T.T

"Air properties"

(1)

Q.1/ 15 mg of vapour in 1 m^3 of air at 24°C and parametric pressure 1 bar find the partial air pressure?

Ans:-

$$P_v V_v = m_v R_v T_v$$

$$P_v = \frac{m_v R_v T_v}{V_v} = \frac{(\frac{15}{1000}) * (461) * (24+273)}{1} = 2053.76 \text{ pa}$$

$$P_a = P_B - P_v$$

$$= 101.325 - 2053.76 = 99271.2 \text{ pa}$$

from steam table

at $T = 24°C \rightarrow P_{sat} = 2982 \text{ Pa}$

So, $P_{sat} > P_v \longrightarrow$ The air is not saturation.

Q2/ Saturation air at 26°c and parometric pressu

1 Find partial air pressure?

(2)

Ans :- $P_B = P_a + P_v$ (From Dalton Law)

From steam table at 26°C, when $T_d = T_w$ for saturation

$T_w = 26°C \xrightarrow{table} P_{sw} = 3.36$ KPa

$P_v = P_{sw} - P_B * A * (T_d - T_w)$ $\boxed{T_w = T_d}$

$P_v = P_{sw} = 3.36$ kpa

* $P_B = 1$ bar $= 101.325$ Kpa

$P_a = P_B - P_v$

$= 101.325 - 3.36 = 97.695$ kpa.

prove $W = 0.622 \frac{P_v}{P_B - P_v}$ or $W = 0.622 \frac{\ldots}{P_a}$

$$PV = mRT$$

for air $P_a V = m_a R_a T \rightarrow m_a = \frac{P_a V}{R_a T}$

for water $P_v V = m_v R_v T \rightarrow m_v = \frac{P_v V}{R_v T}$

$$W = \frac{m_v}{m_a} = \frac{P_v V / R_v T}{P_a V / R_a T} \Rightarrow W = \frac{P_v}{P_a} \cdot \frac{R_a}{R_v}$$

$R_a = \frac{R_o}{M_a} \rightarrow R_v = \frac{R_o}{M_v}$, $M_a = 28.97$, $M_v = 18$

$$\therefore W = \frac{P_v}{P_a} * \frac{R_o / M_a}{R_o / M_v}$$

$$W = \frac{P_v}{P_a} * \frac{M_v}{M_a} = \frac{18}{28.97} \frac{P_v}{P_a}$$

$$W = 0.622 \frac{P_v}{P_B - P_v}$$

when $P_B = P_a + P_v$

Q4/ calculate the specific volume for moist air with 40°c & $\phi = 80\%$ and parametric pressure 100 kpa ? (4)

Sol 8○

$$v_a = \frac{R_a T_d}{P_a} \quad —① $$

$$v_v = \frac{R_v T_v}{P_v} \quad —② $$

$$\phi = \frac{P_v}{P_{sd}} \quad , \quad P_{sd} = 7.375 \text{ kp at } T_d = 40°c \text{ from Table}$$

$$80\% = \frac{P_v}{7.375} \Rightarrow P_v = 5.9 \text{ kpa}$$

$$P_a = P_B - P_v \Rightarrow P_a = 100 - 5.9 = 94.1 \text{ kpa}$$

$$v_a = \frac{287 * (313)}{94.1 * 10^3} = \checkmark$$

$$T_v = T_d$$

$$\therefore V_v = \frac{461 * (313)}{5.9} = —$$

prove $h_v = 1.005T + w(2501 + 1.84T)$

$h = h_a + wh_v$ — ①

$h_a = c_{p_a} T = 1.005T$ — ②

$h_v = c_{p_v} T_d + h_{fg} + c_{p_v}(T - T_d)$ at $T_d = 0$

$c_{p_a} = 1.005 \quad -10 < T < 0$

$c_{p_a} = 1.007 \quad 0 < T < 60°C$

$h_v = 2501 + 1.84T$

$h_v = 1.005T + w(2501 + 1.84T)$

humid specific heat $c_{p_h} = c_{p_a} + w c_{p_v}$

Q3/ The density of moist air founded 0-018 Kg/m³ with 26°c DBT & P_B = 90 Kpa, calculate relative humidity?

(3)

Sol :

$$\phi = \frac{\rho_v}{\rho_{vsd}}$$

$\rho_v = 0.018\ Kg/m^3$ from ex.

from steamtable at $t_d = 26°c \rightarrow \rho_{vsd} = \frac{1}{v_{vsd}}$ (fromtable)

$\Rightarrow \rho_{vsd} = 0.0243\ Kg/m^3$

$$\therefore \phi = \frac{0.018}{0.02437} = \text{—}$$

or $\phi = \frac{P_v}{P_{sd}}$ —— (1)

$P_v V_v = m_v R_v T_v$ and $P_{sd} V_{sd} = m_{sd} R_{sd} T_d$

$$P_v = \frac{m_v R_v T_v}{V_v}$$

$$P_{sd} = \frac{m_{sd} R_{sd} T_{sd}}{V_{sd}}$$

Sub in (1)

*
$T_v = T_{sd} = T_d$
$V_v = V_{sd}$
$R_v = R_{sd}$

$$\phi = \frac{m_v R_v T_v / V_v}{m_{sd} R_{sd} T_d / V_{sd}} \Rightarrow \phi = \frac{m_v}{m_{sd}}$$

$m = \rho * v$

$$\boxed{\phi = \frac{\rho_v * V_v}{\rho_{sd} * V_{sd}} = \frac{\rho_v}{\rho_{sd}}}$$

prove

Q6/ Calculate the dew point Temp. of moist air at 20°c DBT , 15°c WBT and 95 Kpa

SoL :

$P_v = P_{sw} - P_B * A * (DBT - WBT)$

at WBT = 15°c from table P_{sw} = 1.7044 Kpa

∴ $P_v = 1.7044 - 95 * 6.66 * 10^{-4} * (20-15)$

= 1.3876 Kpa

from table at P_v = 1.3876 Kpa

T_{dp} ⇒

11	1.3119	
T	1.3876	
12	1.4017	

$$\frac{1.3119 - 1.4017}{1.319 - 1.3876} = \frac{11-12}{11-T} \Rightarrow T_{dp} = 11.842°C$$