02 December 2019 00:10

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Task: 01
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 vapour 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)

Umidità: Relative humidity, Atmospheric temperature : Air total pressure (1 hPa: 0.1 kPa), Effective Temperature : temperature to be utilized.

Il tempo oggi in Piacenza
Lunedì, 02 Dicembre 2019

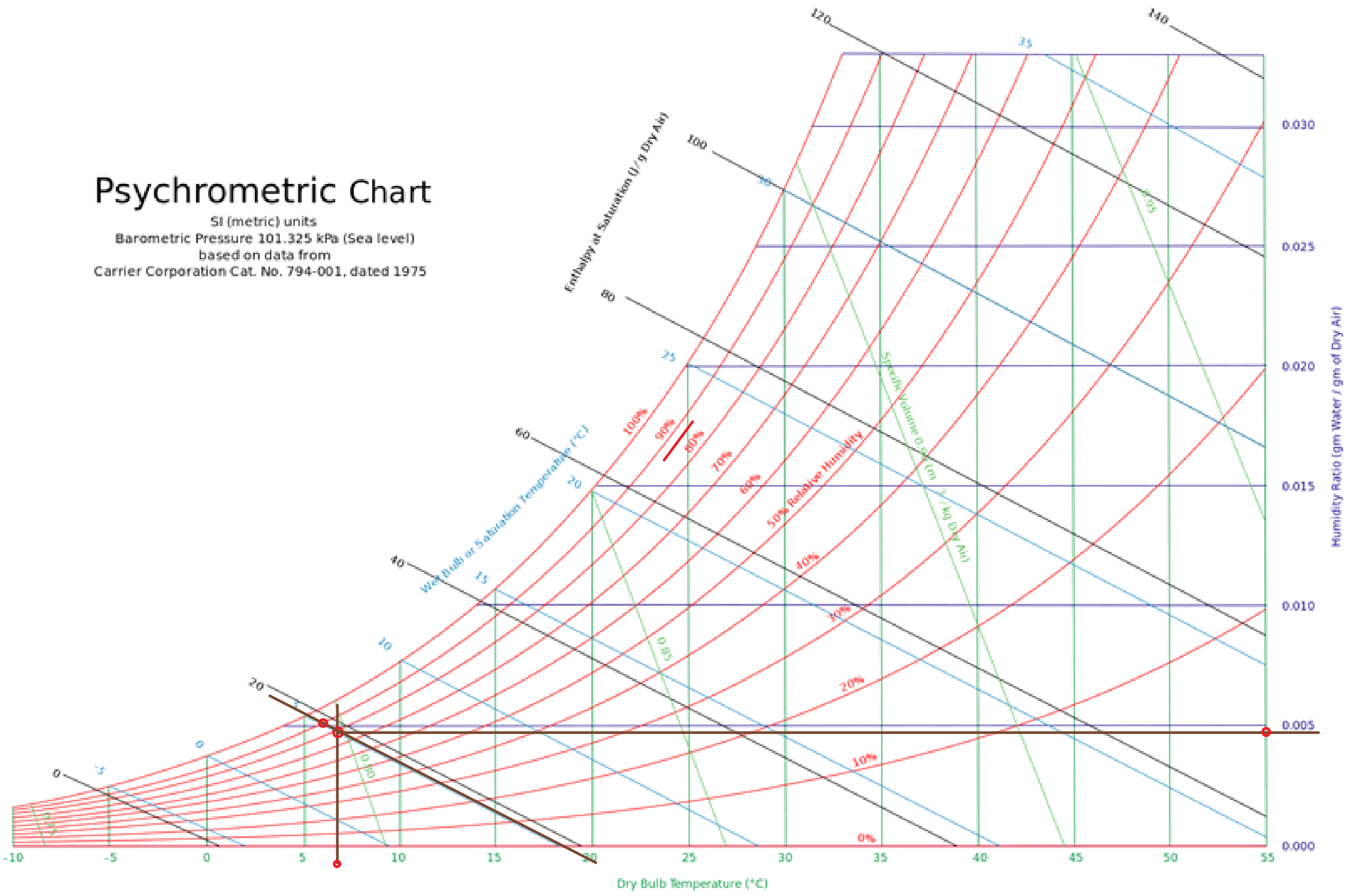
	13:00	14:00	16:00	18:00	20:00	21:00	22:00
	PartlyCloud	PartlyCloud	LightCloud	LightCloud	PartlyCloud	Cloud	PartlyCloud
Temperatura effettiva	10°C	10°C	9°C	6°C	7°C	7°C	8°C
Temperatura percepita	10°C	10°C	8°C	5°C	7°C	6°C	7°C
Precipitazioni	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm
Umidità	79 %	77 %	89 %	90 %	90 %	92 %	91 %
Pressione atmosferica	1016 hPa	1015 hPa	1016 hPa	1017 hPa	1019 hPa	1019 hPa	1020 hPa

The time now is 20:00, from the data given in this website,https://www.meteo-oggi.it/italia/regione-emilia-romagna/tempo-piacenza/

Humidity is 90%, i.e. t=The relative Humidity $\phi = 90\%$

Atmospheric Pressure (P)= 1019hPa.=101.9kPa

Effective temperature= 7°C, i.e. Kelvin temperature scale T=7°C + 273.15 = 230.15K



From the Psychrometric chart we can see,

The humidity ratio i.e. The absolute humidity $\omega = 0.0055$

The wet bulb temperature $T_{wb} = 6\,^{\circ}C$

$\omega = 0.622 * \frac{P_v}{P_a}$, $0.0055 * \frac{0.622P_v}{101.9 - P_v}$

(by taking P =101.9 kPa in equation) $P_v = 0.89$ kPa

$\phi = \frac{m_v}{m_g} = 90\%$

For ideal gas, m= $\frac{PV}{R_{sp}.T}$, we know, $R_{sp} = 0.4615$, Pressure of Water vapour

$P_v = 0.893$ Kpa and definite volume of Aula A is 'V'

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

Maximum water vapour, $m_g = \frac{m_v}{90\%} = 9.34 * 10^{-3}V$

Task: 02

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)

Internal gains

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

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

Average quality -> $A_{ul} = 1.4\ \frac{cm^2}{m2}$

Exposed surface = Wall area +roof area

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

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

In Brindisi,

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

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

DR= 7.1°C = 7.1K

Given,

$IDF_{heating} = 0.073 \frac{}{s.cm^2}$ $IDF_{cooling} = 0.033 \frac{}{s.cm^2}$

Table 5 Typical IDF Values, L/(s·cm²)

H, m	Heating Design Temperature, °C					Cooling Design Temperature, °C			
	−40	−30	−20	−10	0	10	30	35	40
2.5	0.10	0.095	0.086	0.077	0.069	0.060	0.031	0.035	0.040
3	0.11	0.10	0.093	0.083	0.072	0.061	0.032	0.038	0.043
4	0.14	0.12	0.11	0.093	0.079	0.065	0.034	0.042	0.049
5	0.16	0.14	0.12	0.10	0.086	0.069	0.036	0.046	0.055
6	0.18	0.16	0.14	0.11	0.093	0.072	0.039	0.050	0.061
7	0.20	0.17	0.15	0.12	0.10	0.075	0.041	0.051	0.068
8	0.22	0.19	0.16	0.14	0.11	0.079	0.043	0.058	0.074

Calculate infiltration air-flow rate,

$$\dot{V}_{infiltration_{heating}} = A_L \times IDF = 481.6 * 0.073 = 35.15\ \frac{L}{s}$$

$$\dot{V}_{infiltration_{cooling}} = A_L \times IDF = 481.6 * 0.033 = 15.89\ \frac{L}{s}$$

The required minimum whole building ventilation rate is,

$$\dot{V}_{ventilation} = 0.05\ A_{cf} + 3.5\left(N_{br} + 1\right) = 0.05*200+ 3.5* (1+1) = 17\ \ L/S$$

Thus, $\dot{V}_{inf-ventilation_{heating}} = \dot{V}_{infiltration_{heating}} + \dot{V}_{ventilation} = 35.15 + 17 = 52.157\frac{L}{s}$

Given that, $C_{Sensible} = 1.23$, $C_{Latent} = 3010$, $\Delta\omega_{Cooling} = 0.0039$

$q\dot{\square}_{inf} - {Ventilation_{cooling}}_{sensible} = C_{sensible}.\dot{V}_{infiltration_{cooling}}.\Delta T_{cooling} = 1.23 * 32.893 * 7.1 = 287.25W$

$q\dot{\square}_{inf} - {Ventilation_{cooling}}_{latent} = C_{latent}.\dot{V}_{infiltration_{cooling}}.\Delta\omega_{cooling} = 3010 * 32.893 * 0.0039 = 386.13W$

$q\dot{\square}_{inf} - {Ventilation_{heating}}_{sensible} = C_{sensible}.\dot{V}_{infiltration_{cooling}}.\Delta T_{heating} = 1.23 * 52.157 * 24.1 = 1546.09W$