CHE 221A

QUIZ-2

MODEL SOLUTION

1 Given;

$$\Delta \underline{V}_{mix} = x_1 x_2 [-1.026 + 0.0220 (x_1 - x_2)] \quad -(1)$$

$\underline{V}_1 = 58.63 \text{ cm}^3/\text{mol}$, $\underline{V}_2 = 118.46 \text{ cm}^3/\text{mol}$

$\therefore$ # of moles of Ethol :- $n_1 = \frac{750}{58.63}$

$n_1 = 12.79$ moles — 1

$\therefore$ # of moles of Methy Butyl Ether : $n_2 = \frac{1500}{118.46}$

$n_2 = 12.66$ moles — 1

$\therefore$ Mole fraction of Ethanol : $x_1 = 0.502$

" " MBE : $x_2 = 0.498$ — 1

→ Using eqn (1);

$$\Delta \underline{V}_{mix} = -0.256 \text{ cm}^3/\text{mol} \quad - 2$$

→ Volume of mixture : $V_{mix} = (1500 + 750) + (-0.256)(12.66 + 12.79)$

$\therefore \boxed{V_{mix} = 2243.48\ cm^3}$ — 3

→ If the ideal solution were formed then;

$$\Delta \underline{V}_{mix} = 0$$

$$\therefore V_{mix} = 1500 + 750$$

$$\boxed{V_{mix} = 2250\ cm^3}$$ — ~~3~~ 2

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$\boxed{2}$ Given;

$x_1 = 0.33$, $T = 100\ ^\circ C$

$T = 373\ K$

$y_1 = ?$, $P = ?$

→ Using Antoine's eq^n;

$$\therefore \log_{10} P_1^{sat} = 0.3167$$

$$\therefore \boxed{P_1^{sat} = 2.073\ bar}$$ — 2.5

$$\therefore \log_{10} P_2^{sat} = -0.130$$

$$\therefore \boxed{P_2^{sat} = 0.741\ bar}$$ — 2.5

→ Using Raoult's law;

$$y_i P = x_i P_i^{sat}$$

$\therefore \quad P = x_1 P_1^{sat} + x_2 P_2^{sat}$

$$\boxed{P = 1.18 \text{ bar}} \quad - 2.5$$

→ To find y_1;

$$y_1 (1.18) = (0.33)(2.073) \qquad [y_1 P = x_1 P_1^{sat}]$$

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$$\therefore \boxed{y_1 = 0.579} \quad - 2.5$$

3 Given;

$$\underline{G}^E = x_1 x_2 [A + B(x_1 - x_2)]$$

→ $\gamma_1, \gamma_2 = ?$

$$\rightarrow \quad G^E = \frac{N_1 N_2}{(N_1 + N_2)} \left[A + B\left(\frac{N_1}{N_1 + N_2} - \frac{N_2}{N_1 + N_2} \right) \right]$$

→ Using;

$$\ln \gamma_1 = \frac{1}{RT} \left(\frac{\partial \underline{G}^E}{\partial N_1} \right)_{T,P,N_2} \quad - 2$$

$$\therefore \left(\frac{\partial G^E}{\partial N_1} \right)_{T,P,N_2} = \left(\frac{N_2 (N_1 + N_2) - N_1 N_2}{(N_1 + N_2)^2} \right) \left[A + B\left(\frac{N_1}{N_1 + N_2} - \frac{N_2}{N_1 + N_2} \right) \right] +$$

$$\frac{N_1 N_2}{N_1+N_2}\left[B\left(\frac{(N_1+N_2)-N_1}{(N_1+N_2)^2} - \frac{0-N_2}{(N_1+N_2)^2}\right)\right]$$

$$\therefore \left(\frac{\partial G^E}{\partial N_1}\right)_{T,P,N_2} = \frac{N_2^2}{(N_1+N_2)^2}\left[A+B\left(\frac{N_1-N_2}{N_1+N_2}\right)\right] + \frac{N_1N_2}{N_1+N_2}\left[B\left(\frac{N_2}{(N_1+N_2)^2}+\frac{N_2}{(N_1+N_2)^2}\right)\right]$$

$$= x_2^2\left[A+B(1-2x_2)\right] + (1-x_2)x_2\left[B(2x_2)\right]$$

$$= x_2\left[Ax_2 + Bx_2 - 2Bx_2^2 + 2Bx_2 - 2Bx_2^2\right]$$

$$\cancel{= x_2[(A+3B)x_2}$$

$$\left(\frac{\partial G^E}{\partial N_1}\right)_{T,P,N_2} = x_2\left[(A+3B)x_2 - 4Bx_2^2\right] \leftarrow 2$$

$$\therefore \ln \gamma_1 = \frac{1}{RT}\left\{x_2\left[(A+3B)x_2 - 4Bx_2^2\right]\right\}$$

$$\therefore \boxed{\gamma_1 = \exp\left(\frac{1}{RT}\left\{x_2\left[(A+3B)x_2 - 4Bx_2^2\right]\right\}\right)} \leftarrow 2$$

→ For γ_2;

$$\left(\frac{\partial G^E}{\partial N_2}\right)_{T,P,N_1} = \frac{N_1(N_1+N_2) - N_1N_2}{(N_1+N_2)^2}\left[A+B\left(\frac{N_1}{N_1+N_2} - \frac{N_2}{N_1+N_2}\right)\right]$$

$$+ \frac{N_1N_2}{N_1+N_2}\left[B\left(\frac{(N_1+N_2)(0)-N_1}{(N_1+N_2)^2} - \frac{(N_1+N_2)-N_2}{(N_1+N_2)^2}\right)\right]$$

$$= \frac{N_1^2}{(N_1+N_2)^2}\left[A+B\left(\frac{N_1}{N_1+N_2}-\frac{N_2}{N_1+N_2}\right)\right]+\frac{N_1N_2}{N_1 \cancel{N} + N_2}\left[B\left(\frac{-N_1}{(N_1+N_2)^2}+\frac{-N_1}{(N_1+N_2)^2}\right)\right]$$

$$= x_1^2\left[A+B(2x_1-1)\right]+x_1(1-x_1)\left[B(-2x_1)\right]$$

$$= x_1\left\{Ax_1+2Bx_1^2-Bx_1 - 2x_1B+2Bx_1^2\right\}$$

$$\left(\frac{\partial G^E}{\partial N_2}\right)_{T,P,N_1} = x_1\left\{(A-3B)x_1+4Bx_1^2\right\} \quad - 2$$

$$\therefore \quad \ln \gamma_2 = \frac{x_1}{RT}\left\{(A-3B)x_1+4Bx_1^2\right\}$$

$$\therefore \quad \boxed{\gamma_2 = \exp\left(\frac{1}{RT}\left\{x_1\left[(A-3B)x_1+4Bx_1^2\right]\right\}\right)} \quad - 2$$

1.