

SOLUTIONS

- 4.1 $Z = .0015 \text{ m}$, $M_A = 58.5$, $M_B = 18.02$,
 $D_{AB} = 1.3 \times 10^{-5} \text{ cm}^2/\text{s} = 1.3 \times 10^{-9} \text{ m}^2/\text{s}$
 Density of 24% solution is 1081 kg/m^3 . Therefore, for 24% solution

$$x_{A1} = \frac{0.24/58.5}{0.24/58.5 + 0.76/18.02} = \frac{0.0041}{0.0041 + 0.04218} = 0.0886$$

$$x_{B1} = 1 - x_{A1} = 1.0 - 0.0886 = 0.9114$$

$$M = \frac{1}{0.0463} = 21.6 \text{ kg/kg mol} \quad \frac{\rho}{M} = \frac{1081}{21.6} = 50.05 \text{ kg mol/m}^3$$

Similarly for 4% solution

$$x_{A2} = \frac{0.04/58.5}{0.04/58.5 + 0.96/18.02} = \frac{0.000684}{0.054} = 0.0127$$

$$x_{B2} = 1 - 0.0127 = 0.9873$$

$$M = \frac{1}{0.054} = 18.52 \text{ kg/kg mol} \quad \frac{\rho}{M} = \frac{1027}{18.52} = 55.45 \text{ kg mol/m}^3$$

$$\left(\frac{\rho}{M}\right)_{AV} = \frac{50.05 + 55.45}{2} = 52.75 \text{ kg mol/m}^3$$

$$x_{BM} = \frac{0.9873 - 0.9114}{\ln \frac{0.9873}{0.9114}} = 0.9488$$

$$N_A = \frac{D_{AB}}{Z x_{BM}} \left(\frac{\rho}{M}\right)_{AV} (x_{A1} - x_{A2})$$

$$= \frac{1.3 \times 10^{-9}}{0.0015 \times 0.9488} \times (52.75)(0.0886 - 0.0127)$$

$$= 3.657 \times 10^{-6} \frac{\text{kg mol}}{\text{m}^2 \cdot \text{s}}$$

- 4.2 Assume air contains no alcohol. Therefore, $p_{A2} = 0 \text{ bar}$.

The open space of 2 cm is filled with stagnant air. Thus the thickness of film is 2 cm = 0.02 m.

The partial pressure of alcohol at the interface = 0.55 bar = p_{A1} .