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PROBLEMS IN PRACTICE

1 ● Given air at 70 F dry-bulb and 50 per cent relative humidity with a barometric pressure of 29.00 in. Hg, find the weight of vapor per pound of dry air.

Pressure of saturated vapor = e_t = 0.7387 in. Hg (Table 6).
From Equation 5a,

$$W = 0.622\left(\frac{0.5 \times 0.7387}{29.00 - (0.5)\ (0.7387)}\right)$$

W = 0.008024 lb of vapor per pound of dry air at 70 F dry-bulb and 50 per cent relative humidity.

Approximate Method:

Weight of saturated vapor per pound of dry air = W_t = 0.01574 lb (Table 6). 0.01574 × 0.5 = 0.0787 lb of vapor per pound of dry air at 70 F dry-bulb and 50 per cent relative humidity.

2 ● Given air with a dry-bulb temperature of 80 F, relative humidity of 55 per cent, and a barometric pressure of 28.85 in. Hg, calculate the weight of a cubic foot of mixture.

Pressure of saturated vapor at 80 F = e_t = 1.0316 in. Hg (Table 6).

Pressure of the vapor in the mixture = 1.0316 × 0.55 = 0.5676 in. Hg.

Pressure of the dry air in the mixture = 28.85 − 0.5676 = 28.282 in. Hg.

$pV = wR\ (t + 460)$ (R = 0.753 when partial pressure of air is expressed in in. Hg).
28.282 × 1 = d_a × 0.753 × (80 + 460)

$$d_a = \frac{28.282}{0.753 \times 540} = 0.06955 \text{ lb} = \text{weight of dry air in 1 cu ft of the mixture.}$$

Likewise from Equation 4a,

$$d_v = \frac{0.5676}{1.21 \times 540} = 0.000868 \text{ lb} = \text{weight of vapor per cubic feet at 55 per cent}$$
relative humidity.

Weight of 1 cu ft of the mixture = 0.06955 + 0.000868 = 0.070418 lb.

3 ● Given air with a dry-bulb temperature of 75 F, a relative humidity of 60 per cent, and a barometric pressure of 28.80 in. Hg, calculate the volume of 1 lb of the mixture.

Pressure of saturated vapor at 75 F = e_t = 0.8745 in. Hg.

Pressure of vapor in the mixture = 0.8745 × 0.6 = 0.525 in. Hg.

Pressure of dry air in the mixture = 28.80 − 0.525 = 28.275 in. Hg.

$$d_a = \frac{28.275}{0.753 \times 535} = 0.07018 \text{ lb} = \text{weight of dry air in 1 cu ft of the mixture.}$$

From Equation 4a,

$$d_v = \frac{0.525}{1.21 \times 535} = 0.000811 \text{ lb} = \text{weight of vapor per cubic feet at 55 per cent}$$
relative humidity.

Weight of 1 cu ft of the mixture = 0.07018 + 0.000811 = 0.070991 lb.

$$\text{Volume of 1 lb of the mixture} = \frac{1}{0.070991} = 14.08 \text{ cu ft.}$$

4 ● It is desired to maintain a temperature of 80 F and a relative humidity of 50 per cent in a factory where the equipment gives off 6,000 Btu per hour. If the entering air is at 70 F with an average barometric pressure of 29.92 in. Hg; determine the relative humidity, and the pounds of air required per hour if there is no heat interchange between the walls, windows, or floors of the building.

Pressure of saturated vapor at 80 F = 1.0316 in. Hg (Table 6).

Pressure of vapor in the mixture = 1.0316 × 0.5 = 0.5158 in. Hg.

$$W = 0.622\left(\frac{0.5158}{29.92 - 0.5158}\right) = 0.01091 \text{ lb.}$$

Pressure of saturated vapor at 70 F = 0.7387 in. Hg.

With the same specific humidity

$$0.01091 = 0.622\left(\frac{0.7387 \times \Phi}{29.92 - (0.7387 \times \Phi)}\right)$$

Φ = 69.8 per cent relative humidity at 70 F.

h = 0.24 × 80 + 0.01091 (1059.2 + 0.45 × 80) = 31.15 Btu per pound, the heat content of the mixture at 80 F and 50 per cent relative humidity.

h = 0.24 × 70 + 0.01091 (1059.2 + 0.45 × 70) = 28.70 Btu per pound, the heat content of the mixture at 70 F and the same specific humidity.

31.15 − 28.70 = 2.45 Btu to be removed per pound of air.

6000 Btu = heat given off by equipment per hour.

$$\frac{6000}{2.45} = 2449 \text{ lb of air required per hour.}$$

5 ● Given 1 lb of dry air at 78 F and a barometric pressure of 29.92 in. Hg; calculate the volume. If the temperature is raised to 96 F and the volume remains constant, what will be the new pressure, P_2, in in. Hg?

$PV = wR\ (t + 460)$

R (for air) = 53.34.

W = 1 lb.

P = absolute pressure, pounds per square foot.

$$V = \frac{1 \times 53.34 \times (78 + 460)}{29.92 \times 0.491 \times 144}$$

V = 13.57 cu ft = volume of 1 lb.