Week 9

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Task 1: Use a weather forecast website, and utilize the psychometric chart and the formula to determine the absolute humidity, the wet-bulb temperature and the mass of water vapor in the air in Aula A of Piacenza campus.

The space of Aula A: 5m* 4m* 10m
Temperature: 7°C
Saturation pressure of water: 1.0021 kPa
Atmospheric pressure: 102 kPa
Relative humidity: 84% , Rv= 0.4615

as $\phi = \frac{m_v}{m_g} = \frac{P_v}{P_g}$

$$P_v = \phi * P_g = 0.84 * 1.0021 = 0.84\,\text{kPa}$$

$$P_a = P - P_v = 102\,\text{kPa} - 0.84\,\text{kPa} = 101.16\,\text{kPa}$$

About Absolute humidity:

$$\omega = 0.622\frac{P_v}{P_a} = 0.622\frac{0.84}{101.16} = 0.0052\frac{kg_v}{kg_a}$$

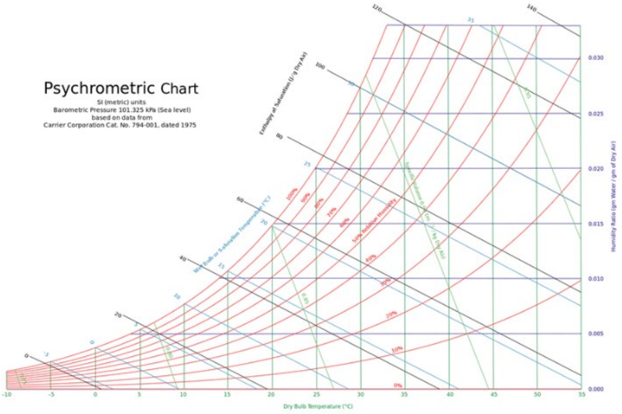
About Mass of water vapor:

$$m = \frac{PV}{R_{sp}T}\ ;\ m_v = \frac{P_v V_v}{R_v T}$$

$$m_v = \frac{0.84 * (5 * 4 * 10)}{0.4615 * (273+7)} = 1.3\,\text{kg}$$

About Enthalpy:

$$h = h_a + wh_v = (1.005 * 7) + 0.0052\,(2501 + (1.82 * 7)) = 20.11\,\frac{\text{kJ}}{\text{kg}_{\text{dryair}}}$$



From the chart we can know,
Wet-bulb temperature≃ 5.5°C

Task 2: Utilize the same methodology 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)

Building height = 2.5m Floor area = 200 m^2 Wall area = 144 m^2

Number of occupants = 2 Number of bedrooms = 1

As the temperature for heating and cooling is:

$$T_{heating} = 4.1 \ ^{\circ}C \qquad T_{cooling} = 31.1 \ ^{\circ}C$$

So the temperature difference is:

$$\Delta T_{heating} = 20 - 4.1 = 15.9 \ ^{\circ}C \qquad \Delta T_{cooling} = 31.1 - 24 = 7.1 \ ^{\circ}C$$

About internal gains:

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

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

About Infiltration:

$$A_{ul} = 1.4 \frac{cm^2}{m^2}$$

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

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

$$IDF_{heating} = 0.065 \frac{L}{s.cm^2}$$

$$IDF_{cooling} = 0.032 \frac{L}{s.cm^2}$$

$$Q_{i_{heating}} = A_L \text{ x IDF} = 481.6 * 0.065 = 31.30 \frac{L}{s}$$

$$Q_{i_{cooling}} = A_L \text{ x IDF} = 481.6 * 0.032 = 15.41 \frac{L}{s}$$

About Ventilation

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

$$Q_{inf-vh} = 31.30 + 17 = 48.30 \frac{L}{s}$$

$$Q_{inf-vc} = 15.41 + 17 = 32.41 \frac{L}{s}$$

$$Q_{inf-vcs} = C_{sensible}\dot{V}\Delta T_{cooling} = 1.23 * 32.41 * 7.1 = 283.04 \text{ W}$$

$$Q_{inf-vcl} = C_{latent}\dot{V}\Delta\omega_{cooling} = 3010 * 32.41 * 0.0045 = 438.99 \text{ W}$$

$$Q_{inf-vhs} = C_{sensible}\dot{V}\Delta T_{heating} = 1.23 * 48.30 * 15.9 = 944.60 \text{ W}$$

$$Q_{inf-vhl} = C_{latent}\dot{V}\Delta\omega_{heating} = 3010 * 48.30 * 0.0046 = 668.76 \text{ W}$$