Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI • EXAMINATION – SUMMER • 2014

Subject Code: 160405 **Date: 26-05-2014**

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)** Define adiabatic saturation temperature for humidification operation and derive the equation of "Adiabatic saturation curve" on the psychometric chart and state its usefulness. **07**

(b) With special reference to "adsorption wave", explain steady state fixed bed adsorber in detail with neat sketches. **07**

Q.2 **(a)** Explain following terms of humidification: **07**

i) Dry –bulb temperature and Dew point ii) Absolute humidities

iii) Percentage and Relative humidity iv) Wet–bulb temperature

(b) A coloured impurity in an aqueous solution is to be removed by adsorption on a decolorizing carbon. It is desired to reduce the colour to 10% of its original value 9.6. Estimate the minimum total quantity of fresh carbon required per ton of solution for two stages cross current operation. The system obeys Freundlich equilibrium isotherm : $Y^* = 8.91\text{x}10^{-5}\ X^{1.66}$ **07**

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

X is adsorbate concentrations, units/kg carbon

Equations for intermediate concentration Y_1 giving minimum total adsorbent for specified terminal concentrations Y_0 and Y_2 is given by

$$\left(\frac{Y_1}{Y_2}\right)^{1/n} - \frac{1}{n}\frac{Y_0}{Y_1} = 1 - \frac{1}{n}$$

OR

(b) Define adsorption, adsorbate, adsorbent and ion exchange. State industrial examples of gaseous and liquid separations using adsorption and ion exchange. Also, explain types of adsorptions. **07**

Q.3 **(a)** Explain differential distillation with a neat figure and derive Rayleigh's equation. **07**

(b) Explain positive deviations from ideality and minimum boiling mixture azeotropes with neat sketches. **07**

OR

Q.3 **(a)** The Benzene – Toluene feed is being distilled in a fractionating tower at 101.3 kPa pressure. The feed of 100 kmol/hr is containing 45 mol % Benzene and 55 mol % Toluene. It gives distillate of composition $x_D = 0.95$ and bottoms, $x_W = 0.1$. Calculate minimum reflux ratio and minimum number of theoretical plates at total reflux when the slope of q line is 6.12. **10**

x	1	0.780	0.581	0.411	0.258	0.130	0
y	1	0.9	0.777	0.632	0.456	0.261	0

(b) Explain: 1) Relative volatility 2) Importance of reflux for distillation operation **04**

Q.4 **(a)** Explain nucleation and crystal growth in crystallization in detail. **07**

(b) A mixture of 100 moles containing 50 mol% n-pentane and 50 mol% n-heptane is distilled under differential conditions at 101.3 kPa until 40 % is distilled. What is the average composition of the vapour distilled over and the composition of the liquid left? The equilibrium data are as follows, where x and y are mole fraction of n-pentane. **07**

X	1	0.867	0.597	0.398	0.254	0.145	0.059	0
y	1	0.984	0.925	0.836	0.701	0.521	0.271	0

OR

Q.4 **(a)** Explain Extractive Distillation with neat diagram in detail **07**

(b) Explain Swenson Walker crystallizer with neat sketch. **07**

Q.5 Classify dryers used in industry. Explain construction, working, advantages, disadvantages and applications of Tray Dryer with neat sketch in detail. **14**

OR

Q.5 Explain construction, working, advantages and disadvantages of Spray Dryer in detail. **14**