B.Tech. Seventh Semester (Chemical Engineering) (CGS)

11657 : Chemical Engineering Operations - III (Mass Transfer - II)

7 CH 01

P. Pages : 3 **AU - 2932**

Time : Three Hours Max. Marks : 80

Notes :
1. Answer **Three** question from Section A and **Three** question from Section B.
2. Due credit will be given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.
4. Diagrams and chemical equations should be given wherever necessary.
5. Illustrate your answer necessary with the help of neat sketches.
6. Discuss the reaction, mechanism wherever necessary.
7. Use of pen Blue/Black ink/refill only for writing book.

SECTION – A

1. a) When would you prefer liquid-liquid extraction instead of distillation? State any two industrial examples. **7**

b) Explain how does the term relative volatility (α) of distillation is analogous to selectivity (β) in case of liquid-liquid extraction operation? State its significance in respective operation. **6**

OR

2. a) Describe multistage cross current extraction operation with the help of schematic diagram. Derive the expression used for determination of quantity extracted up to N^{th} stage. Show the graphical representation of location of tie lines on triangular coordinates corresponds to X-Y diagram. **7**

b) Discuss the steps involved in a typical liquid-liquid extraction operation utilising differences in solubilities of the components of a liquid mixture. **6**

3. a) Describe a system of three liquids-one pair partially miscible, consider a system A (water). C (acetone) and B (Methyl-isobutyl ketone, MIK) at 25°C with the help of equilateral triangular diagram and distribution curve. **8**

b) Define the terms distribution coefficient and distribution constant in dilute solutions at equilibrium. **6**

OR

4. One Thousand kilograms of an aqueous solution containing 35% mass trimethylamine (TMA) and 65% water is to be extracted using benzene as the solvent. A three stage cross current extraction scheme is suggested. The amounts of (98% benzene, 2% TMA) to be used in successive stages are 815kg, 950kg and 2625kg. Determine the fraction of solute removed if the stages are ideal. The compositions of the raffinate and the extract phases as well as the tie line data are given below. [Water-A, Benzene-B and TMA-C]. **14**

Water rich phase [Raffinate].

X_B	0.004	0.006	0.01	0.02	0.03	0.036	0.07	0.13
X_C	0.05	0.10	0.15	0.20	0.35	0.30	0.035	0.40

Benzene rich phase [Extract].

Y_B	0.95	0.90	0.84	0.78	0.71	0.63	0.50	0.26
Y_C	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40

Tie line data.

X_C	0.04	0.083	0.13	0.215	0.395
Y_C	0.035	0.068	0.09	0.145	0.31

5. a) Explain (leaching) Solid-liquid extraction process. What are the various operations involved in leaching process?

   b) Describe graphical representation of equilibrium conditions in leaching with the help of equilibrium diagram.

OR

6. a) Describe multistage counter current leaching process with the help of schematic diagram considering material balance of solution over the first three stages.

   b) Discuss working and construction of Rotocel extractor with the help of schematic diagram.

SECTION – B

7. a) Explain Flash or Equilibrium distillation with the help of schematic diagram. Derive operating line equation or design equation of Flash distillation and show it on equilibrium diagram. 7

   b) 100 moles of benzene and toluene containing 50 mole % benzene is subjected to a differential distillation method at atmospheric pressure till the composition of benzene in the residue is 33% by mole. Calculate the total moles of mixture distilled. 7
   Take relative volatility $\alpha = 2.4$.
   Generate the equilibrium data (x-y data)
   Between x = 0.3 to x = 0.6.

OR

8. a) Describe continuous fractionation process with the help of schematic diagram. Derive operating line equations for rectifying section and stripping section using material balance equations in presence of reflux. 7

   b) Discuss vapour-liquid equilibrium at atmospheric pressure with the help of temperature composition diagram and (x – y), equilibrium diagram. 7

9. How would you calculate number of theoretical plates required and position of feed plate using Lewis-Sorel method? State stepwise graphical procedure with the help of equilibrium (x – y) diagram in detail. **13**

OR

10. What is total reflux, minimum reflux and optimum reflux ratio? Describe with the help of equilibrium (x - y) diagram. **13**

11. a) What is azeotrope and azeotropic distillation? State & draw the graphical representation of minimum boiling and maximum boiling azeotropes using temp. v/s liquid phase composition (x) and vapour phase composition (y) and also on equilibrium (ie x – y) diagram. **9**

b) Discuss extractive distillation operation. **4**

OR

12. a) What are various plates used for contacting liquid & Vapor phases in plate type columns? Explain bubble cap plate with the help of diagram. **7**

b) Discuss construction and working of packed column used for distillation operation with the help of neat diagram. **6**

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