WEEK 9

2019年12月3日 19:56

QUESTIONS:

Task 1

Use a weather forecast website, and utilize the psychrometric chart and the formula we went through in the class to determine the absoloute 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)

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

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

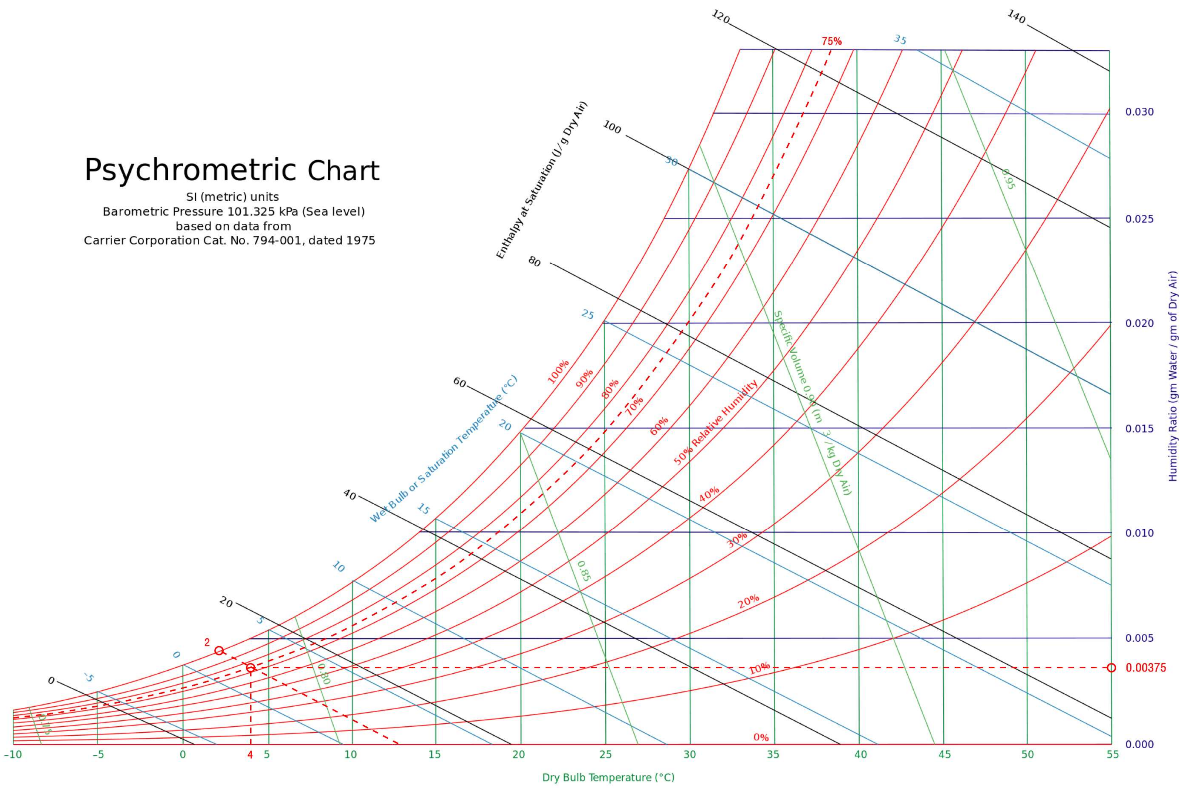
ANSWERS:

Task 1

Il tempo oggi in Piacenza
Martedì, 03 Dicembre 2019

	13:00	14:00	16:00	18:00	20:00	21:00	22:00
	LightCloud	LightCloud	PartlyCloud	LightCloud	Sun	Sun	Sun
Temperatura effettiva	9°C	10°C	8°C	6°C	4°C	2°C	2°C
Temperatura percepita	7°C	10°C	6°C	4°C	2°C	0°C	0°C
Precipitazioni	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm
Umidità	67 %	65 %	69 %	70 %	75 %	83 %	87 %
Pressione atmosferica	1025 hPa	1025 hPa	1025 hPa	1026 hPa	1027 hPa	1027 hPa	1028 hPa

As the weather forecast shows above, we can have these data:
$\phi = 75\%, \qquad T = 4°C = 277K, \qquad P = 102.7\ kPa$



From the Psychrometric Chart, when $T_{dry\ air} = 4°C$ and $\phi = 75\%$,
the $\omega = 0.00375$ and $T_{wb} = 2°C$

From formula $\omega = \dfrac{0.622 * P_v}{P - P_v}$, we can know:

$\rightarrow\ P_v = \dfrac{P * \omega}{0.622 + \omega} = 102.7 * 0.00375 \div (0.622 + 0.00375) \cong 0.62\ kPa$

We consider the size of aula A is 20m*10m*3m, $V = 20 * 10 * 3 = 600\text{m}^3$,
From the class, we have $R_v = 0.4615$,

$\rightarrow\ m_v = \dfrac{P_v * V}{T * R_v} = 0.62 * 600 \div (277 * 0.4615) = 2.91\ kg$

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 99.6%	Heating DB 99%	Humidification DP/MCDB and HR 99.6% DP	99.6% HR	99.6% MCDB	99% DP	99% HR	99% MCDB	Coldest month WS/MCDB 0.4% WS	0.4% MCDB	1% WS	1% MCDB	MCWS/PCWD to 99.6% DB 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 0.4% DB	0.4% MCWB	1% DB	1% MCWB	2% DB	2% MCWB	Evaporation WB/MCDB 0.4% WB	0.4% MCDB	1% WB	1% MCDB	2% WB	2% MCDB	MCWS/PCWD to 0.4% DB 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 0.4% DP	0.4% HR	0.4% MCDB	1% DP	1% HR	1% MCDB	2% DP	2% HR	2% MCDB	Enthalpy/MCDB 0.4% Enth	0.4% MCDB	1% Enth	1% MCDB	2% Enth	2% MCDB	Hours 8 to 4 & 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 1%	2.5%	5%	Extreme Max WB	Extreme Annual DB Mean Min	Mean Max	Standard deviation Min	Standard deviation Max	n-Year Return Period Values of Extreme DB n=5 years Min	n=5 years Max	n=10 years Min	n=10 years Max	n=20 years Min	n=20 years Max	n=50 years Min	n=50 years 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)

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

INTERNAL GAIN:

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

INFILTRATION:

Table 3 Unit Leakage Areas

Construction	Description	A_{ul}, cm²/m²
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

$$A_L = A_{es} A_{ul}$$

where

A_{es} = building exposed surface area, m²
A_{ul} = unit leakage area, cm²/m² (from Table 3)

From Table 3, we can know:

Good quality → $A_{ul} = 1.4\ \mathrm{cm^2/m^2}$
Exposed surface = Wall area +roof area
$A_{es} = 200 + 144 = 344\ m^2$
$A_L = A_{es} \times A_{ul} = 344 \times 1.4 = 481.6 cm^2$

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

$$Q_i = A_L \mathrm{IDF}$$

where

A_L = building effective leakage area (including flue) at reference pressure difference = 4 Pa, assuming discharge coefficient C_D = 1, cm²
IDF = infiltration driving force, L/(s·cm²)

From Table 5, we can know when $T_{heating\ design} = 4.1\ °C,\ \ T_{cooling\ design} = 31.1\ °C,$
→
$IDF_{heating} = 0.065\ L/(s \bullet cm^2)$
$IDF_{cooling} = 0.032\ L/(s \bullet cm^2)$

→ $Q_{infiltration_{heating}} = A_L \times IDF_{heating} = \ 481.6 * 0.065 = 31.30\ L/s$
$Q_{infiltration_{cooling}} = A_L \times IDF_{cooling} = \ 481.6 * 0.032 = 15.41\ L/s$

VENTILATION:

Indoor Conditions.
Based on ASHRAE Standard 55 typical practices are the following:
✓For cooling: 24°C db and a maximum of 50 to 65% rh.
✓For heating: 20°C db and 30% rh

$$Q_v = 0.05 A_{cf} + 3.5(N_{br} + 1)$$

where

Q_v = required ventilation flow rate, L/s
A_{cf} = building conditioned floor area, m²
N_{br} = number of bedrooms (not less than 1)

→ $\Delta T_{heating} = 20 - 4.1 = 15.9°C$
$\Delta T_{cooling} = 31.1 - 24 = 7.7°C$
DR=7.1°C

$Q_{ventilation} = 0.05\ A_{cf} + 3.5\ (N_{br} + 1) = 0.05*200+ 3.5* 2 = 17 \quad L/s$

$\rightarrow$

$Q_{inf-ventilation_{heating}} = 31.30 + 17 = 48.30\ L/s$

$Q_{inf-ventilation_{cooling}} = 15.41 + 17 = 32.41\ L/s$

We have already known： $C_{sensible} = 1.23$, $C_{latent} = 3010$

$\rightarrow$

$$\dot{Q}_{inf-ventilation_{cooling_{sensible}}} = C_{sensible} * Q_{inf-ventilation_{cooling}} * \Delta T_{Cooling}$$
$$= 1.23 * 32.41 * 7.7 = 306.96\ W$$

$$\dot{Q}_{inf-ventilation_{cooling_{latent}}} = C_{latent} * Q_{inf-ventilation_{cooling}} * \Delta\omega_{Cooling}$$
$$= 3010 * 32.41 * 0.0039 = 380.46\ W$$

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