MASS TRANSFER OPERATIONS-I

Course Code : 15CH1111

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Course Outcomes:

On successful completion of the course, the student should be able to

CO 1 Classify the mass transfer operations. Estimate diffusivity and rate of transfer of solute in gases, liquids and solids.

CO 2 Discuss the mass transfer across liquid-gas interface, Operate and select the various equipments for gas-liquid operations

CO 3 Select the suitable solvent for absorption; calculate the number of plates and height of continuous absorber.

CO 4 Explain the humidification process. Design the packed humidifiers, dehumidifiers, cooling towers, and spray chambers.

CO 5 Explain the drying operation and various drying equipments. Calculate the time of drying.

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, heat-, and momentum- transfer analogies, mass transfer coefficients in laminar flow (Explanation of equations only and no derivation), Mass transfer coefficients in turbulent flow, correlation's for mass transfer coefficients in simple situations, diffusion in solids

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 single phase liquids and gas-liquid mixtures, Tray towers, sieve tray design for absorption (Qualitative treatment), venturi scrubbers, wetted wall towers, packed towers, Comparison between Tray towers and packed towers.

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.

UNIT-IV (10 Lectures)

HUMIDIFICATION OPERATIONS:

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

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.

TEXT BOOK:

1. Treybal R.E., *"Mass transfer operations"*, 3rd Edition, McGraw Hill, 1980.

REFERENCES:

1. Cussler E. L., *"Diffusion: Mass Transfer in fluid system"*, Cambridge University Press, 2009.
2. Geankoplis C.J., *"Transport processes and unit operations"*, 3rd Edition, PHI, 2002.