Week 9

Task 1 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)

Weather Forecast Website example

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

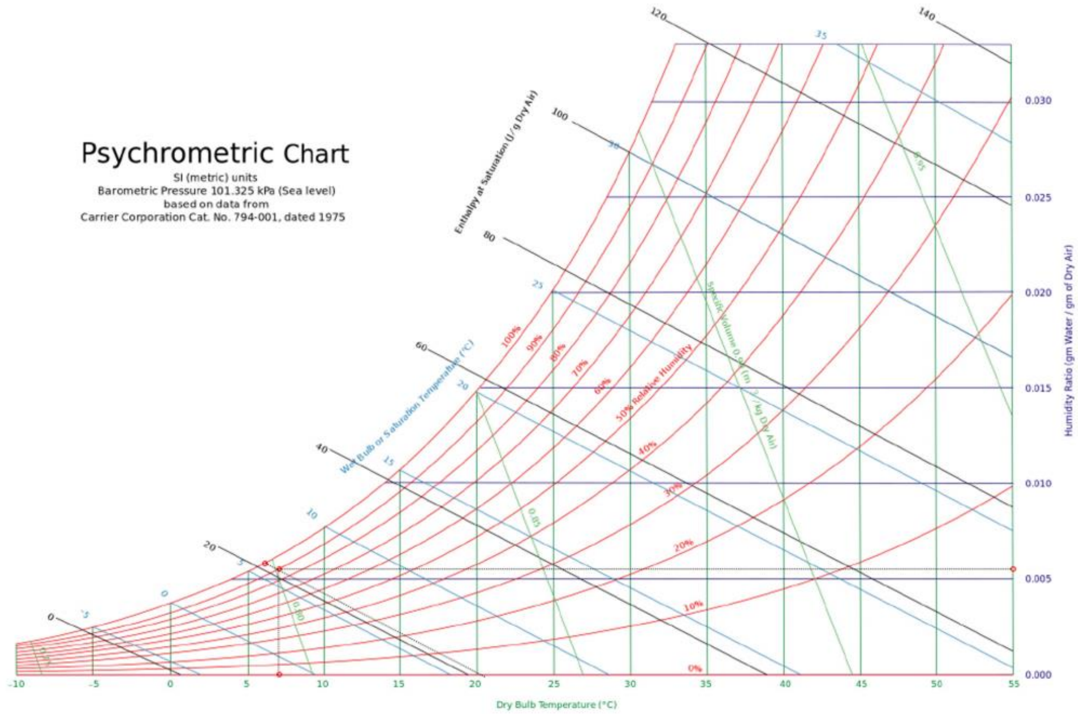
Il tempo oggi in Piacenza
Lunedi, 02 Dicembre 2019

	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

Relative humidity at the moment $\phi = 90\%$

Total air pressure P=101.9kPa

The temperature in Kelvins = 7 C = 230K



Using the psychrometric chart, we see that:

The humidity ratio ie, the absolute humidity $\omega = 0.0055$

The wet bulb temperate is $T_{wb} = 6C$

$\omega = \frac{0.622P_v}{P_a} = \frac{0.622P_v}{P-P_v} = 0.0055$

Introduce P=101.9kPA into the equation

$$P_v = 0.893\ kPA$$

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

For ideal gases $m = \frac{PV}{R_{sp}T}$ We know that Rsp=0.4615

Introduce the pressure of water vapor $P_v = 0.893kPa$

The volume of Aula A = V

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

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

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%			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)

Task 2:

Noc=2

Height=2.5m2

Conditioned Floor Area=200m2

Internal Gains:

$$\dot{Q}_{igsensible} = 136 + 2.2A_{cf} + 22N_{oc}$$

$$= 136 + 2.2(200) + 22(2)$$

$$= 620W$$

$$\dot{Q}_{iglatent} = 20 + 0.22A_{cf} + 12N_{oc}$$

$$= 20 + 0.22(200) + 12(2)$$

$$= 88W$$

Infiltration:

First I must calculate how much the maximum flow rate of air is

To find leakage area:

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

Aul (GOOD CONSTRUCTION)=1.4 cm2/m2

Aes=Awall+Aroof= 200+144 = 344m2

$A_L = A_{es} \times A_{ul} = 344 \times 1.4 = 481.6cm2$

The cooling temperature in Brindisi is $T_{cooling} = 24°C$ and heating temperature $T_{heating} = 20°C$ 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 that $IDF_{heating} = 0.073\ \frac{L}{s.cm^2}$

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

$$\dot{V}_{infiltration\ heating} = A_L IDF$$

$$= 481.6 \times 0.073 = 35.157\frac{L}{S}$$

$$\dot{V}_{infiltration\ cooling} = A_L IDF$$

$$= 481.6 \times 0.033 = 15.89\frac{L}{S}$$

$$\dot{V}_{ventilation} = 0.05A_{cf} + 3.5(N_{br} + 1)$$

$$= 0.05 \times 200 + 3.5 \times 2 = 17\frac{L}{S}$$

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

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

Given that Csensible=1.23, Clatent=3010, $\Delta\omega_{cooling}$ =0.0039

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

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

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