



Subject Code: 01CH0501
Subject Name: Mass Transfer Operation-I
B.Tech. Year – III (Semester V)

Objective: The course is intended to introduce the basic fundamentals and supporting theories of Mass Transfer happening in Chemical processes.

Credits Earned: 5 Credits

Course Outcomes: After completion of this course, student will be able to:

1. Demonstrate the basic knowledge of mass transfer operations and separation processes carried out in chemical process industries.
2. Design of various mass transfer equipment's used in the chemical industries.
3. Calculate the driving forces behind the transport of mass from one phase to another.
4. Demonstrate the knowledge of various physico-chemical separation techniques.

Pre-requisite of course: Fluid Mechanics, Heat Transfer, Stoichiometry

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE (E)	CSE	Internal (IA)	Viva (V)	Term Work (TW)	
3	0	2	4	50	20	30	25	25	150

Contents:

UNIT	TOPIC/CONTENT	HOURS
1.	Diffusion Introduction to Mass transfer operation, Concentration, Mass & Molar Avg. Velocity, Mass & Molar Flux, N & J flux, Fick's law of diffusion, Steady state molecular diffusion in fluids under stagnant and laminar flow conditions, steady state diffusion: of A through non-diffusing B, equimolar counter diffusion. Effect of Temperature and Pressure on diffusivity. Diffusion coefficient measurement and prediction.	6
2.	Interphase Mass Transfer & M.T. Coefficients Concept of Equilibrium, Diffusion between two phases, Modes of Convective Mass transfers. Introduction to Mass transfer coefficients, Gas Phase & Liquid Phase M.T. coefficients, Local & Overall M.T. coefficients, Dimensionless Numbers in Mass transfer, Simultaneous Heat & Mass Transfer, Steady state concurrent & counter-current processes.	6
3.	Theories of Mass Transfer Two Film theory, Penetration Theory, Surface Renewal Theory, Boundary Layer Theory, Momentum, Heat & Mass Transfer analogies.	8

4.	Absorption & Equipments for Gas-Liquid Operations Gas Absorption - Equilibrium solubilities of gases. Material balance for transfer of one component. Counter current multistage operations for binary and multi component systems. Continuous contactors, absorption with chemical reaction. Concept of HTU and NTU. Industrial Absorbers. Sparged vessels (bubble columns), mechanically agitated vessels for a single phase and gas liquid contact. Liquid dispersed scrubbers, venturi scrubbers, wetted towers packed towers. Mass transfer coefficients for packed towers concurrent flow of gas and liquid end effect and axial mixing.	8
5.	Crystallization Principles of Crystallization, Super saturation, Nucleation, Crystal growth, Material & Energy Balance applied to Crystallizers, Types of Crystallizers used in practice.	4
6.	Drying Importance of drying in processes, principles of drying, equilibrium and free moisture, bound and unbound water, constant drying conditions, constant-rate period, critical moisture content and falling-rate period, porous solids and flow by capillarity, calculation of drying time under constant drying conditions. Classification of dryers, solids handling in dryers, equipments for batch and continuous drying processes: working principle of tray dryers, tower dryers, rotary dryers, spray dryers. Concept of freeze drying.	6
TOTAL		38

References:
Text books

1. "Mass transfer operation" by R.E.Treybal, Mc-Graw Hill international, 3rd edition.
2. Principles of Mass transfer & Separation Processes, Binary K. Dutta, PHI Publication, 3rd edition.
3. Unit Operations in Chemical Engineering, Warren L. McCabe, Smith, McGraw Hill Publications, 7th edition.

Reference book

1. Coulson & Richardson's Chemical Engineering- Volume 1 & 2, Butterworth Heinemann Publications, 5th edition.

Suggested Theory distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember	Understand	Apply	Analyze	Evaluate	Create
20%	25%	25%	20%	10%	-

List of Experiments:

- 1 To determine the rate of diffusion of vapors of CCl_4 in atmosphere and to calculate the Diffusivity coefficient.
- 2 To study the drying of wet sand in the tray dryer and to calculate the rate of drying for various moisture contents.



- 3 To study the absorption column for CO₂ absorption rate in NaOH solution using packed column.
- 4 To study the batch crystallizer and to perform crystallization operation.
- 5 To determine the M.T. coefficient of liquid benzene evaporation to atmospheric air at elevated temperature
- 6 To study the extraction of oil from oil seeds using soxhlet extraction apparatus
- 7 To determine the extraction of benzoic acid from aqueous solution using liquid-liquid extraction method.

Instructional Method:

- a. The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.
- b. The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.
- c. Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.
- d. Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory

Design Based Problems (DP)/ Open Ended project (OEP):

In the beginning of the session, subject faculty will allot an OEP / DP to the students. Students will be free to choose a topic of their choice which will be relevant to the syllabus and they will either prepare a working model/ report / presentation / poster on their topic.

Online Web Resources:

1. <http://nptel.ac.in/courses/103103029/>