WEEK 9_ZHU CUILING

Task 1

Use a weather forecast website, and utilize the psychrometric chart and the formula we went through in the class to determine the absoloute 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, Pressione atmosferica: Air total pressure (1 hPa: 0.1 kPa), Temperatura effettiva: temperature to be utilized.

Il tempo oggi in Piacenza

Martedì, 03 Dicembre 2019

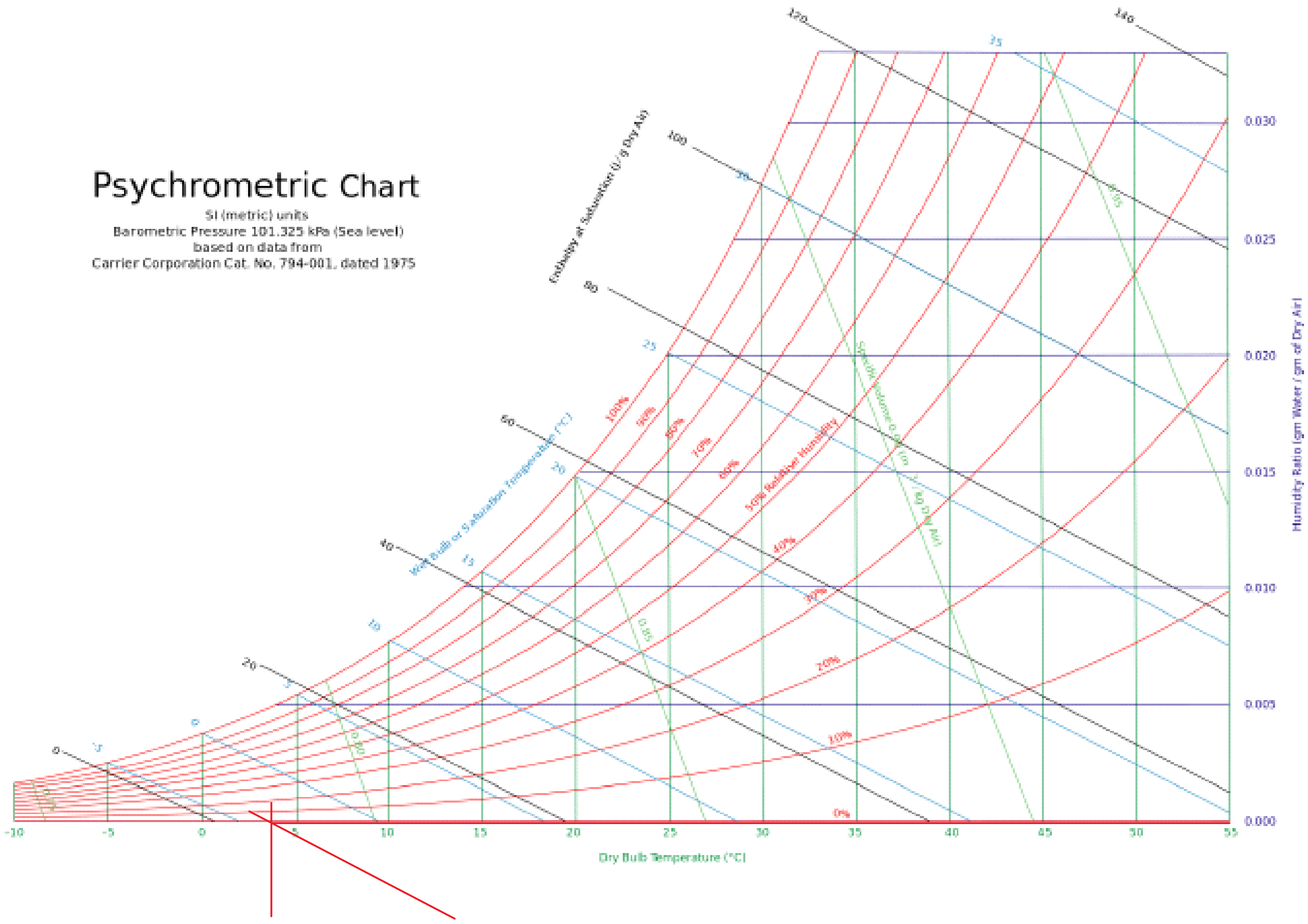
	13:00	14:00	16:00	18:00	20:00	21:00	22:00
	LightCloud	LightCloud	PartlyCloud	LightCloud	Sun	Sun	Sun
Temperatura effettiva	9°C	10°C	8°C	6°C	4°C	2°C	2°C
Temperatura percepita	7°C	10°C	6°C	4°C	2°C	0°C	0°C
Precipitazioni	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm
Umidità	67 %	65 %	69 %	70 %	75 %	83 %	87 %
Pressione atmosferica	1025 hPa	1025 hPa	1025 hPa	1026 hPa	1027 hPa	1027 hPa	1028 hPa

NOW, it's nearly 20:00.

The Relative humidity is 75%, $\phi = 75\%$;

Air total pressure is 1027 hPa, P=102.7 KPa;

Temperature to be utilized is 4°C, the temperature in Kelvin temperature scale T=277.15K



Using the psychrometric chart, we can see:

The humidity ratio, the absolute humidity $\omega = 0.0040$

The wet bulb temperature is $T_{wb} = 2.5C$

$$\because \quad \omega = \frac{0.622P_v}{P_a} = \frac{0.622P_v}{P - P_v} = 0.0040, \qquad P = 102.6\ KPa$$

$$\therefore \quad P_v = 0.665\ KPa$$

$$\because \quad \phi = \frac{m_v}{m_g} = 75\%, \qquad for\ ideal\ gases\ m = \frac{P_v}{R_{sp}T}, we\ know\ that\ R_{sp} = 0.4615$$

The volume of Aula A=V

$$m_v = \frac{0.893V}{0.4615 \times 277.15} = 6.98 \times 10^{-3}V$$

$$m_g = \frac{m_v}{75\%} = 9.31 \times 10^{-3}V$$

Task 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%	99.6%			99%			0.4%		1%				
				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)

Noc=2

Height=2.5m^2

Conditioned Floor Area=200m^2

Internal Gains:

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

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

Infiltration:

Table 3 Unit Leakage Areas

Construction	Description	A_{ul}, cm^2/m^2
Tight	Construction supervised by air-sealing specialist	0.7
Good	Carefully sealed construction by knowledgeable builder	1.4
Average	Typical current production housing	2.8
Leaky	Typical pre-1970 houses	5.6
Very leaky	Old houses in original condition	10.4

Situation	Include	Exclude
Ceiling/roof combination (e.g., cathedral ceiling without attic)	Gross surface area	
Ceiling or wall adjacent to attic	Ceiling or wall area	Roof area
Wall exposed to ambient	Gross wall area (including fenestration area)	
Wall adjacent to unconditioned buffer space (e.g., garage or porch)	Common wall area	Exterior wall area
Floor over open or vented crawlspace	Floor area	Crawlspace wall area
Floor over sealed crawlspace	Crawlspace wall area	Floor area
Floor over conditioned or semiconditioned basement	Above-grade basement wall area	Floor area
Slab floor		Slab area

$A_{ul}(GOOD\ CONSTRUCTION) = 1.4\ cm^2/m^2$

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

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

The cooling temperature in Brindisi is $T_{cooling} = 24$ °C and heating temperature $T_{heating} = 20$°C in Brindisi

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

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

$DR = 7.1°\text{C} = 7.1K$

$IDF_{heating} = 0.073\ L/s \cdot cm^2$

$IDF_{cooling} = 0.033\ L/s \cdot cm^2$

$\dot{V}_{infiltration\ heating} = A_L \times IDF_{heating} = 481.6 \times 0.073 = 35.157\ L/S$

$\dot{V}_{infiltration\ cooling} = A_L \times IDF_{cooling} = 481.6 \times 0.033 = 15.89\ L/$

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

$\dot{V}_{inf-ventilation\ heating} = 35.157 + 17 = 52.157\ L/S$

$\dot{V}_{inf-ventilation\ cooling} = 15.89 + 17 = 32.893\ L/S$

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

$\dot{Q}_{inf-ventilation\ cooling\ sensible} = C_{sensible} \times \dot{V} \times \Delta T_{cooling} = 1.23 \times 32.893 \times 7.1 = 287.25W$

$\dot{Q}_{inf-ventilation\ heating\ sensible} = C_{sensible} \times \dot{V} \times \Delta T_{heating} = 1.23 \times 52.157 \times 24.1 = 1546.09W$

$\dot{Q}_{inf-ventilation\ cooling\ latent} = C_{lantent} \times \dot{V} \times\ \Delta\omega_{cooling} = 3010 \times 32.893 \times 0.0039 = 386.13W$