Aigbogun Ehiedu Mcleod
17/ENG04/091
Petroleum Engineering

Solution

$N_a = \frac{M_a}{M}$ ①

$P_{a1} = 1atm = 1.013 \times 10^{-5} Nm^{-2}$

$P_{a2} = 0$ since the gas is vented to the atmosphere (i.e. 0)

$L = 20m$

$d = 3mm = 0.003m$

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

molar mass $M = 17$ Kg/mol

$R = 8315 J/kgmol K$

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

Using the equimolar counter diffusion equation

$$\frac{N_a}{A} = \frac{D}{RT} = \frac{P_{a1} - P_{a2}}{L}$$

$$N_a = \frac{DA}{RT} = \frac{P_{a1} - P_{a2}}{L}$$

Recall T is the temperature in absolute unit ie °K

$$N_a = \frac{DA}{R} = \frac{P_{a1} - P_{a2}}{\Delta}$$

Substituting equ(1)

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

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

Where M_a is the mass of gas diffusing out in kg/s to convert

$$M_a = \frac{DA}{R} \cdot \frac{P_{a1} - P_{a2}}{L} \cdot M \times 3600 \quad kg/hr$$

$$M_a = \frac{(0.28 \times 10^{-4}) \times (7.0695 \times 10^{-6})}{8.315} \cdot \frac{(1.013 \times 10^{5} - 0)}{20} \times 17 \times 3600$$

$$= 7.38 \times 10^{-6} \ kg/hr$$

b. mass of air diffusing in, M_{air}

Recall

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

$$\therefore N_a = -N_b$$

$$N_b = -N_a$$

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

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

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

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

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