QUESTION 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)

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
Intensità del vento	15 km/h	14 km/h	9 km/h	9 km/h	7 km/h	8 km/h	8 km/h
Direzione del vento	E	E	E	E	SE	SE	SE
Probabilità di nebbia	0 %	0 %	0 %	0 %	0 %	0 %	0 %
Punto di rugiada	3°C	3°C	3°C	1°C	-1°C	0°C	-1°C
Nuvole	21 %	13 %	42 %	15 %	2 %	3 %	3 %
Nuvole basse	11 %	7 %	42 %	15 %	2 %	3 %	3 %
Nuvole medie	18 %	12 %	2 %	0 %	1 %	0 %	0 %
Nuvole alte	0 %	0 %	0 %	0 %	0 %	0 %	0 %

www.engineeringtoolbox.com indique

Water saturation pressure at 4 degree C:

0.813 kPa
0.0081 bar
0.008 atm
0.118 psi
17 psf

Water tends to evaporate or vaporize by projecting molecules into the space above its s
molecules increases until the rate at which molecules reenter the liquid is equal to the r
pressure at which water vapour is in *thermodynamic equilibrium with its condensed stat*
condition the vapor pressure is the **saturation pressure**.

Online Water saturation pressure Calculator

The calculator below can be used to calculate the water saturation pressure at given te
The output pressure is given as kPa, bar, atm, psi (lb/in^2) and psf (lb/ft^2).

Temperatur must be within the ranges 0-370 °C, 32-700 °F, 273-645 K and 492-1160 °R

4 *Temperature*

Choose the actual unit of temperature:
(•) °C ( ) °F ( ) K ( ) °R

Calculate water saturation pressure!

The saturation pressure of water depends on temperature as shown below:

See Water and Heavy Water for thermodynamic properties at standard condtions.

See also other properties of **Water** at **varying temperature and pressure**: Boiling points at high pressure, Boiling points at vacuum pressure, Density and specific weight, Dynamic and kinematic viscosity, Enthalpy and entropy, Heat of vaporization, Ionization Constant, pK$_w$, of normal and heavy water, Melting points at high pressure, Prandtl number, Properties at Gas-Liquid Equilibrium Conditions, Specific gravity, Specific heat (heat capacity), Specific volume, Thermal conductivity, Thermal diffusivity and Vapour pressure at gas-liquid equilibrium.

we have :

- Temperature to be utilized : $T = 4°C = 277\,K$
- relative humidity : $\phi = 0{,}75$ (75%)
- Air to tatal pressure : $P = 102{,}7$ kPa $= P_a + P_v$
- water staturation pressure at (4°C) $P_g = 0{,}813$ kPa

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

$$\Rightarrow P_v = \phi \cdot P_g = 0{,}75 \times 0{,}813 \, (kPa)$$

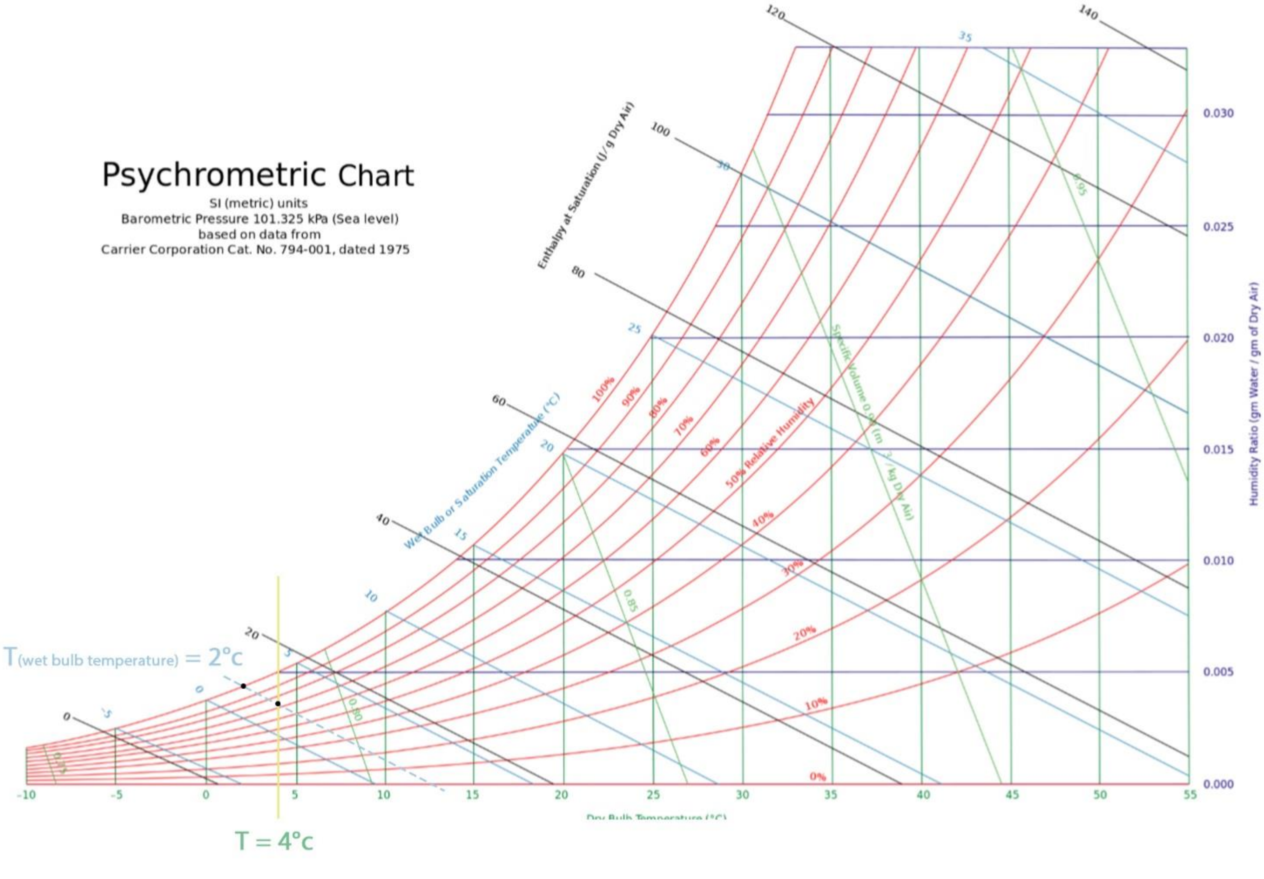
$$\boxed{P_v = 0{,}60975 \text{ KPa}}$$

$$\omega = \frac{0{,}622 \, P_v}{P - P_v} = \frac{0{,}622 \times 0{,}60975}{102{,}7 - 0{,}60975}$$

- Absolute humidity

$$\Rightarrow \boxed{\omega = 0{,}0037 \ \frac{\text{Kg vapour}}{\text{Kg dry air}}}$$

- For the wet bulb temperature we use the psychro-metric chart :



- The wet-bulb temperature is $\boxed{T \simeq 2°C}$
- $m_V = \frac{P_V . V}{R_{sp} . T}$ (we consider air an ideal gas)

we have :
$$\begin{cases} P_V = 0{,}60975 \text{ KPa} \\ V(\text{Aula A}) \simeq 10 \times 5 \times 5 \text{ m}^3 \\ R_{sp} = 0{,}416 \\ T = 277K = 4°C \end{cases}$$

$$m_V = \frac{0{,}60975 \times (10 \times 5 \times 5)}{0{,}416 \times 277}$$

$$\boxed{m_V = 1{,}32 \text{ Kg}}$$

QUESTION 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

- sensible Load :

we have $\begin{cases} A_{cf} = 200 m^2 \\ N_{cf} = 2 \end{cases}$

$$Q_{ips} = 136 + 2{,}2 \times A_{cf} + 22 \times N_{cf} = 136 + 2{,}2 \times 200 + 22 \times 2$$
$$Q_{ipl} = 20 + 0{,}22 \times A_{cf} + 12 \times N_{cf} = 20 + 0{,}22 \times 200 + 12 \times 2$$

$$\boxed{\begin{matrix} Q_{ips} = 620 \text{ w} \\ Q_{ipl} = 88 \text{ w} \end{matrix}}$$

- infiltration :

we have
$$\begin{cases} A_{unit} = 1{,}4 \text{ cm}^2/\text{m}^2 \text{ (good quality construction)} \\ A_{es} = 200 + 144 = 344 \ (S_{floor} + S_{walls}) \\ A_L = A_{es} \times A_{unit} = 481{,}6 \text{ cm}^2 \\ IDF_{heating} = 0{,}073 \text{ L/Scm}^3 \\ IDF_{cooling} = 0{,}0375 \text{ L/Scm}^3 \end{cases}$$

$$\Rightarrow \begin{matrix} V_{infiltration\ heating} = A_L \times IDF_{heating} = 481{,}6 \times 0{,}073 \\ V_{infiltration\ cooling} = A_L \times IDF_{cooling} = 481{,}6 \times 0{,}0375 \end{matrix}$$

$$\Rightarrow \boxed{\begin{aligned} V_{\text{infiltration heating}} &= 35,156 \ L/S \\ V_{\text{infiltration cooling}} &= 18,06 \ L/S \end{aligned}}$$

. Ventilation

we have $\begin{cases} A_{cf} = 200 \\ N_{br} = 1 \end{cases}$

$$V_{\text{ventilation}} = 0,05 \times A_{cf} + 3,5 \times (N_{br} + 1)$$
$$= 0,05 \times 200 + 3,5 \times (1+1)$$

$$\boxed{V_{\text{ventilation}} = 17 \ L/S}$$

we have $\begin{cases} C_{\text{sensible}} = 1,23 \\ C_{\text{latent}} = 3010 \\ \Delta_w \text{cooling} = 0,0132 - 0,0093 = 0,0039 \\ \Delta_w \text{heating} = 0,0190 - 0,0140 = 0,005 \end{cases}$

$\Rightarrow$

- $Q_{\text{inf. vent. cooling sensible}} = C_{\text{sensible}} \times V_{\text{inf cooling}} \times \Delta T_{\text{cooling}}$
$= 1,23 \times 35,06 \times 7,9$
$= 340,67 \ W$

- $Q_{\text{inf. vent. cooling latent}} = C_{\text{latent}} \times V_{\text{inf cooling}} \times \Delta_w \text{cooling}$
$= 3010 \times 35,06 \times 0,0039$
$= 411,57 \ W$

- $Q_{\text{inf ventilation, heating sensible}} = C_{\text{sensible}} \times V_{\text{inf heating}} \times \Delta T_{\text{heating}}$
$= 1,23 \times 52,156 \times 24,8$
$= 1590,97 \ W$

- $Q_{\text{inf vent. heating latent}} = C_{\text{latent}} \cdot V_{\text{inf heating}} \cdot \Delta_w \text{heating}$
$= 3010 \times 52,156 \times 0,005$
$= 784,95 \ W$