Week 9_Francesca Aiuti

Sunday, 8 December 2019 16:32

Task 1

Use a weather forecast website utilizing the psychrometric chart and the formula we went through in class to determine the absolute humidity, the wet-bulb temperature and the mass of water vapour in the air in classroom A of Piacenza campus at the moment you are solving the exercise (providing the inputs you utilized).

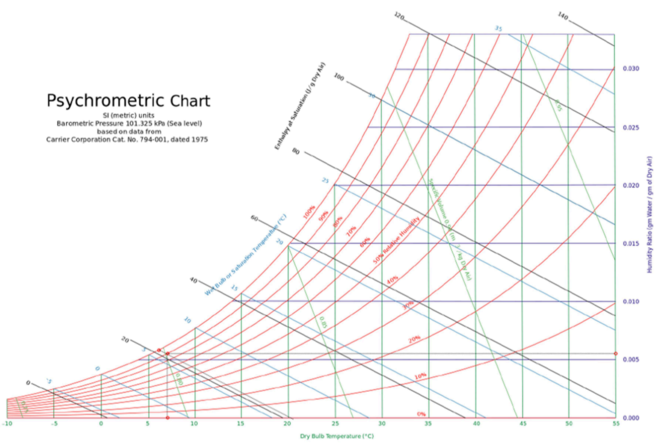
Umidità: Relative humidity; Pressione atmosferica: Air total pressure (1 hPa: 0.1 kPa); Temperatura effettiva: Temperature to be utilized.

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 is 20.24, from the data given in the website https://www.meteo-oggi.it/italia/regione-emilia-romagna/tempo-piacenza/

Umidità: 90%; Relative humidity: ϕ = 90%.
Pressione atmosferica: 1019 hPa; Air total pressure: P = 101.9 kPa.
Temperatura effettiva: 7°C; Temperature: T = 230 K.



Starting from the psychrometric chart, it is possible to see that the humidity ratio is $\boldsymbol{\omega}$ = 0.0055;
The web-bulb temperature is T_{wb} = 6°C.

$\boldsymbol{\omega} = \frac{0.622Pv}{Pa} = \frac{0.622Pv}{P-Pv} = 0.0055, introducing\ P = 101.9\ kPa\ in\ the\ equation, Pv = 0.893\ kPa, \boldsymbol{\phi} = \frac{mv}{mg} = 90\%$

Since for any ideal gas m = $\frac{PV}{RspT}$ $and\ that\ during\ the\ class\ we\ were\ told\ for\ water\ vapor$ Rsp = 0.4615, we introduce the pressure of water vapour (Pv = 0.893 kPa and we define the volume (V) of aula A:

$$mv = 0.893\frac{V}{0.4615*230} = 8.41\ x\ 10^{-3}\ V$$

Then, we calculate the maximum water vapour mg:

$$mg = \frac{mv}{90\%} = 9.34\ x\ 10^{-3}\ V$$

Task 2

Utilize the same methodology we went through in 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, a conditioned floor area of 200 m^2 and a wall area of 144 m^2, calculate the internal gains, infiltration and ventilation loads), as for the example 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)

1) Internal gains

Calculating the sensible cooling load from internal gains:

$$qig, s = 136 + 2.2Acf + 22Noc = 136 + 2.2 * 200 * 22 * 2 = 620\ W$$

Calculating the latent cooling load from internal gains:

$$qig, l = 20 + 0.22Acf + 12Noc = 20 + 0.22 * 200 + 12 * 2 = 88\ W$$

2) Infiltration

For a house with a good construction quality, we have the unit leakage area $Aul = 1.4 \frac{cm2}{m2}$ $and\ the\ exposed\ surface\ Aes = Awall + Aroof = 200 + 144 = 344\ m2$

Therefore, we have $AL = Aes * Aul = 344 * 1.4 = 481.6\ cm2$

Defining the cooling temperature ($T_{cooling}$ = 24°C) and the 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 the $IDF_{heating}$ = 0.073 $\frac{L}{s*cm2}$ and $IDF_{cooling}$ = 0.033 $\frac{L}{s*cm2}$, $we\ calculate\ the\ infiltration\ airflow\ rate$:

$$Qi, heating = AL * IDFheating = 481.6 * 0.073 = 35.157 \frac{L}{s}$$

$$Qi, cooling = AL * IDFcooling = 481.6 * 0.033 = 15.893 \frac{L}{s}$$

The required minimum whole-building ventilation rate is:

$$Qv = 0.05Acf + 3.5\ (Nbr + 1) = 0.05 * 200 + 3.5 * (1 + 1) = 17 \frac{L}{s}$$

Therefore, $Qi - v, heating = Qi, heating + Qv = 35.157 + 17 = 52.157 \frac{L}{s}$

$Qi - v, cooling = Qi, cooling + Qv = 15.893 + 17 = 32.893 \frac{L}{s}$

Given that Csensible = 1.23, Clatent = 3010, $\Delta\boldsymbol{\omega}$cooling $= 0.0039$:

$qinf - ventilationcoolingsensible = CsensibleQi - v, cooling\ \Delta Tcooling = 1.23 * 32.893 * 7.1 = 287.25\ W$

$qinf - ventilationcoolinglatent = ClatentQi - v, cooling\ \Delta\boldsymbol{\omega}\ cooling = 3010 * 32.893 * 0.0039 = 386.13\ W$

$qinf - ventilationheatingsensible = CsensibleQi - v, cooling\ \Delta Theating = 1.23 * 52.157 * 24.1 = 1546.09\ W$