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17/ENG07/079
Petroleum Engineering
PTE 314

Hydrogen gas is maintained at 4bar and 1 bar on the opposite sides of a membrane of 0.5mm thickness. At this temperature the diffusion coefficient is $8.7\times10^{-8} m^2/s$. The Solubility of hydrogen in the material which depends on the pressure is $1.5\times10^{-3} m^2/s$ bar. Determine the mass diffusion rate of hydrogen through the membrane.

Solution.

$C_1 = 1.5\times10^{-3}\times 4 = 6\times10^{-3}$ kgmol/m^3.

$C_2 = 1.5\times10^{-3}\times 1 = 1.5\times10^{-3}$ kgmol/m^3.

$L = 0.5mm = 5\times10^{-4} m$.

$D = 8.7\times10^{-8} m^2/s$

Considering the plane wall. Condition:

$$R = \frac{L}{DA} = \frac{5\times10^{-4} m}{8.7\times10^{-8}\times 1} = 5747.13 \frac{s}{m^3}$$

$$\text{Mole flux} = \frac{(6\times10^{-3} - 1.5\times10^{-3})}{5747.13} = 7.83\times10^{-7} \text{ kgmol/}m^2s$$

For H_2 molecular weight is 2

Mass flux $= 2 \times 7.83 \times 10^{-7} \, m^2/s = 1.566 \times 10^{-6} \, kg/m^2 s$