WEEK 9

giovedì 6 febbraio 2020 11:31

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 x 25 x 5 = 1250 m^2

T = 11°C = 284 K

P = 102.9 kPa ~ 101.325 kPa = 1 atm

Φ = 30%

? = ω - T_{wb} - m_v

FORMULAS

$\Phi = m_v / m_g = P_v / P_g$

$P_g = P_{sat@11°C}$ = 1.2276 kPa (value found in steam tables for $P_{sat@10°C}$)

$P_v = \Phi \times P_g$ = 0.3 x 1.2276 kPa = 0.36828 kPa

$P = P_a + P_v$

$P_a = P – P_v$ = 102.9 kPa – 0.37 kPa = 102.35 kPa

$\omega = 0.622\ P_v / P_a$ = (0.622 x 0.37 kPa) / 102.35 kPa = 0.00225 kg_v/kg_a

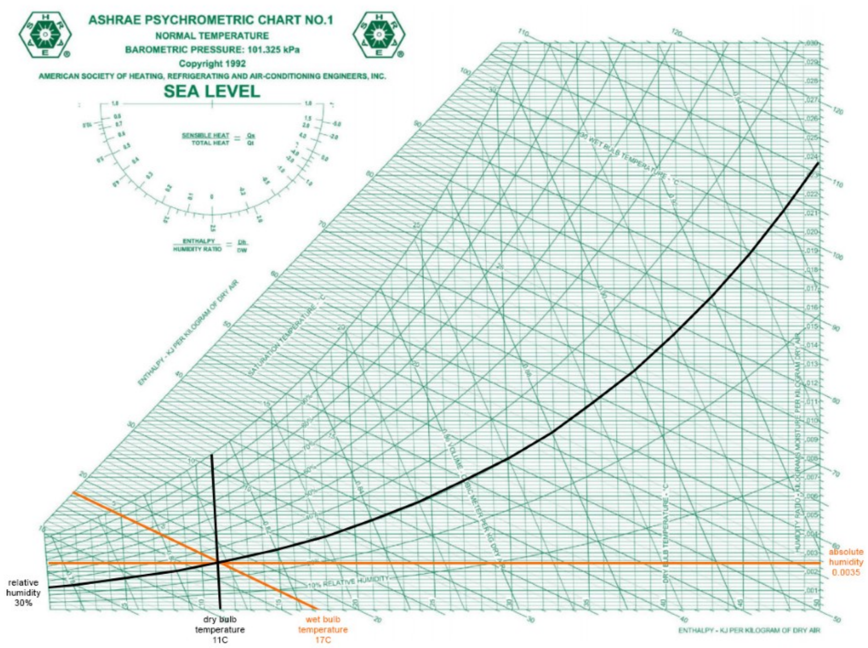
HP: for temperatures below 50°C we treat dry air and water vapour as ideal gasses (**$m=PV/R_{SPECIFIC}T_{inK}$**)

$m_v = P_v V_v / R_v T$

R_v = 0.4615 (found in tables)

m_v = (0.37 kPa x 1250 m^2) / (0.4615 x 284 K) = 3.53 kg

PSYCHROMETRIC CHART



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.

EXAMPLE: A building with a height of 2.5 m and an average construction quality, is located in Piacenza, considering two occupants and one bedroom calculate, and a conditioned floor area of 200 m^2 and wall area is 144 m^2, calculate the internal gains, infiltration, and ventilation loads.

$\mathbf{Q_{igsensible} = 136 + 2.2\ A_{cf} + 22\ N_{oc}} = 136 + 2.2 \times 200\ m^2 + 22 \times 2 = 620$ W

$\mathbf{Q_{iglatent} = 20 + 0.22\ A_{cf} + 12\ N_{oc}} = 20 + 0.22 \times 200\ m^2 + 12 \times 2 = 88$ W

To find the infiltration I must know how much is the max flowrate of air

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

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

Exposed surfaces (wall + roof)

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

$\mathbf{A_L = A_{ex} \times A_{ul}} = 344\ m^2 \times 1.4\ cm^2/m^2 = 481.6\ cm^2$

INFILTRATION DRIVING FORCE

Table 5 Typical IDF Values, L/(s·cm²)

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

$IDF_{heating} = 0.073$ L/s*cm^2

$IDF_{cooling} = 0.033$ L/s*cm^2

$\mathbf{V_{infiltrationH} = A_L \times IDF_{heating}} = 481.6\ cm^2 \times 0.073$ L/s*cm^2 = 35.16 L/s

$\mathbf{V_{infiltrationC} = A_L \times IDF_{cooling}} = 481.6\ cm^2 \times 0.033$ L/s*cm^2 = 15.89 L/s

$\mathbf{V_{ventilation} = 0.05\ A_{cf} + 3.5\ (N_{br}+1)} = 0.05*200\ m^2 + 3.5*(1+1) = 17$ L/s

$V_{ventilation-infiltrationH}$ = 35.16 L/s + 17 L/s = 52.16 L/s

$V_{ventilation-infiltrationC}$ = 15.98 L/s + 17 L/s = 32.89 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	$\boxed{4.1}$	-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	$\boxed{31.1}$	$\boxed{24.3}$	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)

$C_{sensible}$ = 1.23

C_{latent} = 3010

Based on ASHRAE Standard 55: cooling = 24°C – heating = 20°C

$$\mathbf{Q_{sensibleC} = C_{sensible} V_{ventilation\text{-}infiltrationC} \Delta T_{cooling}}$$

$Q_{sensibleC}$ = 1.23 * 32.89 L/s * (31.1 – 24) °C = 287.23 W

$$\mathbf{Q_{sensibleH} = C_{sensible} V_{ventilation\text{-}infiltrationH} \Delta T_{heating}}$$

$Q_{sensibleH}$ = 1.23 * 52.16 L/s * (20 – 4.1) °C = 1020.09 W

$$\mathbf{Q_{latentC} = C_{latent} V_{ventilation\text{-}infiltrationC} \Delta\omega_{cooling}}$$

$Q_{latentC}$ = 3010 * 32.89 L/s * 0.017= 1682.98 W

$\Delta\omega_{cooling}$ = 0.017 (found with the psychrometric chart knowing the dry and wet bulb temperatures)