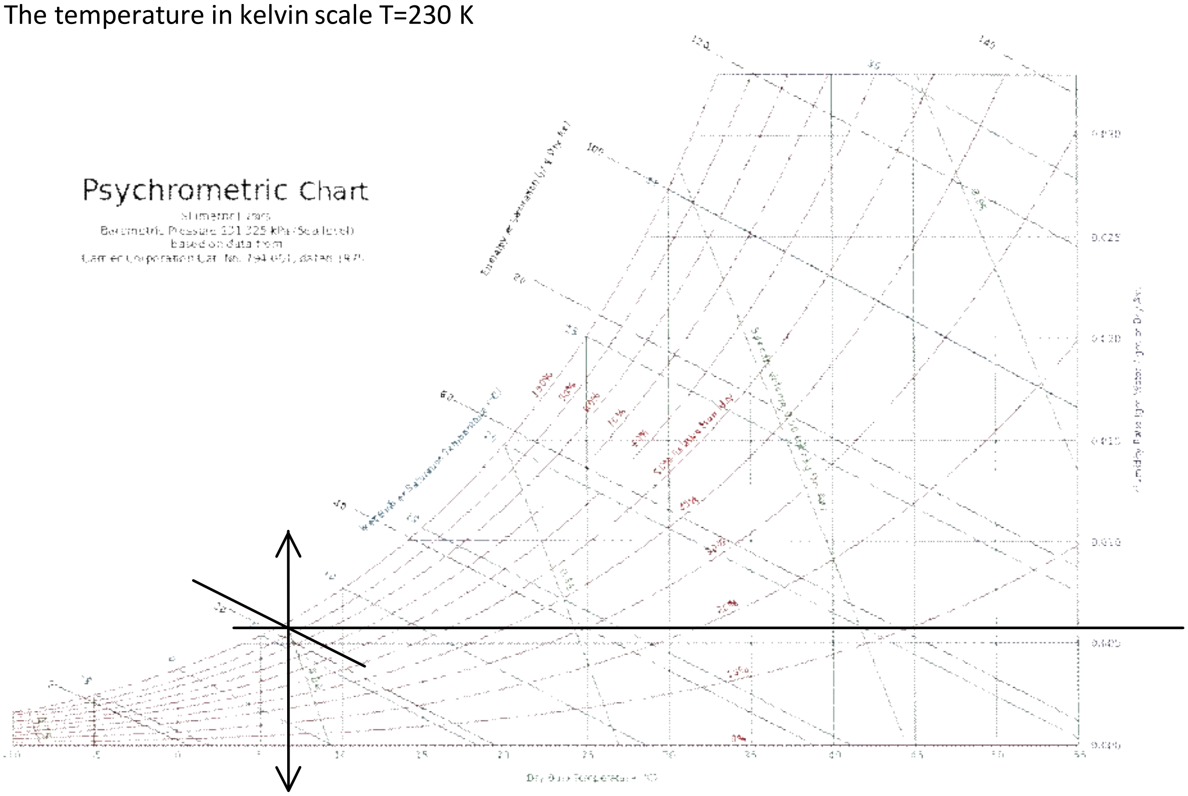
	05:00	07:00	10:00	14:00	18:00	7:00 pm	21:00
	Fog	Fog	PartlyCloud	Cloud	Cloud	Cloud	Cloud
Effective temperature	4 ° C	4 ° C	7 ° C	9 ° C	8 ° C	8 ° C	7 ° C
Perceived temperature	3 ° C	4 ° C	6 ° C	9 ° C	8 ° C	8 ° C	7 ° C
Rainfall	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm
Humidity	99 %	100 %	92 %	86 %	92 %	94 %	95 %
Atmospheric pressure	1021 hPa	1021 hPa	1021 hPa	1019 hPa	1017 hPa	1017 hPa	1016 hPa

Time : 21:00

The relative humidity ϕ= 95%

The total air pressure P= 1016 hPa, i.e. 101.6 kPa

The temperature in kelvin scale T=230 K



The humidity ratio i.e. the absolute humidity =0.00575

The web bulb temperature T_{wb}= 6.5°C

$\omega = 0.622\frac{P_v}{P_a} = 0.622\frac{P_v}{P-P_v}$ =0.00575

$P_v = .930\ kPa$

$\phi = \frac{m_v}{m_g}$ =95%

for ideal gases : $m = \frac{PV}{R_{sp.}T}, for\ water\ vapour\ R_{sp.} = 0.4615$

introduce the pressure of water vapor P_v= .9306 kPa and define the volume of aula a is V, here we have:

$$m_v = \frac{.930 * V}{0.4615\ * (279.65)} = 7.206 * 10^{-3}V$$

Calculate the maximum water vapor m_g

$$m_g = \frac{m_v}{95\%} = 7.585 * 10^{-3}V$$

QUESTION 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%			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

The sensible cooling load from internal gains

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

The latent cooling load from internal gains

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

Infiltration,

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

Exposed surface= Wall area + roof area

$A_{es} = 200 + 144 = 344\ m^2$
$A_L = A_{es} \times A_{ul} = 344 \times 1.4 = 481.6\ cm^2$

The cooling design temperature $T_{cooling}$ = 24°C and

heating design temperature $T_{heating}$ = 20°C

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

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

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

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

Infilteration airflow rate,

$$Q_i = A_L \mathrm{IDF}$$

where

A_L = building effective leakage area (including flue) at reference pressure difference = 4 Pa, assuming discharge coefficient $C_D = 1$, cm²

IDF = infiltration driving force, L/(s·cm²)

$$\dot{Q}_{infiltration_{heating}} = A_L \times IDF = \ 481.6 * 0.073 = 35.157\,\frac{L}{s}$$

$$\dot{Q}_{infiltration_{cooling}} = A_L \times IDF = \ 481.6 * 0.033 = 15.893\,\frac{L}{s}$$

The required ventilation flow rate

$$Q_v = 0.05A_{cf} + 3.5(N_{br} + 1)$$

where

Q_v = required ventilation flow rate, L/s

A_{cf} = building conditioned floor area, m²

N_{br} = number of bedrooms (not less than 1)

$\dot{Q}_v = 0.05\ A_{cf} + 3.5\ (N_{br} + 1)$ =.05*200+ 3.5* 2 = 17 $\frac{L}{s}$

$$\dot{Q}_{i-v,heating} = \dot{Q}_{infiltration_{heating}} + \dot{Q}_v = \ 35.157\,\frac{L}{s} + 17\,\frac{L}{s} = 52.157\,\frac{L}{s}$$

$$\dot{Q}_{i-v,cooling} = \dot{Q}_{infiltration_{cooling}} + \dot{Q}_v = \ 15.893\,\frac{L}{s} + 17\,\frac{L}{s} = 32.893\,\frac{L}{s}$$

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

$$\dot{q}_{inf-ventilation_{cooling_{sensible}}} = C_{sensible}\,\dot{Q}_{i-v,cooling}\,\Delta T_{Cooling} = 1.23\ *32.893*7.1 = 287.25\,W$$
$$\dot{q}_{inf-ventilation_{cooling_{latent}}} = C_{latent}\,\dot{Q}_{i-v,cooling}\,\Delta\omega_{Cooling} = 3010\ *32.893\ *\ 0.0039 = 386.13\,W$$
$$\dot{q}_{inf-ventilation_{heatingg_{sensible}}} = C_{sensible}\,\dot{Q}_{i-v,heating}\,\Delta T_{heating} = 1.23\ *52.157*24.1 = 1546.09\,W$$