

# Multicomponent Mass Transfer - Video course

## COURSE OUTLINE

After successfully completing the course the student should be able to

1. Appreciate the difference between multicomponent and binary mass transfer.
2. Develop mass transfer relations from Fickian, Maxwell-Stefan, irreversible thermodynamics and lattice approach for gases, liquids and solids.
3. Understand various models of interphase mass transfer and estimate multicomponent mass transfer coefficients.
4. Understand and be able to handle the physical and mathematical complexities involved in multicomponent mass transfer.

## Contents

The course can be subdivided in two subheadings viz., Diffusion and Interphase mass transfer.

### 1. Diffusion:

Maxwell-Stefan's, Fickian, Maxwell-Stefan, Irreversible Thermodynamics and Lattice theory approaches to multicomponent diffusion.

Stoke's-Einstein approach to diffusion in liquids. Estimation of multicomponent Diffusion Coefficients.

### 2. Interphase mass transfer:

Mass transfer coefficients, bootstrap matrix, Film Theory, Surface renewal models, Mass transfer in drops and bubbles, mass transfer in turbulent flows.

## COURSE DETAIL

| S.No | Topics   | No. of Hours |
|------|--|--------------|
| 1    | Review of Preliminary Concepts, Definitions.       | 2            |
| 2    | Maxwell-Stefan approach for ideal Gases.           | 8            |
| 3    | Maxwell-Stefan approach to real gases and liquids. | 4            |
| 4    | Irreversible Thermodynamics approach to diffusion. | 2            |
| 5    | Lattice Theory approach to diffusion               | 2            |



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## Chemical Engineering

### Pre-requisites:

Basics of Mass Transfer, Matrix Algebra and Calculus.

### Coordinators:

**Dr. Rajesh Khanna**  
Department of Chemical Engineering IIT Delhi

# Mass Transfer Operations I Video Course Nptel

**A. P. SINHA,PARAMESWAR DE**



## **Mass Transfer Operations I Video Course Nptel:**

Principles and Modern Applications of Mass Transfer Operations Jaime Benitez, 2016-12-27 A staple in any chemical engineering curriculum New edition has a stronger emphasis on membrane separations chromatography and other adsorptive processes ion exchange Discusses many developing topics in more depth in mass transfer operations especially in the biological engineering area Covers in more detail phase equilibrium since distillation calculations are completely dependent on this principle Integrates computational software and problems using Mathcad Features 25 30 problems per chapter *A laboratory course in chemical engineering mass transfer operations*, 1982 **MASS TRANSFER N.**

Anantharaman, K. M. Meera Sheriffa Begum, 2011-05 Mass transfer operations are of great importance in a process industry as it has a direct impact on the cost of the final product A chemical process engineer therefore should have sound knowledge of the basics of mass transfer and its applications This book is designed to equip the reader with sufficient knowledge of mass transfer operations and face the challenges ahead The objective of this textbook is to teach a budding chemical engineer the principles involved in analyzing a process and apply the desired mass transfer operation to separate the components involved It deals with operations involving diffusion interphase mass transfer humidification drying crystallization absorption distillation extraction leaching and adsorption The principles and equipment used for different mass transfer operations have been lucidly explained Designed for a two semester course this text is primarily intended for the undergraduate students of chemical pharmaceutical petrochemical engineering as well as biotechnology and industrial biotechnology It will also be useful to plant engineers and design professionals **KEY FEATURES** 1 Explains the theoretical concepts with full derivation of equations 2 Illustrates the application of theory through worked out numerical examples 3 Provides exercise problems with answers at the end of each chapter for practice Principles and Applications of Mass Transfer Jaime Benitez, 2022-12-13

Principles and Applications of Mass Transfer Core textbook teaching mass transfer fundamentals and applications for the design of separation processes in chemical biochemical and environmental engineering Principles and Applications of Mass Transfer teaches the subject of mass transfer fundamentals and their applications to the design of separation processes with enough depth of coverage to guarantee that students using the book will at the end of the course be able to specify preliminary designs of the most common separation process equipment Reflecting the growth of biochemical applications in the field of chemical engineering the fourth edition expands biochemical coverage including transient diffusion environmental applications electrophoresis and bioseparations Also new to the fourth edition is the integration of Python programs which complement the Mathcad programs of the previous edition On the accompanying instructor's website the online appendices contain a downloadable library of Python and Mathcad programs for the example problems in each chapter A complete solution manual for all end of chapter problems both in Mathcad and Python is also provided Some of the topics covered in Principles and Applications of Mass Transfer include Molecular mass transfer covering concentrations velocities

and fluxes the Maxwell Stefan relations and Fick's first law for binary mixtures The diffusion coefficient covering diffusion coefficients for binary ideal gas systems dilute liquids and concentrated liquids Convective mass transfer covering mass transfer coefficients dimensional analysis boundary layer theory and mass and heat transfer analogies Interphase mass transfer covering diffusion between phases material balances and equilibrium stage operations Gas dispersed gas liquid operations covering sparged vessels tray towers diameter and gas pressure drop and weeping and entrainment Principles and Applications of Mass Transfer is an essential textbook for undergraduate chemical biochemical mechanical and environmental engineering students taking a core course on Separation Processes or Mass Transfer Operations along with mechanical engineers and mechanical engineering students starting to get involved in combined heat and mass transfer applications

*Mass Transfer Operations for the Practicing Engineer* Louis Theodore, Francesco Ricci, 2011-12-06 An invaluable guide for problem solving in mass transfer operations This book takes a highly pragmatic approach to providing the principles and applications of mass transfer operations by offering a valuable easily accessible guide to solving engineering problems Both traditional and novel mass transfer processes receive treatment As with all of the books in this series emphasis is placed on an example based approach to illustrating key engineering concepts The book is divided into two major parts It starts with the principles underlying engineering problems showing readers how to apply general engineering principles to the topic of mass transfer operations It then goes on to provide step by step guidance for traditional mass transfer operations including distillation absorption and stripping and adsorption plus novel mass transfer processes Essential topics for professional engineering exams are also covered Geared towards chemical environmental civil and mechanical engineers working on real world industrial applications *Mass Transfer Operations for the Practicing Engineer* features Numerous sample problems and solutions with real world applications Clear precise explanations on how to carry out the basic calculations associated with mass transfer operations Coverage of topics from the ground up for readers without prior knowledge of the subject Overview of topics relevant to the ABET Accreditation Board for Engineering and Technology for those taking the Professional Engineering PE exams Appendix containing relevant mass transfer operation charts and tables

*Mass-transfer Operations* Robert Ewald Treybal, 1967 Author's purpose is to provide a vehicle for teaching either through a formal course or through self study the techniques of and principles of equipment design for the mass transfer operations of chemical engineering As before these operations are largely the responsibility of the chemical engineer but increasingly practitioners of other engineering disciplines are finding them necessary for their work This is especially true for those engaged in pollution control and environment protection where separation processes predominate and in for example extractive metallurgy where more sophisticated and diverse methods of separation are increasingly relied upon

**Mass Transfer Operations** Alapati Suryanarayana, 2002 In A Simple And Systematic Manner This Book Presents An Exhaustive Account Of Various Mass Transfer Operations Involved In Chemical Engineering Emphasising The Basic

Concepts And Techniques The Book Discusses In Detail Material And Energy Balances Distillation Absorption And Stripping And Extraction The Book Also Explains The Relevant Aspects Of Equipment Design Recent Developments Like Permeation Ion Exchange And Froth Floatation Have Also Been Discussed A Large Number Of Digital Computer Programs Are Included To Illustrate Computer Aided Techniques Several Solved Examples And Practice Problems Are Presented In Each Chapter To Illustrate The Theory With All These Features This Is An Ideal Text For Undergraduate Chemical Engineering Students Practising Engineers And Students Of Pharmacy And Metallurgy Would Also Find The Book A Useful Reference Source

**Mass-transfer Operations** Robert Ewald Treybal,1967      **Mass Transfer** A. P. SINHA,PARAMESWAR DE,2012-05-09  
This book introduces the fundamental principles of the mass transfer phenomenon and its diverse applications in process industry It covers the full spectrum of techniques for chemical separations and extraction Beginning with molecular diffusion in gases liquids and solids within a single phase the mechanism of inter phase mass transfer is explained with the help of several theories The separation operations are explained comprehensively in two distinct ways stage wise contact and continuous differential contact The primary design requirements of gas liquid equipment are discussed The book provides a detailed discussion on all individual gas liquid liquid liquid solid gas and solid liquid separation processes The students are also exposed to the underlying principles of the membrane based separation processes The book is replete with real applications of separation processes and equipment Problems are worked out in each chapter Besides problems with answers short questions multiple choice questions with answers are given at the end of each chapter The text is intended for a course on mass transfer transport and separation processes prescribed for the undergraduate and postgraduate students of chemical engineering      Mass Transfer Operations-I D.C. Sikdar,2022-11-11 Mass Transfer is the net movement of mass of a chemical species from the region of higher concentration to a region of lower concentration It occurs in many industrial and non industrial processes Mass transfer is used by different scientific communities for different processes and mechanisms Mass Transfer Operation is one of the core courses at the undergraduate level of Chemical Engineering curriculum The chapters are organized in a way that enables the students to acquire an in depth understanding of the subject The emphasis is given to the basic concepts of mass transfer operating molecular diffusion inter phase mass transfer humidification operations drying evaporation crystallization adsorption novel separations and Mass transfer analogy all coming under the realm of mass transfer operations Apart from the numerous illustrations the book includes review questions exercises and aptitude test in chemical engineering which bridge the gap between theory and practical implementation All numerical problems are solved in a systematic manner to reinforce the understanding of the concepts This book demonstrates how to solve the industry related problems in chemical Engineering practice This book is primarily intended as a textbook for the undergraduate students of Chemical Engineering It will also be useful for other allied branches such as Mechanical Engineering Petroleum Engineering Polymer Science and Engineering Bio technology as well as Diploma in Chemical

Engineering     PRINCIPLES OF MASS TRANSFER KAL RENGANATHAN SHARMA,2007-01-21 This book addresses the specific needs of undergraduate chemical engineering students for the two courses in Mass Transfer I and Mass Transfer II It is also suitable for a course in Downstream Processing for biotechnology students This self contained textbook is designed to provide single volume coverage of the full spectrum of techniques for chemical separations The operations covered include vapour distillation fluid adsorption gas absorption liquid extraction solid leaching gas humidification solid drying foam separation solution crystallization metal alloying reverse osmosis molecular sieves electro dialysis and ion exchange The text also discusses emerging applications such as drug delivery gel electrophoresis bleaching membrane separations polymer devolatilization solution crystallization and gas chromatography Equipment selection is discussed for different operations A table of industrial applications for each and every mass transfer unit operation is provided The worked examples illustrate problems from chemical process and biotechnology industries Review questions encourage critical thinking and end of chapter problems emphasize grasping of the fundamentals as well as illustrate applications of theory to a wide variety of scenarios KEY FEATURES Includes several case studies ranging from manufacture of vitamin C prilling tower to granulate urea to vanaspati discoloration and wilting of the lettuce Introduces generalized Fick s law of diffusion Discusses hollow fibre mass exchangers Introduces new concepts such as cosolvent factor Z step procedure for multistage cross current extraction     *Mass-transfer Operations* Robert E. Treybal,1988     **WORKED EXAMPLES IN MASS TRANSFER** B. N. Nnolim,2010 Book presents mass transfer fundamentals in easily understandable form using worked examples to illustrate basic concepts and calculations     *Simultaneous Mass Transfer and Chemical Reactions in Engineering Science* Bertram K. C. Chan,2023-01-30 Simultaneous Mass Transfer and Chemical Reactions in Engineering Science A comprehensive look at the basic science of diffusional process and mass transfer Mass transfer as a principle is an essential part of numerous unit operations in biomolecular chemical and process engineering crystallization distillation and membrane separation processes for example use this important method Given this significance particularly in engineering design where these processes occur understanding the design and analysis of such unit operations must begin with a basic understanding of how simultaneous mass transfer and the chemical reactions that influence these occurrences It is also vital to be aware of the most up to date technologies for analyzing and predicting the phenomena Given the significance of this process Simultaneous Mass Transfer and Chemical Reactions in Engineering Science is an important resource as it introduces the reader to the complex subject of simultaneous mass transfer with biochemical and chemical reactions and gives them the tools to develop an applicable design Analyzing the systems of simultaneous mass transfer and reactions is at the core of this book as all known design approaches are carefully examined and compared The volume also provides the reader with a working knowledge of the latest technologies with a special focus on the open sourced computer programming language R and how these tools are an essential resource in quantitative assessment in analysis models Simultaneous Mass Transfer and

Chemical Reactions in Engineering Science provides a working knowledge of the latest information on simultaneous mass transfer and reactions by focusing on the analysis of this process as well as discussing the existence and distinctive quality of the solutions to the Simultaneous Mass Transfer and Chemical Reactions in Engineering Science readers will also find A theoretical basis of each design model that is carefully stated compared and assessed Carefully developed and established Existence and Uniqueness Theorems for a general design model Comprehensive coverage of how the programming language R may be used to analyze models Numerous examples and case studies that provide a working knowledge of simultaneous mass transfer and reactions Simultaneous Mass Transfer and Chemical Reactions in Engineering Science is a useful reference for students in chemical engineering biotechnology or chemistry as well as professional process and chemical engineers

*Mass-transfer Operations* R.E. Treybal,1986 Mass Transfer Conference 1962 Oklahoma State University. School of Chemical Engineering,Oklahoma State University. Engineering and Industrial Extension,1962 Advanced Topics in Mass Transfer Mohamed El-Amin,2011-02-21 This book introduces a number of selected advanced topics in mass transfer phenomenon and covers its theoretical numerical modeling and experimental aspects The 26 chapters of this book are divided into five parts The first is devoted to the study of some problems of mass transfer in microchannels turbulence waves and plasma while chapters regarding mass transfer with hydro magnetohydro and electro dynamics are collected in the second part The third part deals with mass transfer in food such as rice cheese fruits and vegetables and the fourth focuses on mass transfer in some large scale applications such as geomorphologic studies The last part introduces several issues of combined heat and mass transfer phenomena The book can be considered as a rich reference for researchers and engineers working in the field of mass transfer and its related topics

Transfer Operations Robert Albert Greenkorn,D. P. Kessler,1972 Macroscopic balances Dimensional analysis Application of the macroscopic balances to flow measurement Momentum transfer in fluid flow Momentum transfer coefficients Momentun transfer applications Heat trnsfer coefficients and applications Mass transfer Design equations for mass transfer Mass transfer applications Mass Transfer Diran Basmadjian,2003-12-15 In recent years the subject of mass transfer has been treated as a minor player in the larger field of transport phenomena and taken a back seat to its more mature brother heat transfer Yet mass transfer is sufficiently mature as a discipline and sufficiently distinct from other transport processes to merit a separate treatment particularly one that does not overwhelm readers with an abundance of high level mathematics Mass Transfer Principles and Applications takes an integrated approach that uses a wealth of real world examples organizes the material according to mode of operation and highlights the importance of modeling The author begins by introducing diffusion rates Fick s Law film theory and mass transfer coefficients then develops these concepts in complementary stages The treatment of phase equilibria covers topics generally not addressed in thermodynamics courses and these concepts are then used to analyze compartmental models and staged processes as well as continuous contact operations The final chapter offers a concise survey of simultaneous mass and

heat transfer Throughout the book discussions transition smoothly between theory and practice and clearly reflect the author's many years of engineering experience and the breadth of mass transfer applications *Mass Transfer Principles and Applications* is a unique and accessible treatment of this relatively complicated topic that will fill a significant gap as both a textbook and professional reference     **Mass Transfer Operations** Louis Theodore, 1995

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## **Table of Contents Mass Transfer Operations I Video Course Nptel**

1. Understanding the eBook Mass Transfer Operations I Video Course Nptel
  - The Rise of Digital Reading Mass Transfer Operations I Video Course Nptel
  - Advantages of eBooks Over Traditional Books
2. Identifying Mass Transfer Operations I Video Course Nptel
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Mass Transfer Operations I Video Course Nptel
  - User-Friendly Interface
4. Exploring eBook Recommendations from Mass Transfer Operations I Video Course Nptel
  - Personalized Recommendations
  - Mass Transfer Operations I Video Course Nptel User Reviews and Ratings

- Mass Transfer Operations I Video Course Nptel and Bestseller Lists
- 5. Accessing Mass Transfer Operations I Video Course Nptel Free and Paid eBooks
  - Mass Transfer Operations I Video Course Nptel Public Domain eBooks
  - Mass Transfer Operations I Video Course Nptel eBook Subscription Services
  - Mass Transfer Operations I Video Course Nptel Budget-Friendly Options
- 6. Navigating Mass Transfer Operations I Video Course Nptel eBook Formats
  - ePub, PDF, MOBI, and More
  - Mass Transfer Operations I Video Course Nptel Compatibility with Devices
  - Mass Transfer Operations I Video Course Nptel Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Mass Transfer Operations I Video Course Nptel
  - Highlighting and Note-Taking Mass Transfer Operations I Video Course Nptel
  - Interactive Elements Mass Transfer Operations I Video Course Nptel
- 8. Staying Engaged with Mass Transfer Operations I Video Course Nptel
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Mass Transfer Operations I Video Course Nptel
- 9. Balancing eBooks and Physical Books Mass Transfer Operations I Video Course Nptel
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Mass Transfer Operations I Video Course Nptel
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Mass Transfer Operations I Video Course Nptel
  - Setting Reading Goals Mass Transfer Operations I Video Course Nptel
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Mass Transfer Operations I Video Course Nptel
  - Fact-Checking eBook Content of Mass Transfer Operations I Video Course Nptel
  - Distinguishing Credible Sources

13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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