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17/ENG07/006
PETROLEUM ENGINEERING
PTE 314

QUESTION

In order to avoid pressure build up gas at atmospheric pressure in a pipe is vented to the atmosphere through a pipe of 3mm diameter and 2m length. Determine the mass of the gass diffusing out and mass of air diffusing in per hour. Assume $D = 0.28 \times 10^{-4} m^2/s$, $M = 17 kg/kgmole$

ANSWER

$$N_a = \frac{m_a}{m} \quad \text{---} \quad \text{Equ (1)}$$

$L = 2m$

$d = 3mm = 0.003m$

$A = \pi/4 (d^2) = \pi/4 \times (0.003)^2 = 7.0695 \times 10^{-6} m^2$

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

Molar mass $M = 17 kg/mol$

$D = 0.28 \times 10^{-4} m^2/s$

$R = 8315 J/kgmolK$

Making use of the equimolar counter diffusion equation

(a) $$\frac{N_a}{A} = \frac{D}{RT} \cdot \frac{P_{a_1} - P_{a_2}}{L}$$

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

Recall T is the temperature $= 0^0 K$

Substituting Equ (1)

$$\frac{m_a}{m} = \frac{DA}{R} \cdot \frac{P_{a_1} - P_{a_2}}{L}$$

$$m_a = \frac{D.A}{R} \cdot \frac{P_{a_1} - P_{a_2}}{L} \cdot m$$

$$m_a = \frac{(0.28 \times 10^{-4}) \times (7.0695 \times 10^{-6}) \cdot (1.013 \times 10^5 - 0) \times 17 \times 3000}{8315}$$

$$= 7.3 \times 10^{-6} kg/hr$$

(b) mass of air diffusing in, m_{air}

Recall

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

$$\therefore N_a = -N_b$$

$$N_b = -N_a$$

mole of air $= \dfrac{-7.38 \times 10^{-6}}{17}$

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

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

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