III B.Sc., - Petroleum & Petrochemicals

Semester - V
Paper - V: **Mass Transfer operations**

Unit -1: Absorption (Gas Absorption) -Selection criteria for solvent in Gas absorption - material balances for a packed column – Pressure drop in packed columns Gas Absorption equipment – Tower packing's.
Adsorption: Types of Adsorption - Adsorption equipment.

Unit – 2: Distillation (I):

Concept of distillation – vapour – liquid equilibrium – relative volatility – Boiling point diagram -

Various methods of distillation – differential distillation, Flash distillation, Fractionating column - Analysis of Fractionating columns – calculations of number of theoretical stages by McCabe – Thiele method –

Unit -3: Distillation (II):

Derivation of equation of q-line, effect of feed condition on slope of q-line, calculation-of number of plates and location of feed plate, Importance of reflux ratio-concept of total reflux and minimum reflux ratio-optimum reflux ratio. – Equipment for Gas-liquid operations.

Unit -4: Extraction:

Liquid – liquid extraction – extraction schemes – distribution coefficient – triangular diagram – selection of solvent for extraction – single stage equilibrium extraction – multistage extraction process – Industrial liquid – liquid extraction equipment's.

Unit -5: Crystallization & Drying -

Solubility and solubility curves, saturation and super-saturation – methods of achieving super saturation – The Mier's super saturation theory – mechanism of crystallization process – material and Heat balances in crystallization – classification and construction of crystallization equipment.
Drying: Material and Heat balance equations in Continuous drying operation
- Drying equipment - Tray dryer, rotary dryer & Spray dryer.

Suggested Reading:

1) Introduction to Chemical Engineering by Salil K Ghosal and others Tata Mc. Graw – Hill Publishing Company.
2) Unit operations – I and II by K.A. Gavhane. Nirali Prakashan – Pune,

III B.Sc., - Petroleum & Petrochemicals
MODEL QUESTION PAPER
Paper –V: MASS TRANSFER OPERATIONS

Time: 2 $^1/_2$ Hrs.   Semester - V   Max. Marks 60

Section - I

Answer any three questions from the following
All questions carry equal marks.   3x16=48 Marks

1. a. Define gas absorption. Give suitable examples.
        What factors should be considered while selecting solvent for gas absorption.
        b. Draw a neat sketch of packed column and write its construction and
        functioning.

2. a. What is differential distillation? Derive Rayleigh equation.
        b. Explain briefly McCabe – Thiele method used for obtaining theoretical plates
        required for a given degree of separation.

3. a. Explain the flow through feed plate for various thermal conditions of feed.
        b. Explain the concepts of minimum and optimum Reflux Ratios.

4. a. Define the following terms with respect to extraction.
        i) feed   ii) solvent   iii) raffinate   iv) Extract
        Explain briefly the selection criteria for solvents to be used for liquid – liquid extraction.
        b. with a neat sketch explain briefly the mixer – settler assembly and its
        functioning.

5. a. With a neat sketch explain the construction and working of continuous
        vacuum crystallizer.
        b. Carry out material and energy balance calculations in a continuous drying
        operation.

Section II
Write short notes on ANY FOUR of the following   4 x 3 = 12 Marks
6. Adsorption equipment.
7. Boiling Point Diagram.
8. Optimum Reflux Ratio.
9. Triangular Diagram.
10. Rotary Dryer.

Note to paper setter:
In Section I one essay question is to be set from each of the Five (5) units.
Similarly in Section II one short answer question is to be set from each of the Five (5)
units.

Essay Questions: 16 M

UNIT –I:

1. a. Define gas absorption. Give suitable examples.
      What factors should be considered while selecting solvent for gas absorption
   b. Explain about the material balances for packed columns

2. a. Draw a neat sketch of packed column and write its construction and
      functioning.
   b. Write about the pressure drop in packed columns.

3. a. State and derive Longmuir's adsorption isotherm
   b. Explain in detail about adsorption equipment

UNIT –II:

1. a. What is differential distillation? Derive Rayleigh equation
   b. Describe the details of constructing boiling point diagrams

2. a. Explain about the Flash distillation and derive the expression for operating
      material balance of flash distillation.
   b. Explain in detail about the method of carrying out analysis of fractionating
      columns.
3. a. Explain briefly McCabe – Thiele method used for obtaining theoretical
      plates required for a given degree of separation.
   b. With a neat diagram describe the design and functioning of a fractionating
      column.

UNIT –III:

1. a. Explain the flow through feed plate for various thermal conditions of feed.
   b. What is q – factor? Derive the expression for q – factor and write about the
      effect of feed conditions on feed line.
2. a. Explain the method of calculating the total number of plates and
      location of feed plate in a fractionating column.
   b. Explain the concepts of minimum and total Reflux Ratios.

3. a. Write in detail about the equipment for Gas – liquid Operations
   b. Write a detailed note on the design of plate columns used to carry out
      fractionation

UNIT –IV:

1. a. Explain the principles of Liquid – liquid extractions and   Explain briefly the selection criteria for solvents to be used for liquid – liquid extraction
   b. Explain about single stage equilibrium extraction

2. a. Explain about the extraction schemes used in Liquid – liquid extraction.
   b. Write about multi stage extraction process

3. a. With a neat sketch explains briefly the mixer – settler assembly and its functioning.
   b. With a neat sketch explain briefly about pulse column extraction technique

UNIT –V:

1. a. Define solubility and write in detail about solubility curves
   b. Write in detail about the Miers super saturation theory

2. a. Explain in detail about the mechanism of crystallization
   b. Carry out the material balance calculations for crystallization process.

3. a. With a neat sketch explain the construction and working of continuous vacuum crystallizer.
   b. With a neat sketch explain the construction and working of agitated tank crystallizer.

4. a. Carry out material and heat balance calculations in a continuous drying operation.
   b. With the help of a neat diagram describe the design and working of rotary dryer.

Short answer questions: 03 M

UNIT - I:
1. Write about types of adsorption
2. Explain about Freundlisch adsorption isotherm
3. What factors should be considered while selecting solvent for gas absorption
4. What is gas absorption? Give example
5.

UNIT - II:
1. Explain briefly the concept of Distillation
2. Write a short note on Vapour – Liquid equilibria
3. Write a short note on relative volality
4. Explain briefly about differential distillation
5. Explain briefly about Flash distillation

UNIT - III:
1. Explain the terms Reflux and Reflux ratios
2. Write about Optimum reflex ratio
3. Write about q – line
4. Explain the effect of feed condition on slope of q – line.

UNIT - IV:
1. Write about triangular diagrams.
2. Explain about the classification of industrial extraction equipment
3. Write about distribution coefficient
4. Explain briefly about Solvent extraction.

UNIT - V:
1. Explain the terms saturation and super saturation
2. Write briefly about the methods of super saturation
3. Write a note on classification of crystallization equipment
4. Write a short note on drying process
5. Write about the classification of industrial dryers

IMPORTANT NOTE TO PAPER SETTER:
In section - I, one essay question is to be set from each of the five units. Similarly in
Section - II, one short answer question is to be set from each of the five units.
Questions should be given from QUESTION BANK.