GUJARAT TECHNOLOGICAL UNIVERSITY M. E. - SEMESTER – II • EXAMINATION – SUMMER • 2013

Subject code: 1721604Date: 03-06-2013Subject Name: Property Prediction for Mixtures - CAD GroupTime: 10.30 am - 01.00 pmTotal Marks: 70Instructions:

Instructions:

- 1. Attempt all questions.
- 2. Make suitable assumptions wherever necessary.
- 3. Figures to the right indicate full marks.
- Q.1 Explain the concept of õPartial Molal Quantitiesö. Under different sets of 14 conditions, elaborate the evaluation of õPartial Molal Enthalpies for binary mixtureö by Graphical Technique.
- Q.2 (a) Starting from first principles, derive the following relationship for properties C_P 07 and C_V :

$$C_{P} \circ C_{V} = \circ T \left(\frac{\delta V}{\delta T} \right)_{P}^{2} \cdot \left(\frac{\delta p}{\delta v} \right)_{T}$$

(b) Derive the following relationships for properties C_P and C_V : 07

(i)
$$d\mathbf{S} = \frac{\mathbf{C}_{\mathrm{V}}}{\mathrm{T}} \cdot \frac{\partial \mathrm{T}}{\partial \mathrm{P}} \Big|_{\mathrm{V}} d\mathbf{P} + \frac{\mathbf{C}_{\mathrm{P}}}{\mathrm{T}} \cdot \frac{\partial \mathrm{T}}{\partial \mathrm{V}} \Big|_{\mathrm{P}} \cdot d\mathbf{V}$$

(ii)
$$dH = C_{P} \cdot dT + \left[V - T\frac{\partial V}{\partial T}\right]_{P} dP$$

OR

(b) Derive the following relationship for ratio of properties Cp and Cv:

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$$\frac{C_{P}}{C_{V}} = \frac{\frac{\partial P}{\partial V}}{\frac{\partial P}{\partial V}}_{T}$$

- Q.3 (a) Outline the Concept of õHypothetical Ideal Gas Stateö and derive relevant 07 generalized equation for ΔH_{TP}^{1} under reduced state conditions.
 - (b) Outline stepwise procedure in detail with relevant equations for calculations of H and G at any temperature (T) and any pressure (P) under ideal gas conditions.

OR

- Q.3 (a) Outline the Concept of õHypothetical Ideal Gas Stateö and derive relevant 07 generalized equation for ΔS_{TP}^1 under reduced state conditions.
 - (b) Outline stepwise procedure in detail with relevant equations for calculations of S and U at any temperature (T) and any pressure (P) under ideal gas conditions.
- Q.4 (a) Using concept of Hypothetically Ideal Component (Carlson and Coulburn 07 Method) how constants of Van Laarøs Equations could be determined conveniently?
 - (b) Calculate the degree of vaporization of a ternary system containing molar 10% 07 propane, 65%, n-butane and 25% n-pentane at t=5°c and P=600 mmHg. The value of equilibrium constants for phase equilibrium are K₁=6.34, K₂=1.37 and K₃=0.32 respectively. Show that the degree of vaporization (e) is 0.665.



Q.4 (a) A wild gasoline contains 15% CH₄, 10% C₂H₆, 30% C₃H₈, 5% i-C₄H₁₀, 07 10% C₄H₁₀, 15% C₅H₁₂ and 15% C₆H₁₂⁺(heavier) as feed. Vaporization is carried out at 232 psia (15.78 atm) and 50 °C. What is the composition of residue gasoline and that of the gas that is vaporized ? Also show that $\left(\frac{V}{L}\right)$

ratio of 0.429 is the suitable ratio.

Use following data of vapour pressures at 50 °C for different components: Component C_3H_8 , $C_6H_{14}^+$ CH_4 , C_2H_6 , $i-C_4H_{10}$, C_4H_{10} , C_5H_{12} , 56, V.P. (psia) 4100, 750, 194, 78, 19, 04

(b) Derive the following relationship for multi-component mixture:

$$\mathbf{F}_{i} \cdot \mathbf{P} = \mathbf{L}_{i} \left[\mathbf{P} + \mathbf{P}_{i} \left(\frac{\mathbf{V}}{\mathbf{L}} \right) \right]$$

All symbols used have conventional meanings.

Q.5 Critically evaluate any two of the following.

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- (i) Use of Maxwelløs Relations in Property Predictions.
- (ii) Estimation of low pressure gas viscosity.
- (iii) Outline various methods to evaluate fugacity of mixtures.
- (iv) Effect of high pressure on liquid viscosity.
