(1) NOV-Dec 2017
MTO-I Sem-V CBSGS
Solution for Question Paper.
Q.P. Code 26249

Q.No. 1 b

Consider a binary solution of A and B
Here-

$$N_A = J_A + x_A N$$

&

$$N_B = J_B + x_B N$$

$$\therefore \quad N = N_A + N_B$$

$$\therefore \quad N = J_A + x_A N + J_B + x_B N.$$

$$\therefore \quad N = J_A + J_B + [x_A + x_B] N$$

$$\because \quad x_A + x_B = 1$$

$$\therefore \quad N = J_A + J_B + N$$

$$\therefore \quad J_A = -J_B$$

$$\therefore \quad -D_{AB} \frac{dC_A}{dZ} = -\left(-D_{BA} \frac{dC_B}{dZ}\right)$$

Now since $C_A + C_B = C$

$$\therefore \quad d[C_A + C_B] = dC$$

But $dC = 0$ $\because$ C is constant

$$\therefore \quad dC_A + dC_B = 0$$

$$\therefore \quad dC_A = -dC_B \quad \therefore \boxed{D_{AB} = D_{BA}}$$

02

Q. No. 2)

a

Equilibrium relationship is-

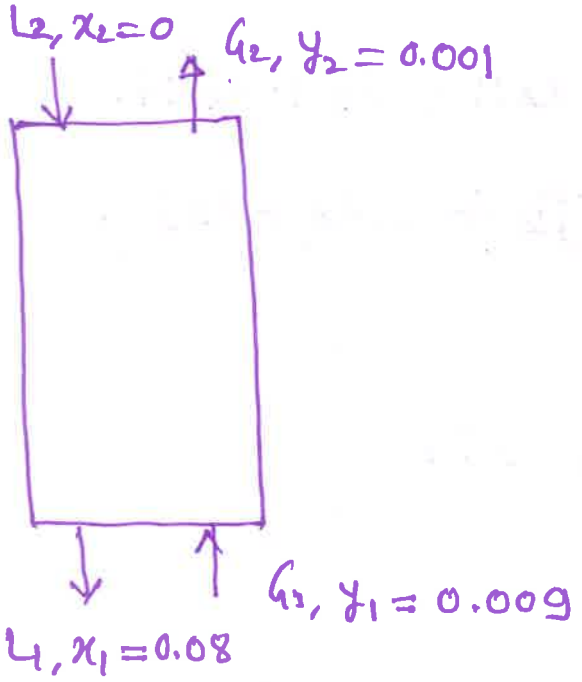
$$y = 0.06x \; ; \; m = 0.06$$

In terms of Y & X we have

$$\frac{Y}{1+Y} = 0.06\frac{X}{1+X}$$

$$\therefore \quad Y = \frac{0.06X}{1+0.94X}$$

Here-



$$Y_1 = \frac{y_1}{1-y_1} = \frac{0.009}{1-0.009} = 9.08\times10^{-3} \qquad x_1 = \frac{x_1}{1-x_1} = \frac{0.08}{1-0.08} = 0.087$$

$$Y_2 = \frac{y_2}{1-y_2} = \frac{0.001}{1-0.001} = 1.001\times10^{-3}$$

Since-

$$H_{tOG} = H_{tG} + m\frac{G_s}{L_s}H_{tL}$$

$$\frac{L_s}{G_s} = \frac{Y_2-Y_1}{X_2-X_1} = 0.0928 \; ; \; H_{tOG} = 0.515m$$

(03)

$$N_{tOG} = \frac{Y_1 - Y_2}{\dfrac{(Y_1 - Y_1^*) - (Y_2 - Y_2^*)}{\ln\left(\dfrac{Y_1 - Y_1^*}{Y_2 - Y_2^*}\right)}}$$

$Y_1^* = \dfrac{0.06 X_1}{1 + 0.94 X_1}$ & $Y_2^* = \dfrac{0.06 X_2}{1 + 0.94 X_2}$

$= 4.82 \times 10^{-3}$ $\quad Y_2^* = 0$

$\therefore N_{tOG} = 3.59$

Since $Z = N_{tOG} H_{tOG}$

$= 3.59 \times 0.515$

$= 1.84 m$.

Hence- $\boxed{Z = 1.84 m}$

Q No.2) b

i. $N_A = \dfrac{D_{AB}}{RTZ}[P_{A1} - P_{A2}]$

$N_A = 3.636 \times 10^{-5}$ kmole/m^2s

ii. At point 0.02m, $Z = 0.02 m$

Hence-

$$N_A = \frac{D_{AB}}{RTZ}[P_{A1} - P_A]$$

$P_A = 28.33$ Kpa.

04

Q.No. 3) a

$$\delta = \left[\frac{3\mu M}{S^2 g}\right]^{1/3}$$

$$\delta = \left[\frac{3 \times 8.94 \times 10^{-4} \times 0.05}{(998)^2 \times 9.81}\right]^{1/3}$$

$$\delta = 2.39 \times 10^{-4} m$$

$$Re = \frac{4M}{\mu} = \frac{4 \times 0.05}{8.94 \times 10^{-4}} = 223.71 > 100$$

$$\bar{u}_y = \frac{M}{S\delta} = \frac{0.05}{998 \times 2.39 \times 10^{-4}} = 0.209 \text{ m/s}$$

$\therefore Re > 100$,

$$k_{Lavg} = \left[\frac{6 D_{AB} M}{\pi S \delta L}\right]^{1/2}$$

$$= \left[\frac{6 \times 1.96 \times 10^{-9} \times 0.05}{\pi \times 998 \times 2.39 \times 10^{-4} \times 1}\right]^{1/2}$$

$$= 2.80 \times 10^{-5}$$

$$N_{Avg} = \frac{\bar{u}_y \delta}{L}(C_{AL} - C_{A0}) = k_{Lavg}(C_{Ai} - C_A)_{lm}$$

$$= k_{Lavg}\left[\frac{(C_{Ai} - C_{A0}) - (C_{Ai} - C_{AL})}{\ln\left[\frac{C_{Ai} - C_{A0}}{C_{Ai} - C_{AL}}\right]}\right]$$

$$\frac{0.209 \times 2.39 \times 10^{-4}}{1}(C_{AL} - 0) = 2.80 \times 10^{-5}\left[\frac{(0.0366 - 0) - (0.0366 - C_{AL})}{\ln\left[\frac{0.0366 - 0}{0.0366 - C_{AL}}\right]}\right]$$

$$C_{AL} = 0.0157 \text{ kmole/m}^3$$

05 $N_{Aavg} = \frac{0.209 \times 2.99 \times 10^{-4}}{1} \times [0.0157 - 0]$

$= 7.84 \times 10^{-7}$ kmole/m²s.

∴ $N_{Aavg} = 7.84 \times 10^{-7}$ kmole/m²s.

Q.No.4) a

$X_1 = \frac{55}{45} = 1.22$

$X_2 = \frac{4}{96} = 0.042$

$X_c = \frac{26}{74} = 0.351$

$X^* = \frac{0}{100} = 0$

sheet volume = @ 125 × 140 × 5

$= 87500\ cm^3$

$= 87500 \times 10^{-6}$

$= 0.0875\ m^3$

density = $\frac{mass}{volume}$ ∴ mass = 4000 × 0.0875

Ls. = 350 kg = Ls

$A = 2 \times 125 \times 140 = 35000\ cm^2 = 3.5\ m^2$

$N_c = 1.5 \times 10^{-3} \times 10^4$ $\frac{kg}{m^2 hr}$

$Q_T = Q_c + Q_f$

$= \frac{L_s}{AN_c}\left[(X_1 - X_2) + (X_c - X^*) \ln \frac{X_c - X^*}{X_2 - X^*}\right]$

$$Q_T = \frac{350}{3.5 \times 1.5 \times 10^{-3} \times 10^4} \left[(1.22 - 0.351) + (0.351 - 0) \ln \left(\frac{0.351 - 0}{0.042 - 0} \right) \right]$$

$$\therefore Q_T = 6.67 \left[0.869 + 0.351 \times 2.12 \right]$$

$$\therefore Q_T = 10.76 \text{ Hrs.}$$

Hence -

$$Q_T = 10.76 \text{ Hrs.}$$