

WEEK 9

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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)

$$A=10*25*5 \quad T=10 \quad P=100\text{kPa} \quad \phi = 65\%$$

$$\phi = \frac{m_v}{m_g} = \frac{P_v}{P_g} \rightarrow P_g = P_{sat} 10^\circ\text{C} = 1.2276 \text{ kPa}$$

$$\phi = \frac{P_v}{P_g} \rightarrow P_v = \phi \times P_g = 0.65 \times 1.2276 = 0.7979 \text{ kPa}$$

$$P_a = P - P_v = 100 \text{ kPa} - 0.80 \text{ kPa} = 99.20 \text{ kPa}$$

$$\omega = 0.622 \frac{P_v}{P_a} = 0.622 \frac{0.80}{99.20} = 0.005 \frac{\text{kg}_{\text{vapour}}}{\text{kg}_{\text{dryAir}}}$$

$$R_a = 0.287, R_v = 0.4615$$

$$m_a = \frac{99.20 \times (10 \times 25 \times 5)}{0.287 \times (273 + 10)} = 1526.70 \text{ kg of dry air}$$

$$m_v = \frac{0.80 \times (10 \times 25 \times 5)}{0.4615 \times (273 + 10)} = 7.66 \text{ kg}$$

$$h_a = 1.005 \times T = 1.005 \times 10 = 10.05 \frac{\text{kJ}}{\text{kg}_{\text{dryAir}}}$$

$$h_v = 2501.3 + 1.82 \times 10 = 2519.5 \frac{\text{kJ}}{\text{kg}_{\text{water}}}$$

$$h = h_a + \omega h_v = 10.05 + 0.005 \times 2519.5 = 22.65 \frac{\text{kJ}}{\text{kg}_{\text{dryAir}}}$$

Task 2

A building with a height of 2.5 m and a good construction quality, is located in Piacenza, considering two occupants and one bed room calculate, and a conditioned floor area of 200 m² wall area is 144 m², calculate the internal gains, infiltration, and ventilation loads.

Internal gains

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

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

Table 3 Unit Leakage Areas

Construction	Description	$A_{ul}, \text{cm}^2/\text{m}^2$
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

Good quality $\rightarrow A_{ul} = 1.4 \frac{\text{cm}^2}{\text{m}^2}$

Exposed surface = Wall area + roof area

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

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

Table 5 Typical IDF Values, $\text{L}/(\text{s} \cdot \text{cm}^2)$

H, m	Heating Design Temperature, °C					Cooling Design Temperature, °C			
	-40	-30	-20	-10	0	10	30	35	40
2.5	0.10	0.095	0.086	0.077	0.069	0.060	0.031	0.035	0.040
3	0.11	0.10	0.093	0.083	0.072	0.061	0.032	0.038	0.043
4	0.14	0.12	0.11	0.093	0.079	0.065	0.034	0.042	0.049
5	0.16	0.14	0.12	0.10	0.086	0.069	0.036	0.046	0.055
6	0.18	0.16	0.14	0.11	0.093	0.072	0.039	0.050	0.061
7	0.20	0.17	0.15	0.12	0.10	0.075	0.041	0.051	0.068
8	0.22	0.19	0.16	0.14	0.11	0.079	0.043	0.058	0.074

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

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

$$V_{infiltration_{heating}} = A_L \times IDF = 481.6 * 0.073 = 35.16 \frac{L}{s}$$

$$V_{infiltration_{cooling}} = A_L \times IDF = 481.6 * 0.033 = 15.89 \frac{L}{s}$$

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

(2)	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)
	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

(3)	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)	
	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 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)			

$$V_{ventilation} = 0.05 A_{cf} + 3.5 (N_{br} + 1) = .05 \cdot 200 + 3.5 \cdot 2 = 17 \text{ L/S}$$

$$V_{inf-ventilation_{heating}} = 35.16 + 17 = 52.16 \text{ L/s}$$

$$V_{inf-ventilation_{cooling}} = 15.89 + 17 = 32.89 \text{ L/s}$$

$$C_{sensible} = 1.23, C_{latent} = 3010$$

$$Q_{inf-ventilation_{cooling_{sensible}}} = C_{sensible} V \Delta T_{cooling} = 1.23 \cdot 32.89 \cdot (31.1 - 24.3) = 275.09 \text{ W}$$

$$Q_{inf-ventilation_{cooling_{latent}}} = C_{latent} V \Delta \omega_{cooling} = 3010 \cdot 32.89 \cdot 0.0039 = 386.09 \text{ W}$$

$$Q_{inf-ventilation_{heating_{sensible}}} = C_{sensible} V \Delta T_{heating} = 1.23 \cdot 52.16 \cdot (20 - 4.1) = 1020.09 \text{ W}$$