Mass Transfer II - Video course

COURSE OUTLINE

This second course on mass transfer introduces the fundamental concepts, principles and applications of mass transfer processes.

The course covers mass transfer fundamentals such as diffusion, film theory and mass transfer coefficients.

The modeling, design and performance calculation aspects of separation processes using rate-based and equilibrium stage based modeling approaches are then developed.

Separation processes covered in detail include absorption, distillation, extraction, adsorption and drying.

Newer processes such as membrane separations, ion exchange etc are also covered.

For completeness, salient equipment design features are presented.

A number of chosen problems are solved to illustrate the concepts clearly.

COURSE DETAIL

S.No	Topics	No. of Hours
1	**Mass transfer operations in process industries:** 1. Absorption, Distillation, Extraction, Adsorption, Drying; Design and performance of unit. **Operations:** 1. Rate and equilibrium stage based modeling approaches.	2
2	**Fundamentals of mass transfer:** 1. Diffusion, Fick's first law, mass transfer coefficients, film theory/surface renewal theory/boundary layer theory. 2. Cocurrent, counter current and cross-current continuous contact, material balance and operating line.	4
3	**Equilibrium stage modeling:** Co-current cascades, counter-current cascades, cross-current cascades, operating and equilibrium lines, number of equilibrium stages.	2
4	**Absorption:** **Equilibrium approach:**	6

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Chemical Engineering

Pre-requisites:

Mass Transfer I, Process Calculations, Thermodynamics.

Coordinators:

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	Henry's law, Raoult's law, material balance, operating line, minimum liquid flowrates, number of equilibrium stages, deviation from ideal systems (Murphee efficiency). **Rate approach:** Number of transfer units (NTU), height of transfer units (HTU) Packed and staged columns. **Hydrodynamic considerations:** Loading/flooding criterion, pressure-drops.	
5	**Distillation:** 1. Vapor-liquid equilibrium, T-x-y diagram, bubble and dew point calculations. 2. Flash calculations. 3. Ponchon-Savarit and McCabe-Thiele method for equilibrium stage calculations. 4. Minimum and total reflux., optimum design. **Deviation from ideal VLE:** 1. azeoptropic distillation, packed column design, complex distillation columns. 2. Fenske- Underwood-Gilliland shortcut method for multi-component distillation Design.	8
6	**Extraction:** 1. Ternary liquid-liquid equilibrium, triangular coordinates, single-stage extraction. 2. Multi-stage cross-current extraction, continuous countercurrent multistage extraction.	3
7	**Adsorption and ion exchange:** 1. Physical and chemical adsorption, adsorbents, adsorption equilibrium and isotherms. 2. Single-stage, multi-stage cross-current and multi-stage counter current operations,equilibrium and operating lines. 3. Liquid-solid agitated vessel adsorber, packed continuous contactor, breakthrough curves. 4. Rate equations for non-porous and porous adsorbents, nonisothermal operation, pressure-swing adsorption. 5. Principles of ion exchange, analogy between adsorption and ion exchange.	7
8	**Drying:** 1. Equilibrium, insoluble and soluble liquids. 2. Drying rate curve, rate and time of batch drying. 3. Mechanisms of batch drying, continuous drying.	5
	Total	37

References:

1. Mass-Transfer Operations: R. E. Treybal, McGraw-Hill International Editions, 3rd Ed.1981.

2. Principles of Mass Transfer and Separation Processes: B. K. Dutta, Prentice-Hall of India Private Ltd., 2007.

3. Separations in Chemical Engineering: Equilibrium Staged Separations: P. C. Wankat, Prentice Hall, NJ, US, 1988.