MASS TRANSFER I

ENCH 301

Lecture : 3 **Year : III**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objectives:
The objective of this course is to provide concepts of the principles of mass transfer. The course is emphasized on analyzing and comparing different mass transfer theories, evaluating gas-liquid contacting equipment, and applying design principles to separation processes. By the end of the course, students will be able to design separation systems, extend mass transfer concepts to multicomponent mixtures, and solve complex industrial problems.

1 Mass Transfer by Diffusion (9 hours)

1.1 Concept of diffusion; Fick's law; Fick's second law
1.2 Molecular diffusion at steady state through a constant area within a binary fluid mixture: Molecular diffusion in gas; Molecular diffusion in liquids; Diffusivity of gases and liquids
1.3 Diffusion in solids; Types of solid diffusion
1.4 Mass diffusion with homogeneous chemical reactions

2 Mass Transfer by Convection (7 hours)

2.1 Convective mass transfer and mass transfer coefficients; Types of mass transfer coefficient
2.2 Theories of mass transfer: Film theory; Penetration theory; Boundary layer theory
2.3 Inter-phase mass transfer: Equilibrium; Raoult's and Henry's Law; Mass transfer between two phases
2.4 Momentum; Heat and mass transfer analogies; Dimensionless number in mass transfer

3 Gas-Liquid Contacting Equipment (5 hours)

3.1 Tray or plate; Agitated vessel; Bubble column; Packed column; Spray tower
3.2 Flooding in a packed tower; Comparison between packed and tray tower
3.3 Cooling tower: Classification and design

4 Gas Absorption and Stripping (10 hours)

4.1 Equilibrium in a gas-liquid system; Selection of solvent and stripping medium

4.2 Minimum liquid and gas rate for absorption and desorption; Design of an isothermal absorption tower
4.3 Design of a packed tower; Height equivalent to a theoretical plate (HETP)

5 Distillation (10 hours)

5.1 Vapor-liquid equilibrium; Relative volatility; Computation of VLE data
5.2 Deviation from ideality; Enthalpy concentration diagram; Flash distillation
5.3 Batch distillation; Continuous multistage fractionation; McCabe-Thiele method; Ponchon-Savarit method; Comparison between azeotropic and extractive distillation

6 Multicomponent Distillation (4 hours)

6.1 Multicomponent phase equilibria; Degree of freedom in multicomponent distillation; Key components
6.2 Multicomponent flash and batch distillation

Tutorial (15 hours)

1. Calculation of diffusivity of gases and liquids
2. Computation of mass transfer between two phases
3. Design of cooling tower
4. Design of HETP
5. Design of distillation column(Mccabe-Thiele and Ponchon-Savarit methods)
6. Calculation of multicomponent flash and batch distillation

Practical (22.5 hours)

1. Determination of the diffusion coefficient of an organic vapour in air
2. Heat and mass transfer process in cooling tower for different flow and thermodynamic conditions
3. Absorption of gas into a liquid using a packed column
4. Operation of sieve plate distillation column to obtain a desired separation of an alcohol water feed product
5. Determination of the vapour liquid equilibrium curve for any mixture.
6. Mass transfer with and without chemical reaction

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	9	12
2	7	10
3	5	6
4	10	14
5	10	14

6	4	4
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Treybal, R. E. (1981). Mass transfer operations (Latest Edition). McGraw-Hill.
2. Incropera, F. P., DeWitt, D. P., Bergman, T. L., Lavine, A. S. (2007). Incropera's principles of heat and mass transfer (6th ed.). John Wiley & Sons.
3. McCabe, W. L., Smith, J. C., Harriott, P. (2005). Unit operations of chemical engineering (Latest Edition). McGraw-Hill Education (India) Private Limited.
4. Seader, J. D., Henley, E. J., Roper, D. K. (2011). Separation process principles (3rd ed.). John Wiley & Sons.
5. Geankoplis, C. J. (2003). Transport processes and separation process principles (including unit operations) (Latest Edition). Prentice Hall of India.
6. Dutta, B. K. (2007). Principles of mass transfer and separation processes. PHI Learning Private Limited.