Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV • EXAMINATION – SUMMER • 2014

Subject Code: 143502 **Date: 20-06-2014**

Subject Name: Chemical Engineering Operations

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.**

Q.1 **(a)**

i. Define absolute humidity. **07**

ii. In _____ filtration, the rate of filtration decreases with time (a) Constant pressure (b) Constant rate (c) Constant temperature (d) None of above

iii. State Freundlich equation.

iv. Adsorption is an exothermic process. (True/False?)

v. Classify membrane processes based on pore size.

vi. Forward feeding method has less operating cost than backward feeding method in multiple effect evaporators. Justify.

vii. Define economy of an evaporator.

(b) What is flash distillation? Derive an equation of operating line for binary mixture. **07**

Q.2 **(a)** 1000 kmol/h of ethanol-propanol mixture containing 60 mole percent of ethanol is to be separated in a continuous plate column operating at 101.3 kPa of total pressure. It is required to obtain 90 mole percent of ethanol in distillate and the bottoms contains 7 mole percent of ethanol. **07**

The feed is saturated vapor and total condenser is used. When the reflux flow rate is four times the amount of top product, find the number of theoretical plates required for the operation.

Consider the relative volatility of ethanol-propanol system equal to 2.1.

(b) Explain with the neat sketch, the principle and working of spray dryer. **07**

OR

(b) Discuss the construction and operation of ball mill. **07**

Q.3 **(a)** Slabs of paper pulp of dimension 1 m x 1.2 m x 0.01 m are to be dried under constant drying conditions from 71 % to 25 % moisture content. The value of equilibrium moisture content for this material is 0.5 %. If the critical moisture content is 60 % and the rate of drying at the critical point is 1.75 $kg \cdot m^{-2} \cdot h^{-1}$, calculate the drying time. The dry weight of each slab is 3.15 kg. All moisture contents are on weight basis. The falling rate may be assumed to be linear. **07**

(b) Why solution must be supersaturated in crystallization operation? What are the methods to supersaturate a solution? Discuss. **07**

OR

Q.3 **(a)** For a sample of solid mixture following results are reported. Represent average particle size of the mixture with volume-surface mean diameter, mass mean diameter and volume mean diameter. **07**

Screen opening, D_{pi} (mm)	4.5	3.4	1.15	0.82	0.40	0.20	0.10	0.05	Pan
Mass fraction retained, *xi*	0	0.21	0.27	0.04	0.12	0.2	0.10	0.02	0.04

(b) Describe construction and working of plate and frame filter press. **07**

Q.4 **(a)** State basic principles and mechanism of microfiltration. Also discuss microfiltration membranes. **07**

(b) Explain principles of liquid-liquid extraction process. State its industrial applications. **07**

OR

Q.4 **(a)** What is the difference between evaporation, drying and dehumidification operations? Which factors affect evaporation operations? **07**

(b) In a gas absorption operation, 98 % of CO_2 is recovered from a gas mixture which originally contains 10 % CO_2 and 90 % air. The solvent used in this operation is pure water. Consider $Y = 14\ X$, where $Y = kg\ CO_2 / kg\ dry\ air$ and $X = kg\ CO_2 / kg\ water$. Calculate minimum liquid to gas rate. If the water to gas rate is kept 30 % more than the minimum value, calculate the outlet compositions of water. **07**

Q.5 **(a)** Discuss the criteria for choice of solvent for liquid-liquid extraction. **07**

(b) Draw a neat sketch of a plate column for absorption operation and write its construction and functioning. **07**

OR

Q.5 **(a)** Calculate the yield of $MgSO_4{\cdot}7H_2O$ crystals when 1000 kg of saturated solution of $MgSO_4$ at 80 °C is cooled to 30 °C assuming 10 % of the water is lost by evaporation during cooling. Take solubility of $MgSO_4$ at 80 °C = 64.2 kg/100 kg water and at 30 °C = 40.8 kg/100 kg water. **07**

Consider atomic weight of Mg = 24, S = 32, O = 16 and H = 1.

(b) Define adsorption. Differentiate between physical adsorption and chemisorption. **07**

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