Week 7_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).

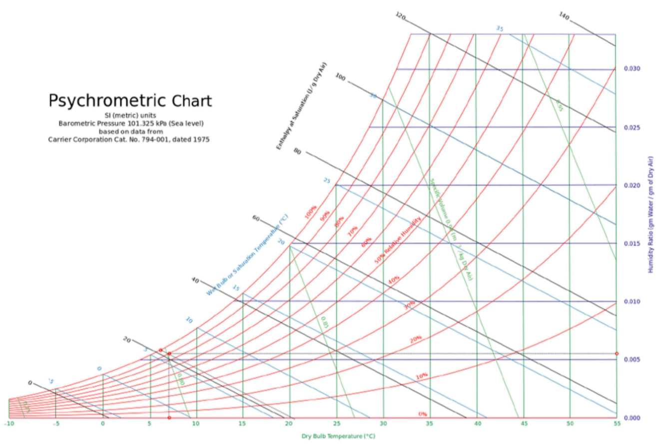
Umidità: Relative humidity; Pressione atmosferica: Air total pressure (1 hPa: 0.1 kPa); Temperatura effettiva: Temperature to be utilized.

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: $\boldsymbol{\phi}$ = 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:

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

Then, we calculate the maximum water vapour mg:

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

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**

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**

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, $\Delta \boldsymbol{\omega}\mathrm{cooling} = 0.0039$:

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

$qinf - ventilationcoolinglatent = ClatentQi - v, cooling$ *Δ***ω** *cooling = 3010* $* 32.893 * 0.0039 = 386.13\ W$

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