

(3 Hours)

Total Marks: 80

N.B.: 1. Question No.1.iscompulsory.

2. Attempt any **three** questions out of the remaining **five** questions.3. Assume **suitable** data wherever **required**.4. **Figures** to the **right** indicates **full** marks.

1. (a) Explain steam distillation and write its application [5]

(b) Mention common adsorbents and write their application. [5]

(c) Explain solubility curve for crystallisation. [5]

(d) Discuss the selection criteria for solvents in liquid-liquid extraction process [5]

2. a. Explain differential distillation with neat diagram and derive Rayleigh equation [08]

b. An ethanol-water mixture containing 36% by weight of ethanol is differentially distilled at 1 atm. pressure and the mixture is reduced to a maximum ethanol concentration of 6 mole%. Determine the composition of the distillate. Molecular weight of ethanol = 46

The VLE data are :

Mole fraction of Ethanol in liquid (x)	0.18	0.16	0.14	0.12	0.10	0.08	0.06
Mole fraction of Ethanol in vapour (y)	0.517	0.502	0.485	0.464	0.438	0.405	0.353

[12]

3. a. Derive the operating line equation for multistage counter current extraction for immiscible solvents. Show the construction of number of stages required for any specific extraction process. [12]

b. A solution containing 5% acetaldehyde and 95% toluene is to be extracted with water in a five stage crosscurrent extraction unit to extract acetaldehyde. Toluene and water are essentially insoluble. If 25 kg of water each time are used per 100 kg of feed. Calculate the amount of acetaldehyde extracted and the final concentration of the exit solution. The equilibrium relationship is given by

$$Y = 2.20 X, \text{ where } Y = \text{kg acetaldehyde/kg water and } X = \text{kg acetaldehyde/kg toluene} \quad [08]$$

4. a. Discuss the adsorption in fixed beds. Explain break through curve and adsorption zone [10]

b. 500 kg/min of dry air at 20 °C and carrying 5 kg of water vapour/min is to be dehumidified with silica gel to 0.001 kg of water vapour/ kg of dry air. The operation has to be carried out isothermally and counter currently with 25 kg/min of dry silica gel. How many theoretical stages are required and what will be the water content in the silica gel leaving the last stage?

kg of water vapour/ kg of dry silica gel, X	0	0.05	0.10	0.15	0.20
kg of water vapour/ kg of dry air. Y	0	0.0018	0.0036	0.0050	0.0062

[10]

5 a. A hot solution containing 5000 kg of  $\text{Na}_2\text{CO}_3$  and water with a concentration of 25% by weight  $\text{Na}_2\text{CO}_3$  is cooled to 293 K (20 °C) and crystals of  $\text{Na}_2\text{CO}_3 \cdot 10 \text{H}_2\text{O}$  are precipitated. At 293 K, the solubility is 21.5 kg anhydrous  $\text{Na}_2\text{CO}_3$  per 100 kg of water. Calculate the yield of  $\text{Na}_2\text{CO}_3$  crystals obtained if 5% of the original water in the system evaporates on cooling. Atomic weight: Na =23, C = 12, O = 16, H = 1. [12]

b. Explain the working and application of Oslo cooling crystalliser with neat diagram. [8]

6 Write short notes on (any four) [20]

- Binodal curve
- Micro, Nano and Ultra filtration
- Extractive distillation
- Freundlich adsorption isotherm.
- Methods to achieve supersaturation
- Factors affecting leaching process.