Substituting eqn 1

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

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

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

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

$$M_a = \frac{(0.28 \times 10^{-9}) \times (7.0695 \times 10^{-6})}{8315} \cdot \frac{(1.013 \times 10^{5} - 0)}{20} \times 17 \times 3600$$

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

Mass of air diffusing in, M_{air}

Recall

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

$\therefore N_a = -N_b$

$N_b = -N_a$

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

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

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

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

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

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17ENG071007
HEAT AND MASS TRANSFER

Q. In order to ~~determine~~ avoid a pressure build up gas at atmospheric pressure in a pipe is vented to atmosphere through a pipe of 3mm diameter and 20m length. Determine the mass of gas diffusing out and mass of air diffusing in per hour. Assume $D = 0.28 \times 10^{-4}\ m^2/s$ $= M = 17$ kg/kg mole.

Answer

$N_a = \frac{M_a}{M}$ — eqn — (1)

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

$P_{a2} = 0$, since the gas is vented to atmosphere

$L = 20m$

$d = 3mm = 0.003m$

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

Molar mass, $M = 17$ kg/mol

$R = 8315$ J/kg mol K

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

Using the equimolal counter diffusion equation

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

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

Recall T is the temperature in absolute unit i.e °K

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