

GUJARAT TECHNOLOGICAL UNIVERSITY

BE-5 SEMESTER – OLD PAPER – W22 TO S25 – QUESTION BANK

Subject Name & Code:

Mass Transfer Operations I- 3150501

Chapter 1: Introduction to Mass Transfer Operations

Repeated Questions:

- **Classify mass transfer operations with examples.**
 - (WINTER 2022 - Q1(a) - 03 Marks)
- **Discuss the choice of separation methods.**
 - (SUMMER 2022 - Q1(c) - 07 Marks)

Other Important Questions:

- Explain design principles of mass transfer equipment.
 - (SUMMER 2024 - Q1(a) - 03 Marks)
- Discuss in detail classification of mass transfer operations and explain with examples.
 - (WINTER 2023 - Q2(c) - 07 Marks)

Chapter 2: Molecular Diffusion in Fluids

Repeated Questions:

- **State and explain Fick's law of diffusion.**
 - (SUMMER 2023 - Q2(a) - 03 Marks)
 - (SUMMER 2022 - Q1(a) - 03 Marks)
 - (SUMMER 2025 - Q1(a) - 03 Marks)
- **Differentiate between N and J flux.**
 - (SUMMER 2022 - Q1(a) - Part of 03 Marks)
 - (SUMMER 2024 - Q2(b) - 04 Marks)
 - (SUMMER 2025 - Q1(b) - 04 Marks)
- **Prove that $D_{AB} = D_{BA}$.**
 - (WINTER 2022 - Q1(b) - Part of Q)
 - (SUMMER 2022 - Q1(b) - 04 Marks)
- **Derive the equation for steady-state diffusion of A through non-diffusing B.**
 - (SUMMER 2023 - Q1(b) - 04 Marks)
 - (SUMMER 2022 - Q2(a) - 03 Marks)
 - (SUMMER 2025 - Q1(c) - 07 Marks)
 - (WINTER 2023 - Q2(c) OR - 07 Marks)

Other Important Questions:

- Define molecular diffusion.
 - (SUMMER 2023 - Q1(b) - Part of Q)
- Discuss the effect of temperature and pressure on diffusivity for gases and liquids.
 - (SUMMER 2024 - Q1(b) - Part of Q)

Numerical Problems:

- **Steady-State Diffusion through Stagnant Film:** Ammonia diffusion through a stagnant N_2+H_2 mixture. (SUMMER 2022 - Q2(b))
- **Equimolar Counter Diffusion:** Oxygen-Nitrogen mixture diffusion. (SUMMER 2025 - Q2(c))
- **Evaporation Loss:** Benzene loss from an open tank. (SUMMER 2022 - Q2(c) OR, SUMMER 2025 - Q2(c) OR)
- **Diffusion with Changing Conditions:** Diffusivity calculation with changing T and P. (SUMMER 2024 - Q1(b))
- **Combined Equimolar and Stagnant Diffusion:** Ethanol through water vapor film. (SUMMER 2024 - Q1(c))
- **Flux under different conditions:** CO_2-H_2 system in a tube. (WINTER 2022 - Q1(c))
- **Equimolar Counter Diffusion in a tube:** NH_3 and Air. (WINTER 2023 - Q3(c))

Chapter 3: Mass Transfer Coefficients

Repeated Questions:

- **Explain the Film Theory.**
 - (SUMMER 2023 - Q2(b) - Part of Q on Penetration Theory implies knowledge)
 - (SUMMER 2022 - Q2(c) OR - 07 Marks)
 - (WINTER 2023 - Q1(a) - 03 Marks)
- **Explain the Penetration Theory.**
 - (SUMMER 2023 - Q2(b) - 04 Marks)
- **Explain mass, heat and momentum transfer analogies.**
 - (SUMMER 2023 - Q5(b) - 04 Marks)
 - (WINTER 2023 - Q4(b) OR - 04 Marks)

Other Important Questions:

- State the assumptions of film theory and derive the relation for mass transfer coefficient.
 - (SUMMER 2022 - Q2(c) OR - 07 Marks)
- Discuss F and k type mass transfer coefficients.
 - (SUMMER 2024 - Q3(b) OR - Part of Q)

Numerical Problems:

- **Interrelation of Coefficients:** Finding k_y and k_g in a wetted wall column. (SUMMER 2024 - Q3(a))

Chapter 4: Inter Phase Mass Transfer

Repeated Questions:

- **Derive the relationship between overall and individual mass transfer coefficients (Two-Film Theory).**
 - (SUMMER 2023 - Q1(c) - 07 Marks)
 - (SUMMER 2022 - Q3(a) - 03 Marks)
 - (WINTER 2023 - Q4(c) OR - Part of Q)
- **Discuss local and overall mass transfer coefficients.**
 - (WINTER 2023 - Q4(b) - 04 Marks)

Other Important Questions:

- Explain the principle of interphase mass transfer with a neat sketch.
 - (SUMMER 2025 - Q3(b) OR - 04 Marks)
- Explain controlling mass transfer resistances.
 - (Implied in Two-Film Theory questions)

Numerical Problems:

- **Finding Interface Concentration:** For ammonia-water system. (SUMMER 2023 - Q2(c) OR)

Chapter 5: Gas Absorption

Repeated Questions:

- **Explain the concept of Minimum Liquid to Gas (L/G) ratio. / Give the procedure for determining L_{min}/G .**
 - (SUMMER 2023 - Q3(b) - 04 Marks)
 - (SUMMER 2025 - Q4(b) - 04 Marks)
 - (WINTER 2022 - Q4(a) OR - Part of Q)
- **Define/Explain: Absorption Factor, HETP, NTU.**
 - (WINTER 2022 - Q5(a) - 03 Marks)
 - (SUMMER 2025 - Q5(a) - 03 Marks)
- **Discuss the selection criteria for solvent in absorption.**
 - (SUMMER 2023 - Q3(a) - 03 Marks)
 - (SUMMER 2022 - Q3(b) OR - 04 Marks)
 - (WINTER 2023 - Q3(b) OR - 04 Marks)

Other Important Questions:

- Differentiate between physical and chemical absorption.
 - (WINTER 2022 - Q4(a) - Part of Q)
- Discuss material balance over a counter-current absorber.
 - (SUMMER 2025 - Q4(b) OR - 04 Marks)

Numerical Problems:

- **Packed Tower Design (NTU/HTU):** Absorption of NH_3 , H_2S , SO_2 . (SUMMER 2023 - Q3(c), SUMMER 2025 - Q3(c), SUMMER 2025 - Q3(c) OR, WINTER 2023 - Q5(c))
- **Analytical Calculation of Oil Circulation Rate:** Benzene absorption from coal gas. (SUMMER 2022 - Q3(c) OR)
- **Graphical Determination of Stages:** For NH_3 absorption. (SUMMER 2024 - Q5(c))
- **Minimum Solvent Rate Calculation:** For cyclohexane and pentane absorption. (WINTER 2022 - Q5(c) OR, WINTER 2023 - Q5(c))

Chapter 6: Equipment for Gas-Liquid Operations

Repeated Questions:

- **Compare Packed Tower and Tray Tower.**
 - (SUMMER 2023 - Q4(c) - 07 Marks)
 - (SUMMER 2024 - Q2(c) - Part of Q)
 - (WINTER 2023 - Q1(b) - 04 Marks)
- **Define/Explain: Flooding, Loading, Weeping, Entrainment, Channeling, HETP.**
 - (SUMMER 2023 - Q4(a) - 03 Marks)
 - (SUMMER 2025 - Q2(a) - 03 Marks)
 - (WINTER 2023 - Q2(a) - 03 Marks)
 - (WINTER 2023 - Q3(b) - 04 Marks)
- **Explain the working of a Wetted Wall Column.**
 - (SUMMER 2023 - Q4(b) - 04 Marks)
 - (SUMMER 2024 - Q3(a) - Context of Numerical)

Other Important Questions:

- Explain the working of a Tray Tower and associated problems.
 - (SUMMER 2022 - Q3(c) - 07 Marks)
- Explain the function of: Downspout, Weir, Entrainment Eliminator.
 - (SUMMER 2025 - Q4(a) OR - 03 Marks)
- Discuss Random and Regular packing.
 - (SUMMER 2025 - Q2(b) - 04 Marks)
 - (WINTER 2023 - Q3(a) OR - 03 Marks)
- Explain the working of a Venturi Scrubber / Sparged Vessel.
 - (SUMMER 2025 - Q5(b) - 04 Marks)
 - (WINTER 2022 - Q2(c) OR - Part of Q)
 - (WINTER 2023 - Q4(a) - 03 Marks)
- Discuss bubble cap trays.
 - (SUMMER 2025 - Q5(a) OR - 03 Marks)

Chapter 7: Liquid-Liquid Extraction

Repeated Questions:

- **Explain the Equilateral Triangular Coordinates / system of three liquids (one/two pairs partially soluble).**
 - (SUMMER 2023 - Q4(a) OR - 03 Marks)
 - (SUMMER 2024 - Q4(a) - 03 Marks)
 - (WINTER 2023 - Q3(c) OR - 07 Marks)
- **Define: Tie-line, Binodal curve, Plait point, Solutropy.**
 - (SUMMER 2023 - Q3(a) OR - 03 Marks)
 - (SUMMER 2024 - Q2(a) - 03 Marks)
 - (WINTER 2022 - Q2(a) - 03 Marks)
 - (WINTER 2023 - Q3(c) OR - 07 Marks)
- **Discuss the selection criteria for solvent in extraction.**
 - (SUMMER 2023 - Q3(a) - 03 Marks)
 - (SUMMER 2022 - Q4(c) - 07 Marks)
 - (WINTER 2022 - Q4(b) - Part of Q)
 - (WINTER 2023 - Q4(c) - 07 Marks)
- **Explain the material balance for single-stage extraction.**
 - (WINTER 2023 - Q2(b) - 04 Marks)
 - (SUMMER 2025 - Q4(c) - 07 Marks)

Other Important Questions:

- Deduce the equation for solvent-to-feed ratio for single-stage extraction.
 - (SUMMER 2023 - Q3(b) OR - 04 Marks)
- Explain selectivity and distribution coefficient.
 - (SUMMER 2024 - Q4(a) OR - Part of Q)

Numerical Problems:

- **Counter-Current Multistage Extraction:** Acetic Acid-Water-Isopropyl Ether system. (SUMMER 2023 - Q3(c) OR, SUMMER 2024 - Q3(c) OR, WINTER 2022 - Q3(c), WINTER 2022 - Q3(c) OR)
- **Single-Stage and Multistage Cross-Current Extraction:** Nicotine-Water-Kerosene system. (SUMMER 2022 - Q4(c) OR, SUMMER 2024 - Q3(c))
- **Minimum Solvent Requirement:** For dioxane-water-benzene system. (SUMMER 2023 - Q3(c))

Chapter 8: Leaching

Repeated Questions:

- **Explain various leaching equipments (e.g., Bollman Extractor, Rotocell, Shanks system).**
 - (SUMMER 2022 - Q5(c) - 07 Marks)
 - (SUMMER 2023 - Q4(b) OR - 04 Marks)
 - (SUMMER 2024 - Q4(b) - Part of Q)
 - (SUMMER 2025 - Q5(c) - 07 Marks)
 - (WINTER 2023 - Q4(c) OR - 07 Marks)
- **Explain the preparation of solids for leaching.**
 - (SUMMER 2022 - Q5(b) - 04 Marks)
 - (WINTER 2023 - Q5(a) - 03 Marks)
- **Explain equilibrium diagrams in leaching.**
 - (SUMMER 2022 - Q5(a) - 03 Marks)
 - (WINTER 2022 - Q3(b) - Part of Q)

Other Important Questions:

- What is leaching? Give industrial applications.
 - (SUMMER 2023 - Q5(c) - Part of Q)
 - (WINTER 2023 - Q4(a) OR - 03 Marks)
- Discuss the effect of pre-treatment and agitation on leaching.
 - (WINTER 2022 - Q3(b) OR - Part of Q)
- Explain material balance for single-stage leaching.
 - (WINTER 2023 - Q5(b) - 04 Marks)
- Write a short note on heap leaching.
 - (SUMMER 2022 - Q4(a) OR - 03 Marks)

Chapter 9: Crystallization

Repeated Questions:

- **Define Supersaturation and explain Mier's Supersaturation Theory.**
 - (SUMMER 2023 - Q5(b) - 04 Marks)
 - (WINTER 2022 - Q5(b) - Part of Q)
 - (WINTER 2023 - Q5(b) OR - Part of Q)
- **Explain different crystallizers (e.g., Swenson-Walker, Oslo, Agitated Tank).**
 - (SUMMER 2022 - Q5(b) OR - 04 Marks)
 - (SUMMER 2025 - Q5(b) OR - 04 Marks)
 - (WINTER 2023 - Q5(b) OR - 04 Marks)

Other Important Questions:

- Explain nucleation and crystal growth.
 - (WINTER 2022 - Q5(a) OR - Part of Q)
- Write a brief note on the steps of crystallization.
 - (SUMMER 2024 - Q5(a) - 03 Marks)

Numerical Problems:

- **Crystal Yield Calculation:** $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ and $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ systems. (SUMMER 2023 - Q5(c), SUMMER 2022 - Q5(c) OR, SUMMER 2024 - Q5(b))
- **Weight of Crystals and Mother Liquor:** $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ system. (WINTER 2022 - Q5(b) OR)
