Assignment

Cussler

Chapter 3

Problems 1 7

Group 4

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3.1 Solution:

$$j_1 = -Dc\frac{dy_1}{dz} = Dc(\frac{1-y_{10}}{l})(\frac{1-y_{1l}}{1-y_{10}})^{z/l}\ln(\frac{1-y_{1l}}{1-y_{10}}) \tag{1-1}$$

$$n_1 = \frac{Dc}{l}\ln(\frac{1-y_{1l}}{1-y_{10}}) \tag{1-2}$$

$$\frac{n_1}{j_1} = \frac{1}{(1-y_{10})(\frac{1-y_{1l}}{1-y_{10}})^{z/l}} \tag{1-3}$$

Boundary condition:

$$z = 0: \qquad y_{10} = \frac{c_{10}}{c} = \frac{p_1(sat)}{p} \tag{1-4a}$$

$$z = l: \qquad y_{1l} = \frac{c_{1l}}{c} = \frac{0}{p} = 0 \tag{1-4b}$$

In this case, halfway up the capillary, so $z/l = 0.5$.

$$\frac{n_1}{j_1} = \frac{1}{(1-y_{10})(\frac{1-y_{1l}}{1-y_{10}})^{z/l}} = \frac{1}{(1-y_{10})(\frac{1-0}{1-y_{10}})^{0.5}} = \frac{1}{(1-y_{10})^{0.5}} \tag{1-5}$$

a) $1-y_{10} = 1-\frac{5}{760} = 0.993$

$$\frac{n_1}{j_1} = \frac{1}{(1-y_{10})(\frac{1-y_{1l}}{1-y_{10}})^{z/l}} = \frac{1}{(1-y_{10})(\frac{1-0}{1-y_{10}})^{0.5}} = \frac{1}{(1-y_{10})^{0.5}} = \frac{1}{0.993^{0.5}} = 1.003$$

b) $1-y_{10} = 1-\frac{400}{760} = 0.474$

$$\frac{n_1}{j_1} = \frac{1}{(1-y_{10})(\frac{1-y_{1l}}{1-y_{10}})^{z/l}} = \frac{1}{(1-y_{10})(\frac{1-0}{1-y_{10}})^{0.5}} = \frac{1}{(1-y_{10})^{0.5}} = \frac{1}{0.474^{0.5}} = 1.453$$

3.7 Solution:

$$P = \left[\frac{ARTP_0}{Vl} \right] (HDt - \frac{l^2 H}{6}) \qquad (7\text{-}1)$$

$$P(\mu mHg) = 88(t - 2.3) \qquad (7\text{-}2a)$$

$$P(cmHg) = 88 \times 10^{-4}(t - 2.3) \qquad (7\text{-}2b)$$

$$A = \pi \left(\frac{3}{2} \right)^2 \times 17.3\% = 1.223 cm^2 \qquad P_0 = 76 cmHg$$

$$R = 8.31 \qquad T = 273K \qquad V = 68 cm^3$$

$$l = 35\mu m = 35 \times 10^{-4} cm$$

$$\frac{ARTP_0}{Vl} = \frac{1.223 cm^2 \times 8.31 \times 273K \times 76 cm}{68 cm^3 \times 35 \times 10^{-4} cm} = 88.76 \times 10^4$$

$$\frac{l^2 H}{6} = \frac{\left(35 \times 10^{-4} cm\right)^2 H}{6} = 204.167 \times 10^{-8} H$$

$$\frac{ARTP_0}{Vl} \frac{l^2 H}{6} = 18122 \times 10^{-4} H$$

Compare Eq.7-1 with 7-2b,

$$\frac{ARTP_0}{Vl} \frac{l^2 H}{6} = 18122 \times 10^{-4} H = 88 \times 2.3 \times 10^{-4}$$

$$\rightarrow H = 1.117 \times 10^{-2}$$

$$\frac{ARTP_0}{Vl} HD = 88.76 \times 10^4 \times 1.117 \times 10^{-2} D = 88 \times 10^{-4}$$

$$\rightarrow D = 8.9 \times 10^{-7} cm^2 / \sec$$