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17/ENG07/019
Petroleum Engineering
PTE 314

In order to avoid pressure build up gas at atmosphere pressure in a pipe, is vented to atmosphere through a pipe of 3mm dia and 20m length. Determine the mass of the gas diffusing out and mass of air diffusing in per hour. Assume $D = 0.28 \times 10^{-4} m/s$, $M = 17 kg/kg\ mole$

$L = 20m$

$d = 3mm = 0.003m$

$D = 0.28 \times 10^{-4} m^2/s$, $R = 8315 J/kg\ mol\ K$

Molar mass $M = 17$ kg/kg mole

$P_{a_1} = 1\ atm = 1.013 \times 10^{5} Nm^{-2}$

$P_{a_2} = 0$, since gas vented to the atmosphere.

Using the equimolal Counter diffusion equation

$$\frac{N_a}{A} = \frac{D}{R_T} \cdot \frac{P_{a_1} - P_{a_2}}{L}$$

$$N_a = \frac{DA}{R_T} \frac{P_{a_1} - P_{a_2}}{L}$$

where $A = \frac{\pi d^2}{4} = \frac{3.14 \times (0.03)^2}{4} = 7.0673 \times 10^{-4}\ m^2$

Recall T is the temperature in absolute unit

$$N_a = \frac{DA}{R} \cdot \frac{P_{a1} - P_{a2}}{L} \quad -(1)$$

Recall $N_a = \frac{M_a}{M} \quad -(2)$

Substituting eqn 2 into eqn 1

$$\frac{M_a}{M} = \frac{DA}{R} \cdot \frac{P_{a1} - P_{a2}}{L}$$

$$M_a = \frac{DA}{R} \cdot \frac{(P_{a1} - P_{a2})}{L} \cdot M$$

Converting kg/s to kg/hr.

$$M_a = \frac{DA}{A} \cdot \frac{P_{a1} - P_{a2}}{L} \cdot M(3600$$

$$M_a = \frac{(0.28 \times 10^{-4}) \times (7.0673 \times 10^{-5}) \cdot (1.013 \times 10^5 - 0)}{8315} \cdot \frac{}{20}$$

$$\times 17 \times 3600$$

$M = 7.38 \times 10^{-6}$ kg/hr. (Mass diffusing out)

b. Mass of air diffusing in

$$\frac{N_a}{\pi} = -\frac{N_b}{\pi}$$

$N_a = -N_b$, $N_b = -N_a$

$N_b = -7.38 \times 10^{-6}$

Mole of air $= \frac{N_a}{M} = -\frac{7.38 \times 10^{-6}}{17}$

$= -4.34 \times 10^{-7}$

Mass of air $= -4.34 \times 10^{-7} \times 28.97$

$= -1.26 \times 10^{-5}$ kg/hr