21415

3 Hours / 100 Marks   Seat No.

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. a) **Attempt any THREE of the following:**   12

(i) State Fick's law for diffusion. Give its mathematical statement.

(ii) State the significance of Boiling Point Diagram. Explain the effect of total pressure on Boiling Point Diagram.

(iii) State the selection criteria for selecting a solvent in liquid-liquid extraction (Four points).

(iv) State the factors on which rate of drying depends (Four points).

b) **Attempt any ONE of the following:**   6

(i) With a neat diagram describe the process of flash distillation.

(ii) Explain the construction and working of Osloo cooler crystallizer with a neat diagram.

Marks

2. **Attempt any FOUR of the following:** **16**

a) State Mier's super saturation theory.

b) Define :

    (i) Bound Moisture

    (ii) Free Moisture

    (iii) Critical Moisture

    (iv) Humidity

c) Derive the equation for calculating the molar flux for diffusion of a gas 'A' through stagnant gas 'B'.

d) Explain the process of rectification on as ideal plate.

e) State any two situations where liquid-liquid extraction is preferred over distillation. Define selectivity ratio and state its significance.

3. **Attempt any TWO of the following:** **16**

a) Explain the term reflux ratio. What is the effect of reflux ratio on the number of plates in a column. Explain optimum reflux ratio.

b) Derive the equation for the q - line and show the q - line on diagram for all possible types of feed, also mention the value of 'q' for each type of feed to distillation column.

c) 50,000 kg/hr of Benzene-Toluene mixture containing 30% benzene by weight is to be distilled in a continuous distillation column to obtain a top product containing 95% benzene and a bottom product containing 95% toluene. The feed is liquid at its bubble point. Calculate the number of ideal required for this seperation. State the position of the feed plate. The average relative volatality of the mixture is 2.6 and the reflux ratio maintained is 3.5:1.

Marks

4. a) **Attempt any THREE of the following:**   **12**

    (i) State the types of ternary system that may be formed by addition of new solvent in liquid-liquid extraction.

    (ii) With a neat diagram describe the Whitman's two film theory.

    (iii) Describe briefly the triangular diagram in liquid-liquid extraction.

    (iv) Ammonia in Ammonia-air mixture is to be absorbed in an absorption tower;

        The data for tower is

        Air flow rate $= 150$ kg/m^{2}hr

        Liquid phase composition at top of packing $= 0.0000135$ kg NH_3/kg water

        Liquid phase composition at bottom of packing $= 0.0005260$ kg NH_3/kg water

        Gas phase concentration at top of packing $= 0.000568$ kg NH_3/kg air.

        Gas phase concentration at bottom of packing $= 0.000957$ kg NH_3/kg air.

        Assuming liquid concentration to be in equilibrium with gas phase. Calculate mass flow rate of water.

   b) **Attempt any ONE of the following:**   **6**

    (i) Distinguish between absorption and adsorption of gases and state the criteria for selecting the packing in packed column for gas absorption.

    (ii) Derive the equation for calculating the total time required for drying solids from initial moisture content 'X_1' to final moisture content 'X_2' such that $X_2 < X_C < X_1$ where X_C is critical moisture content.

Marks

5. **Attempt any FOUR of the following:** 16

a) Define Azeotrope. How are they separated? Give one example each of a minimum boiling and maximum boiling azeotrope.

b) Differentiate between packed column and plate column used for distillation (Any four points).

c) Define channeling in packed column. State any two methods for avoiding channeling.

d) Explain why reboiler is considered as an ideal plate and condenser is not considered an ideal plate in distillation column.

e) What is HETP? State the factors on which HETP depends.

6. **Attempt any TWO of the following:** 16

a) Solids are to be dried from 67% to 25% moisture under constant drying conditions. The value of equilibrium moisture is 1%. If the critical moisture content is 40% and the rate of drying in constant rate period is 1.5 kg/m²h; calculate the drying time.

b) With help of a neat diagram describe the construction and working of a spray drier. Also mention any two applications of spray drier.

c) Calculate the yield of $MgSO_4.7H_2O$ crystals when 1000 kg saturated solution of $MgSO_4$ at 353 k is cooled to 303 k. assuming 10% of water is lost by evaporation during cooling.

Data :

Solubility of $MgSO_4$ at 353 k $= \dfrac{64.2 \text{ kg}}{100 \text{ kg water}}$

Solubility of $MgSO_4$ at 303 k $= \dfrac{40.8 \text{ kg}}{100 \text{ kg water}}$

Atomic weight : Mg = 24
                        S = 32
                        H = 1
                        O = 16

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