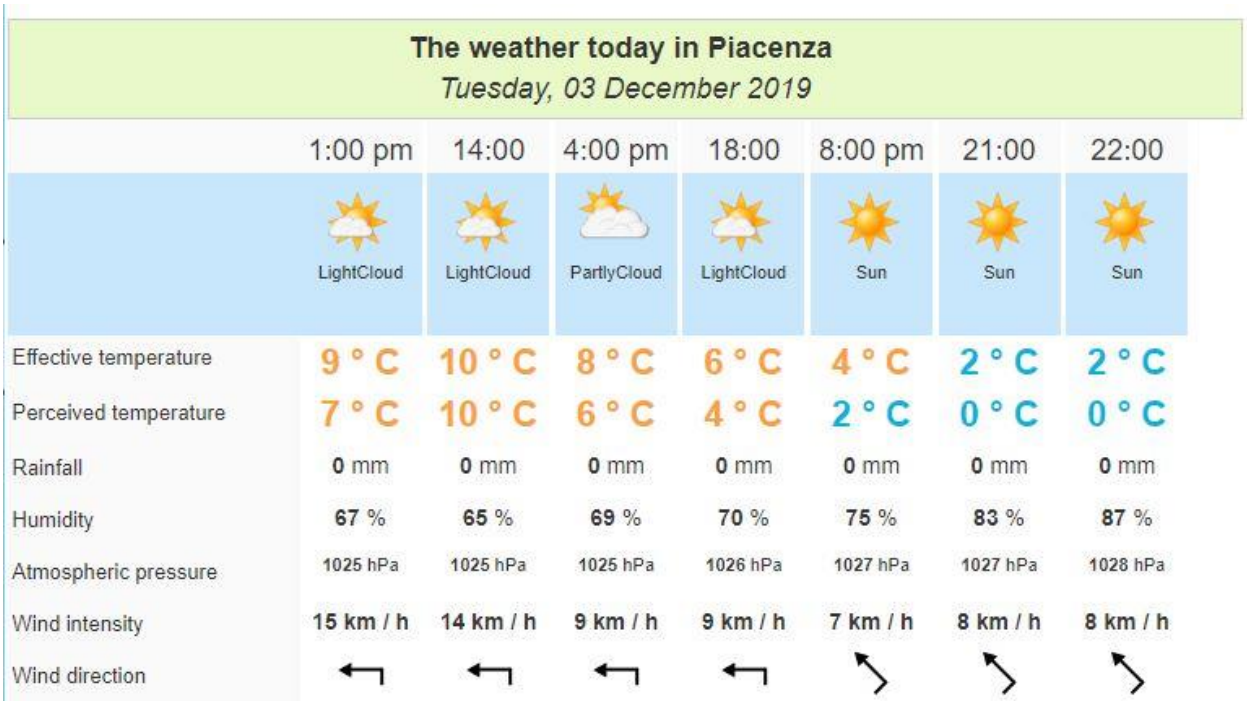
Hana Abou Baker **Week 9**

Task 1

Use a weather forecast website, and utilize the psychometric chart and the formula we went through in the class to determine the absolute humidity, the wet-bulb temperature and the mass of water vapor in the air in Classroom A (Aula A) of Piacenza campus in the moment that you are solving

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

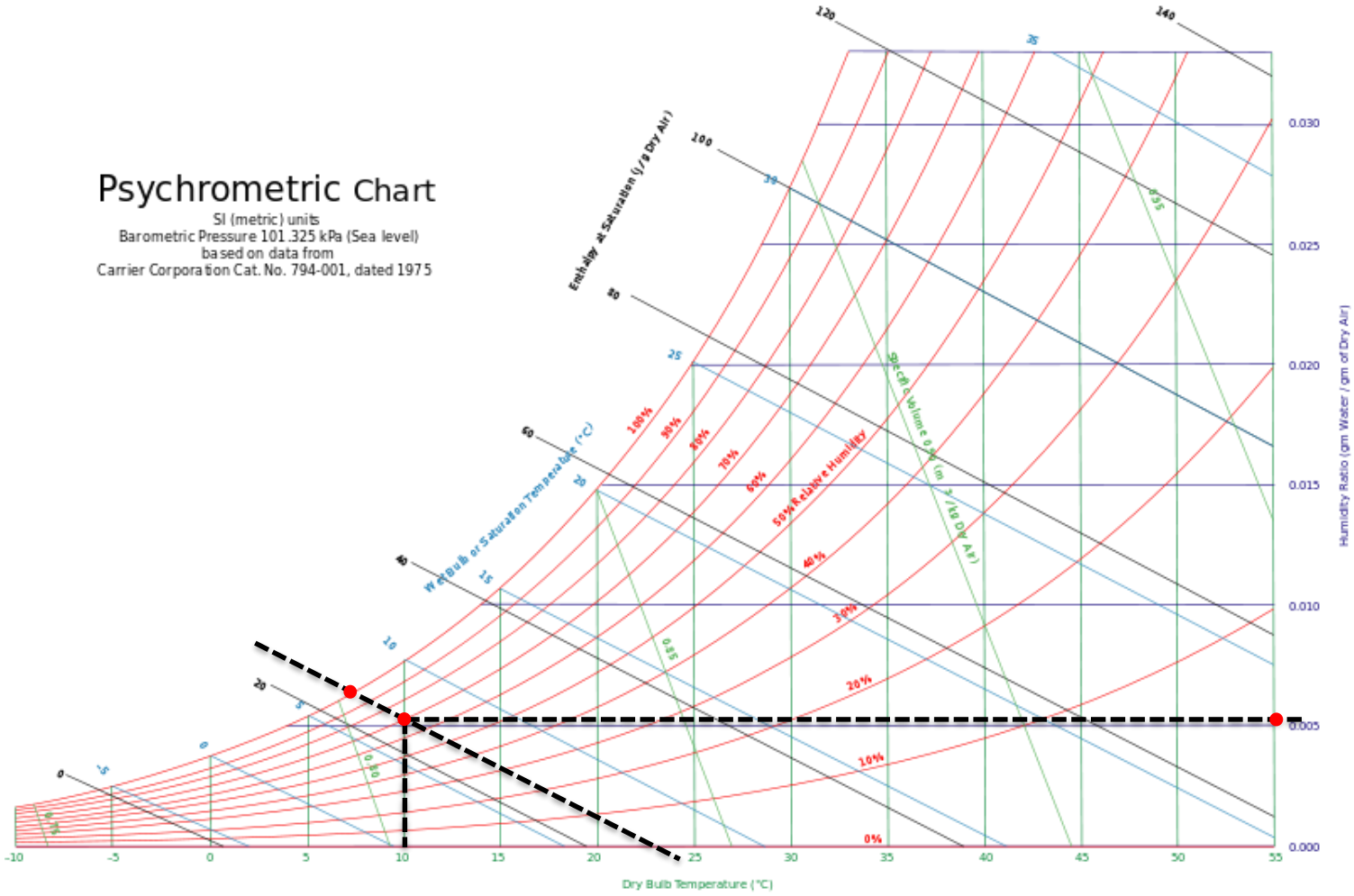


The weather today in Piacenza

Tuesday, 03 December 2019

	1:00 pm	14:00	4:00 pm	18:00	8:00 pm	21:00	22:00
	LightCloud	LightCloud	PartlyCloud	LightCloud	Sun	Sun	Sun
Effective temperature	9 ° C	10 ° C	8 ° C	6 ° C	4 ° C	2 ° C	2 ° C
Perceived temperature	7 ° C	10 ° C	6 ° C	4 ° C	2 ° C	0 ° C	0 ° C
Rainfall	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm
Humidity	67 %	65 %	69 %	70 %	75 %	83 %	87 %
Atmospheric pressure	1025 hPa	1025 hPa	1025 hPa	1026 hPa	1027 hPa	1027 hPa	1028 hPa
Wind intensity	15 km / h	14 km / h	9 km / h	9 km / h	7 km / h	8 km / h	8 km / h
Wind direction	←	←	←	←	↘	↘	↘

The hour at the moment is 14:30. According to the weather forecast shown above we know that there is no chances of rainfall, effective temperature 9˚C (T= 282.15 Kalvin), the humidity is 65% (relative humidity ϕ= 65%), and the atmospheric pressure 1025 hPa (total air pressure P= 102.5 kPa)



Utilize the psychometric chart, we can see, the humidity ratio, i.e., the absolute humidity ω=0.0052

The web-bulb temperature T_{wb} = 10˚C

Therefore $\omega = \frac{0.622\,Pv}{Pa} = \frac{0.622\,Pv}{P-Pv}$ = 0.0052, introduce P = 102.5 KPa into this equation, and solve it.

$\frac{0.622\,Pv}{102.5-pv} = 0.0052$

P_V = 0.8498 KPa

Autem, $\phi = \frac{mv}{mg}$ = 70% ……. (1)

For any ideal gas, m = $\frac{Pv}{RSPT}$, during the class we were told that for water vapor, R_{sp}= 0.4615

Introduce the pressure of water vapor P_V = 0.8498 KPa, and define the volume of Aula A is

V: $m_v = \frac{0.8498V}{0.4615*282.15}$ = 130.212225 V

Subordinate this value to equation number (1)

Calculate the maximum water vapor $m_g = \frac{mv}{70\%}$ = 9.34 x 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

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
	0.4%			1%			2%			0.4%		1%		2%		8 to 4 &
	DP	HR	MCDB	DP	HR	MCDB	DP	HR	MCDB	Enth	MCDB	Enth	MCDB	Enth	MCDB	12.8/20.6
	(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	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%	WB	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

Height= 2.5 m; Floor area= 200 m^2; Wall area= 144 m^2

Internal Gains:

Sensible cooling load from internal gains,

$q_{ig,sensible}$ = 136+2.2A_{cf}+22N_{oc}= 136+2.2*200+22*2 = 620W

Latent cooling load from internal gains,

$q_{ig,latent}$ = 20+0.22A_{cf}+12N_{oc}= 20+0.22*200+12*2 = 88W

Infiltration:

Unit leakage area A_{ul}= 1.4 cm^2/m^2

Exposed surface A_L= A(wall)+ A(roof)= 200+144= 344m^2

So, A_L= A_{es}*A_{ul}= 344*1.4= 481.6 cm^2

Define the cooling temperature $T_{cooling}$ = 24°C, and heating temperature $T_{heating}$ = 20°C in Brindisi,

△ T cooling = 31.1– 24 = 7.1°C = 7.1 k

△ T heating = 20 °C – (- 4.1°C) = 24.1 °C = 24.1 k

DR = 7.1 °C = 7.1 k

Given: IDF (heating) = 0.073 $\frac{L}{s*cm2}$

IDF (cooling) = 0.033$\frac{L}{s*cm2}$

Calculate infiltration airflow rate,

$Q_{I, heating} = A_L * IDF_{heating} = 481.6 * 0.073 = 35.157 \frac{L}{s}$

$Q_{i,cooling} = A_L * IDF_{cooling} = 481.6 * 0.033 = 15.893 \frac{L}{s}$

The required minimum whole building ventilation rate is

$Qv= 0.05A_{cf} + 3.5 (N_{br} + 1) = 0.05 * 200 + 3.5 * (1+1) = 17 \frac{L}{s}$

Thus,

$Q_{i\text{-}v, heating} = Q_{I, heating} + Q_v = 35.157 + 17 = 52.157 \frac{L}{s}$

$Q_{i\text{-}v, cooling} = Q_{I, cooling} + Q_v = 15.893 + 17 = 32.893 \frac{L}{s}$

Given that $C_{sensible} = 1.23$, $C_{talent} = 3010$, $\triangle\omega$ cooling = 0.0039

$\dot{q}_{inf\text{-}ventilation\ (cooling\ sensible)} = C_{sensible} Q_{i\text{-}v,cooling} \triangle T cooling = 1.23 * 32.893 * 7.1 = 287.25$ W

$\dot{q}_{inf\text{-}ventilation\ (cooling\ talent)} = C_{talent} Q_{i\text{-}v,cooling} \triangle\omega cooling = 3010 * 32.893 * 0.0039 = 386.13$ W

$\dot{q}_{inf\text{-}ventilation\ (heating\ sensible)} = C_{sensible} Q_{i\text{-}v,cooling} \triangle T heating = 1.23 * 52.157 * 24.1 = 1546.09$W