Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI • EXAMINATION – SUMMER 2013

Subject Code: 160405 Date: 30-05-2013

Subject Name: Principles of Process Engineering - III

Time: 10.30 am - 01.00 pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Notations used have their conventional meanings.**

Q.1 **(a)** What is an azeotrope? Explain minimum boiling and maximum boiling azeotropes with suitable examples. **07**

(b) Calculate the vapor and liquid compositions in equilibrium for benzene ï toluene using the vapor pressure data from the table given below at 101.32 kPa. **07**

Temperature, ^{o}C	Vapor pressure , mm Hg	
	Benzene	Toluene
80.1	760	-
85	877	345
90	1016	405
95	1168	475
100	1344	557
105	1532	645
110.6	1800	760

Q.2 **(a)** A mixture of 50 % mole n-heptane and 50 % mole n-octane at 30^{0}C is continuously flash distilled at 1 std atmosphere so that 60 mole % of the feed is vaporized. What will be the composition of the vapor and liquid products? **07**

x_A	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
y_A	0.247	0.453	0.607	0.717	0.796	0.853	0.898	0.935	0.968

(b) Explain steam distillation with its significance. **07**

OR

(b) Give stepwise procedure to find number of theoretical stages on H-xy diagram. **07**

Q.3 **(a)** A continuous fractionating column is to be designed to separate 30,000 kg/h of a mixture of 40 % of benzene and 60 % toluene into an overhead product containing 97 % benzene and a bottom product containing 98% toluene. These percentages are by weight. A reflux ratio of 3.5 mole to 1 mole of product is to be used. The molal latent heats of benzene and toluene are 7,360 and 7,960 cal/mol, respectively. $\breve{U}_{AB}$ = 2.5. The feed has a boiling point of 95^{o}C at a pressure of 1 atm. Calculate : **10**

(i) The moles of overhead product and bottom product per hour.

(ii) The number of ideal plates and the position of the feed plate if the feed is liquid and at its boiling point.

Data : Molecular Weight of Benzene = 78

Molecular Weight of Toluene = 92

(b) Explain the following terms: **04**

i) Bound moisture
ii) Free moisture
iii) Equilibrium moisture
iv) Critical moisture

OR

Q.3 **(a)** Explain constant rate and falling rate periods in drying. Also describe different methods to find time of drying in filling rate period. **10**

(b) How the numbers of plates are related to reflux ratio? Explain. **04**

Q.4 **(a)** Explain the Meirs theory of super saturation in crystallization briefly. **04**

(b) Define : **10**

i) Dry-bulb temperature
ii) Molal absolute humidity
iii) Relative humidity
iv) Percentage humidity
v) Dew Point
vi) Humidity volume
vii) Humid heat
viii) Adiabatic saturation temperature
ix) Grosvenor humidity
x) Enthalpy of vapor-gas mixture

OR

Q.4 **(a)** Discuss the effect of impurities in crystallization. **04**

(b) Define wet-bulb temperature. Derive the expression for wet-bulb depression using concepts of wet-bulb theory, simultaneous heat and mass transfer and Lewis relation. Also, prove that wet-bulb temperature and adiabatic saturation temperature are same for air-water vapor system. **10**

Q.5 **(a)** With special reference to applications of humidification operations, explain various types of cooling towers used in process industries. **08**

(b) Write a note on ñNature of adsorbentsò along with some examples of industrial adsorbents. **06**

OR

Q.5 **(a)** A coloured impurity in an aqueous solution is to be removed by adsorption on a decolourizing carbon. It is desired to reduce the colour to 10% of its original value 9.6. Estimate the quantity of fresh carbon required per ton of solution for two stage counter-current operation. The system obeys Freundlich equilibrium isotherm: $Y^* = 8.91 \times 10^{-5} X^{1.66}$ **08**

where Y^* Ÿ equilibrium colour, units/kg solution,

XŸ Adsorbate concentrations, unit/kg carbon

Equation for intermediate concentration Y_1 for specified terminal concentrations Y_0 and Y_2 is given by $\left(\frac{Y_0}{Y_2}-1\right)=\left(\frac{Y_1}{Y_2}\right)^{\frac{1}{n}}\left(\frac{Y_1}{Y_2}-1\right)$

(b) Write a short note on Mechanism, Equilibria and rate of Ion exchange. **06**

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