

MASS TRANSFER OPERATIONS-I

Course Code: 22CH1110

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Course Outcomes: At the end of the course the student shall be able to

- CO1** Estimate the diffusivity of a solute through a gas, a liquid and a solid. (L5)
- CO2** Classify different Gas-liquid mass transfer equipment. (L4)
- CO3** Determine the number of plates and height of packing for plate and packed absorbers. (L3)
- CO4** Discuss the working of humidifiers and dehumidifiers. (L2)
- CO5** Explain the mechanisms of batch drying. (L2)

UNIT-I

10 Lectures

INTRODUCTION: Classification of the mass transfer operations, molecular diffusion in fluids, binary solutions, Fick's law, equation of continuity, steady state molecular diffusion in fluids at rest and in laminar flow, Stefan's diffusion, estimation of diffusivity of gases and liquids, application of molecular diffusion, theories of mass transfer, mass transfer coefficients in laminar and turbulent flow, Mass, heat and momentum transfer analogies..

Learning outcomes: After the completion of the Unit I, the student will be able to

1. Classify different types of mass transfer operations (L4)
2. Determine mass transfer rates using Fick's Law (L3)
3. Calculate the diffusivity of gases and liquids (L3)
4. Demonstrate the concept of mass transfer coefficient (L3)
5. Differentiate theories of mass transfer in turbulent flow (L2)

UNIT-II

10 Lectures

INTER PHASE MASS TRANSFER:

Concept of equilibrium, diffusion between phases, material balances in steady state co-current and counter current stage processes.

EQUIPMENT FOR GAS - LIQUID OPERATIONS: Sparged vessels (Bubble columns), mechanically agitated vessels for gas-liquid mixtures, qualitative treatment of tray towers, venturi scrubbers, wetted wall towers, and packed towers. Compare the features of Tray towers and packed towers.

Learning outcomes: After the completion of the Unit II, the student will be able to

- 1.Explain the concept of inter-phase mass transfer. (L2)
- 2.Determine the equations for the operating lines in steady state co-current and counter current stage processes. (L3)
- 3.Identify different types of equipment for gas-liquid operations. (L1)
- 4.Explain different types of Tray Efficiencies (L2)
- 5.Discuss the performance of tray towers and packed towers (L2)

UNIT-III**10 Lectures**

ABSORPTION AND STRIPPING: Absorption equilibrium, ideal and non ideal solutions, selection of a solvent for absorption, one component transferred: material balances. Determination of number of plates (graphical), absorption factors, estimation of number of plates by Kremser Brown equation, continuous contact equipment; HETP, absorption of one component, determination of number of transfer units and height of the continuous absorber, overall coefficients and transfer units, dilute solutions, overall height of transfer units; Absorption with chemical reaction.

Learning outcomes: After the completion of the Unit III, the student will be able to

1. discuss the selection of a solvent for absorption. (L2)
2. determine the number of plates required for a given absorber and a stripper. (L3)
3. determine the number of transfer units and height requirements for a packed column. (L3)

UNIT-IV**10 Lectures**

HUMIDIFICATION OPERATIONS: Vapor gas mixtures, Humidity and relative saturation, dew point, adiabatic, saturation and wet bulb temperatures, psychometric charts, enthalpy of gas vapor mixtures, humidification and dehumidification, operating lines and design of packed humidifiers, dehumidifiers and cooling towers, spray chambers.

Learning outcomes: After the completion of the Unit IV, the student will be able to

1. Explain the concept of humidity and saturation (L2)
2. Solve humidification problems using psychometric charts. (L3)
3. Determine the number of plates and height of packed bed humidifiers, cooling towers and spray chambers (L3)

UNIT-V**10 Lectures**

DRYING: Moisture contents of solids, equilibrium moisture content, bound and unbound moisture, drying conditions – rate of batch drying under constant drying conditions, mechanism of batch drying, drying time, thorough circulation drying, batch and continuous drying equipment, design of continuous counter current dryer.

Learning outcomes: After the completion of the Unit V, the student will be able to

1. Explain various types of moistures in solid. (L2)
2. Calculate the drying time for a wet solid. (L3)
3. Explain the working of Batch and Continuous Drying Equipment. (L2)

Text Books:

1. Treybal R.E., “Mass transfer operations”, 3rd Edition, McGraw Hill, 1980.

References:

1. Binay K Dutta., “Principles of Mass Transfer and Separation Processes” Kindle Edition, PHI, 2011.
2. Cussler E.L., “Diffusion: Mass Transfer in fluid system”, Cambridge University Press, 3rd edition, 2009.
3. Geankoplis C.J., “Transport processes and unit operations”, 4th Edition, PHI, 2006.