Name: **Roll No.:**

NATIONAL INSTITUTE OF TECHNOLOGY CALICUT
DEPARTMENT OF CHEMICAL ENGINEERING

MONSOON SEMESTER 2014
CH3001 CHEMICAL ENGINEERING THERMODYNAMICS II

Time : 1 hour TEST SERIES II
Max marks : 20

1. For Acetaldehyde (1) and water (2), the van Lar equation constants, α and β are 1.59 and 1.80, respectively in the temperature range 19.8-100^{0}C. The activity coefficients γ_1 and γ_2 are given by the following expressions

$$\ln \gamma_1 = \frac{\alpha}{\left[1 + \frac{\alpha}{\beta}\frac{x_1}{x_2}\right]^2}$$

and

$$\ln \gamma_2 = \frac{\beta}{\left[1 + \frac{\alpha}{\beta}\frac{x_2}{x_1}\right]^2}$$

For the above system

(1) Calculate the bubble pressure at 75°C for $x_1 = 0.25$;
(2) Calculate the bubble Temperature for 1.013 bar for x_1=0.5;

$$\log_{10} P_1^{sat} = 3.68639 - \frac{822.894}{T - 69.899} \quad and$$

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$$\log_{10} P_2^{sat} = 4.6543 - \frac{1435.264}{T - 64.848}$$ T in K and P^{sat} is in bar.

(3 + 5)

2. Define *azeotrope*. Draw the typical $T_{x\text{-}y}$ diagrams, for binary mixture exhibiting minimum and maximum boiling azeotrope behaviours, separately. (3)

3. For a given binary system, the activity coefficients are represented by the relation $\ln\gamma_1 = Ax_2^2$ and $\ln\gamma_2 = Ax_1^2$. Show that the system forms an azeotrope when $A > |\ln(P_2^S/P_1^S)|$ and the azeotropic composition is given by

$$x_1 = \frac{1}{2}\left[1 - \frac{1}{A}\ln(P_2^S/P_1^S)\right].$$

(4)

4. For the binary system n pentanol(1) + n-hexane (2), the Wilson equation constants are A_{12} = 1718 Cal/mol, A_{21} = 166.6 cal/mol. Assuming the vapour phase to be an ideal gas determine the composition of the vapou in equilibrium with a liquid containing 20 mol % n-pentanol at 30 °C. Also calculate the equilibrium pressure. P_1^{sat} = 3.23 mm Hg; P_2^{sat} = 187.1 mm Hg.

Data:

Densities are given as : ρ_1 = 0.8144 g/ml (MW = 88 g/mol); ρ_2 = 0.6603 g/ml(MW = 86 g/mol)

$$\ln\gamma_2 = -\ln(x_2 + \Lambda_{21}x_1) - x_1\left(\frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{\Lambda_{21}x_1 + x_2}\right)$$

$$\ln\gamma_1 = -\ln(x_1 + \Lambda_{12}x_2) + x_2\left(\frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{\Lambda_{21}x_1 + x_2}\right)$$

$$\Lambda_{12} = \frac{V_2}{V_1}\exp\left(\frac{-A_{12}}{RT}\right)$$

$$\Lambda_{21} = \frac{V_1}{V_2}\exp\left(\frac{-A_{21}}{RT}\right)$$

(5)