

## INTERNATIONAL CENTRE FOR APPLIED SCIENCES MAHE, MANIPAL B.Sc. (Applied Sciences) in Engg. End – Semester Theory Examinations – Nov./ Dec. 2020 III SEMESTER - CHEMICAL ENGINEERING THERMODYNAMICS-II (ICHM 232) (Branch: Chemical)

Гime: З I	Hours	Date: 23 November 2020	Max. Marks: 50			
✓ A	nswer ALL the	e questions.				
✓ M	<ul> <li>Missing data, if any, may be suitably assumed</li> </ul>					

**1A.** Calculate the fugacity of CO at 400 bar if the following data are applicable at 273 K. (Use compressibility factor method)

<i>P</i> , bar	25	50	100	200	400	800	1000
Ζ	0.9890	0.9792	0.9741	1.0196	1.2482	1.8057	2.0819

- **1B.** It is required to prepare 1 m3 of methanol(1)- water(2) solution at 25°C with  $x_1=0.7779$ . Determine the volume of methanol and water to be mixed at 25°C. Use the partial molar volumes of methanol and water as  $\overline{v_1}=40.487 \times 10^{-6} \text{ m}^3/\text{mol}$  and  $\overline{v_2}=15.686 \times 10^{-6} \text{ m}^3/\text{mol}$ . The density of methanol at 25°C is 786.846 kg/m<sup>3</sup>.
- **2A** The molar volume of a binary solution at constant T and P is given by the relation

 $v = 1000x_2 + 500x_1 + (40x_2 + 50x_1)x_1x_2$ 

where v is in m<sup>3</sup>/mol. Determine  $\overline{v_1}$  and as function of  $x_1$  and find the value of pure component volume and partial molar volume at infinite dilution for component 1.

**2B** Define the terms: Raoult's law, Henry's law, fugacity, activity

**3A.** Discuss the effect of increasing pressure on boiling point diagram. **4** 

**3B.** Check whether the following equations satisfy Gibbs Duhem equation.

 $ln\gamma_{1} = 500 + 140x_{1} - 60x_{1}x_{2} - 20x_{2}^{2} + 20x_{1}x_{2}^{2}$   $ln\gamma_{2} = -120x_{2} - 90x_{1}x_{2} - 20x_{2}^{2} + 20x_{1}x_{2}^{2}$  (Note: The final answer on both sides of the Gibbs Duhem equation should be in terms of x<sub>1</sub>.) **06** 

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**4A.** For the system n-pentane (1)- n-heptane (2), the vapour pressures are given by the Antoine equation

 $\ln P = A - \frac{B}{T - C}$ 

where P is in kPa and T is in K. The constants are as follows

System	А	В	С
n-pentane	13.8183	2477.07	40.00
n-heptane	13.8587	2911.32	56.56

Assuming that the solution formed is ideal, calculate the composition of the liquid and vapour phase at 95kPa and 336.2 K.

- **4B.** Methanol(1)- acetone(2) forms an azeotrope at 760 Torr with  $x_1=0.2$  and t=55.7°C. The vapour pressures at 55.7°C are  $P_1^S=530.97$  Torr and  $P_2^S=749.65$  Torr. Predict the P-x-y data (any two sets of data) at 55.7°C. Assume that van Laar equation is applicable to the system.
- **5A.** The gases from the pyrites burner of a contact sulphuric acid plant have the following composition:  $SO_2 = 7.80\%$ ,  $O_2 = 10.80\%$  and  $N_2 = 81.40\%$ . This is then passed into a converter where the  $SO_2$  is converted to  $SO_3$ . The temperature and pressure in the converter are 775 K and 1 bar. The equilibrium constant for the reaction

$$SO_2 + \frac{1}{2}O_2 \rightarrow SO_3$$

may be taken as K = 85. Calculate the equilibrium conversion.

- **5B.** Distinguish between bubble point and dew point.
- **5C.** Discuss LeChatelier's principle and how it is applicable to exothermic and endothermic reactions.

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