Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – II • EXAMINATION – SUMMER • 2014

Subject code: 1721604 **Date: 20-06-2014**

Subject Name: Property Prediction for Mixtures

Time: 02:30 pm - 05:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full mark.**

Q.1 **(a)** Starting with following two equations: **14**

$$T \cdot dS = Cp \cdot dT - T\left.\frac{\delta V}{\delta T}\right)_P dP \text{ and } T \cdot dS = Cv \cdot dT + T\left.\frac{\delta P}{\delta T}\right)_V dV$$

Prove the following equations:

$$Cp \text{ ï } Cv = \text{ï } T\left(\frac{\delta V}{\delta T}\right)_P^2 \cdot \left(\frac{\delta P}{\delta V}\right)_T \quad \text{and} \quad \frac{Cp}{Cv} = \frac{\left.\frac{\delta P}{\delta V}\right)_S}{\left.\frac{\delta P}{\delta V}\right)_T}$$

Q.2 **(a)** Using concept of Hypothetically Ideal Component (Carlson and Coulburn Method), explain in detail how constants of Van Laarôs Equations could be determined conveniently? **05**

(b) Calculate the degree of vaporization of a ternary system containing feed having molar 10% propane, 65% n-butane and 25% n-pentane is flashed in a separator at t=5 ºC and P=600 mm Hg. The values of equilibrium constants for phase equilibria under above mentioned conditions are K_1=6.34 for propane, K_2=1.37 for n-butane and K_3=0.32 for n-pentane. **09**

Derive the equation you may utilize while solving this problem starting from first principles.

OR

(b) A mixture of hydrocarbon having composition 10% methane, 20% ethane, 30% propane, 15% iso-butane, 20% n-butane and 5% pentane is flashed in a separator at t=46 ºC and P=10 atm. The values of K at 46 ºC and 100 atm for different components are as under. **09**

Component:	Methane	Ethane	Propane	iso-Butane	n-Butane	Pentane
K Value:	17	3.1	1.0	0.44	0.32	0.096

Show that the degree vaporization under above mentioned conditions is 50%.
Derive the equation you may utilize while solving this problem starting from the first principles.

Q.3 **(a)** Outline the concept of ñHypothetical Ideal Gas Stateò and derive relevant generalized equation for $\Delta H'_{T,P}$ under reduced state conditions using equation of state PV=ZRT. **07**

(b) Explain in detail calculations of Energy function ï Enthalpy (H) at any temperature (T) and any pressure (P) under ideal conditions. **07**

OR

Q.3 **(a)** Outline the concept of ñHypothetical Ideal Gas Stateò and derive relevant generalized equation for $\Delta S'_{T,P}$ under reduced state conditions using equation of state PV=ZRT. **07**

	(b)	Explain in detail calculations of Energy function ï Entropy (S) at any temperature (T) and any pressure (P) under ideal conditions.	**07**
Q.4	**(a)**	Explain the concept of ñPartial Molal Quantitiesò ï (PMQ). Elaborate the evaluation of ñPartial Molal Enthalpiesò for binary mixture by Graphical Technique.	**07**
		OR	
	(a)	Define Viscosity. Enlist the five methods for prediction of viscosity for solutions and explain any one of the methods in detail.	**07**
Q.4	**(b)**	Explain in detail, prediction of VLE data for binary mixture under non-ideal conditions.	**07**
		OR	
	(b)	Explain the term-Thermal conductivity. Enlist the various methods for prediction of thermal conductivity of pure liquids and explain any one of the methods in detail.	**07**
Q.5		Critically evaluate any **Four** of the followings:	**14**

(i) Estimation of low pressure gas viscosity.

(ii) Use of Maxwellôs Relations in property prediction.

(iii) Derive the following relationship for properties C_P, C_V & S.

$$dS = \frac{C_V}{T} \cdot \left.\frac{\partial T}{\partial P}\right)_V dP + \frac{C_P}{T} \cdot \left.\frac{\partial T}{\partial V}\right)_P \cdot dV$$

(iv) Various methods to evaluate property ï ñfugacityò.

(v) Evaluation of Activity Coefficients for binary mixture.

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