Technical environmental system – Weekly submission IX

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Task I

Considering:
Classroom A (Aula A) = *10m x 5m x 4m*
Temperature = *7°C*
Saturation pressure of water = *1.0021 kPa*
Atmospheric pressure = *102 kPa*
$Rv = 0.4615$

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

$$P_v = \phi \, x \, P_g = 0.84 \, x \, 1.0021 = 0.84 \, kPa$$

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

Absolute humidity

$$\omega = 0.622 \frac{P_v}{P_a} = 0.622 \frac{0.84}{101.16} = 0.0052 \frac{kg_{vapour}}{kg_{dryAir}}$$

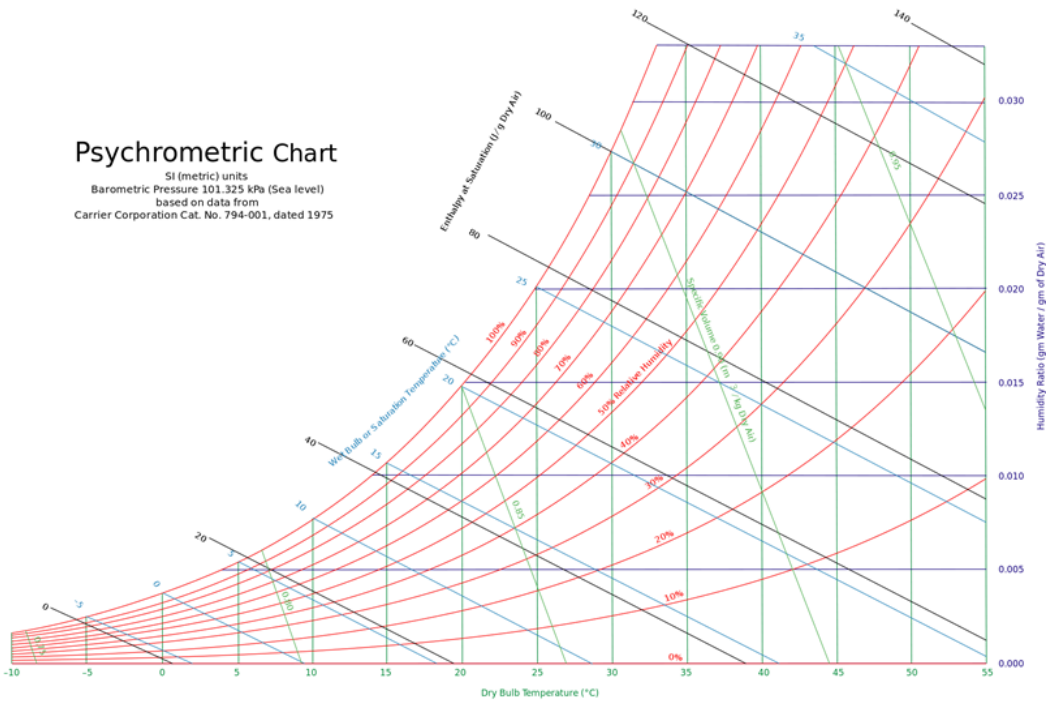
Mass of water vapor

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

$$m_v = \frac{0.84 \, x \, (10 \, x \, 5 \, x \, 4)}{0.4615 \, x (273 + 7)} = 1.3 \, kg \; water \; vapor$$

Enthalpy

$$\mathrm{h} = \mathrm{h}_a + w\mathrm{h}_v = (1.005 \, x \, 7) + 0.0052 \, (2501 + (1.82 \, x \, 7)) = 20.11 \, \frac{kJ}{kg_{dryAir}}$$



Wet-bulb temperature
≃ 5.5°C

Task 2

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
	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 (3)

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 (4)

Building height = 2.5m
Floor area = 200 m^2
Number of occupants = 2
Number of bedrooms = 1
Wall area = 144 m^2

Temperature for cooling and heating

$T_{cooling} = 31.1\ ℃$
$T_{heating} = 4.1\ ℃$

Temperature difference

$\Delta T_{cooling} = 31.1 - 24 = 7.1\ ℃$
$\Delta T_{heating} = 20 - 4.1 = 15.9\ ℃$

Internal gains

$$\dot{Q}_{ig_{sensible}} = 136 + 2.2A_{cf} + 22N_{oc} = 136 + 2.2\,x\,200 + 22\,x\,2 = 620\ W$$
$$\dot{Q}_{ig_{latent}} = 20 + 0.22A_{cf} + 12N_{oc} = 20 + 0.22\,x\,200 + 12\,x\,2 = 88\ W$$

Infiltration

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

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

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

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

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

$$\dot{Q}_{i_{heating}} = A_L\,x\,IDF = 481.6\,x\,0.065 = 31.30\ \frac{L}{s}$$
$$\dot{Q}_{i_{cooling}} = A_L\,x\,IDF = 481.6\,x\,0.032 = 15.41\ \frac{L}{s}$$

Ventilation

$$\dot{Q}_v = 0.05A_{cf} + 3.5(N_{br} + 1) = 0.05\,x\,200 + 3.5\,x\,2 = 17\ \frac{L}{s}$$
$$\dot{Q}_{inf-ventilation_{heating}} = 31.30 + 17 = 48.30\ \frac{L}{s}$$

$$\dot{Q}_{inf-ventilation_{cooling}} = 15.41 + 17 = 32.41\ \frac{L}{s}$$

$$\dot{Q}_{inf-ventilation_{cooling_{sensible}}} = C_{sensible}\dot{V}\Delta T_{cooling} = 1.23\ x\ 32.41\ x\ 7.1 = 283.04\ W$$

$$\dot{Q}_{inf-ventil\square tion_{cooling_{latent}}} = C_{latent}\dot{V}\Delta\omega_{cooling} = 3010\ x\ 32.41\ x\ 0.0045 = 438.99\ W$$

$$\dot{Q}_{inf-ventilation_{heating_{sensible}}} = C_{sensible}\dot{V}\Delta T_{heating} = 1.23\ x\ 48.30\ x\ 15.9 = 944.60\ W$$

$$\dot{Q}_{inf-ventilation_{heating_{latent}}} = C_{latent}\dot{V}\Delta\omega_{heating} = 3010\ x\ 48.30\ x\ 0.0046 = 668.76\ W$$