

## Solution Of Mass Transfer Operations Robert Treybal

Part of the Essential Engineering Calculations Series, this book presents step-by-step solutions of the basic principles of mass transfer operations, including sample problems and solutions and their applications, such as distillation, absorption, and stripping. Presenting the subject from a strictly pragmatic point of view, providing both the principles of mass transfer operations and their applications, with clear instructions on how to carry out the basic calculations needed, the book also covers topics useful for readers taking their professional exams.

Book presents mass transfer fundamentals in easily understandable form using worked examples to illustrate basic concepts and calculations

Fundamental concepts coupled with practical, step-by-step guidance With its emphasis on core principles, this text equips readers with the skills and knowledge to design the many processes needed to safely and successfully manufacture thermoplastic parts. The first half of the text sets forth the general theory and concepts underlying polymer processing, such as the viscoelastic response of polymeric fluids and diffusion and mass transfer. Next, the text explores specific practical aspects of polymer processing, including mixing, extrusion dies, and post-die processing. By addressing a broad range of design issues and methods, the authors demonstrate how to solve most common processing problems. This Second Edition of the highly acclaimed Polymer Processing has been thoroughly updated to reflect current polymer processing issues and practices. New areas of coverage include: Micro-injection molding to produce objects weighing a fraction of a gram, such as miniature gears and biomedical devices New chapter dedicated to the recycling of thermoplastics and the processing of renewable polymers Life-cycle assessment, a systematic method for determining whether recycling is appropriate and which form of recycling is optimal Rheology of polymers containing fibers Chapters feature problem sets, enabling readers to assess and reinforce their knowledge as they progress through the text. There are also special design problems throughout the text that reflect real-world polymer processing issues. A companion website features numerical subroutines as well as guidance for using MATLAB®, IMSL®, and Excel to solve the sample problems from the text. By providing both underlying theory and practical step-by-step guidance, Polymer Processing is recommended for students in chemical, mechanical, materials, and polymer engineering.

Theory and Practice

Principles and Design

Mass Transfer in Fluid Systems

Principles and Applications

*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.*

*This easy-to-follow guide is a step by step workbook intended to enhance students' understanding of complicated concepts in food engineering. It also gives them hands-on practice in solving food engineering problems. The book covers problems in fluid flow, heat transfer, and mass transfer. It also tackles the most common unit operations that have applications in food processing, such as thermal processing, cooling and freezing, evaporation, psychometrics and drying. Included are theoretical questions in the form of true or false, solved problems, semi-solved problems, and problems solved using a computer. The semi-solved problems guide students through the solution.*

*Essentials & Applications of Food Engineering provides a comprehensive understanding of food engineering operations and their practical and industrial utility. It presents pertinent case studies, solved numerical problems, and multiple choice questions in each chapter and serves as a ready reference for classroom teaching and exam preparations. The first part of this textbook contains the introductory topics on units and dimensions, material balance, energy balance, and fluid flow. The second part deals with the theory and applications of heat and mass transfer, psychrometry, and reaction kinetics. The subsequent chapters of the book present the heat and mass transfer operations such as evaporation, drying, refrigeration, freezing, mixing, and separation. The final section focuses on the thermal, non-thermal, and nanotechnology-based novel food processing techniques, 3D food printing, active and intelligent food packaging, and fundamentals of CFD modeling. Features Features 28 case studies to provide a substantial understanding of the practical and industrial applications of various food engineering operations Includes 178 solved numerical problems and 285 multiple choice questions Highlights the application of mass balance in food product traceability and the importance of viscosity measurement in a variety of food products Provides updated information on novel food processing techniques such as cold plasma, 3D food printing, nanospray drying, electrospraying, and electrospinning The textbook is designed for undergraduate and graduate students pursuing Food Technology and Food Process Engineering courses. This book would also be of interest to course instructors and food industry professionals.*

*Numerical Solution of Nonequilibrium Multicomponent Mass Transfer Operations*

*A Practical Approach with EES CD*

**PRINCIPLES OF MASS TRANSFER**

*Fluid Mechanics, Heat Transfer, and Mass Transfer*

*Mass Transfer Operations for the Practicing Engineer*

Mass transfer along with separation processes is an area that is often quite challenging to master, as most volumes currently available complicate the learning by teaching mass transfer linked with heat transfer, rather than focusing on more relevant techniques. With this thoroughly updated second edition, Mass Transfer and Separation Processes: Principles and Applications presents a highly thoughtful and instructive introduction to this sophisticated material by teaching mass transfer and separation processes as unique though related entities. In an ever increasing effort to demystify the subject, with this edition, the authorâ€ Avoids more complex separation processes Places a greater emphasis on the art of simplifying assumptions Conveys a greater sense of scale with the inclusion of numerous photos of actual installations Makes the math only as complicated as necessary while reviewing fundamental principles that may have been forgotten The book explores essential principles and reinforces the concepts with classical and contemporary illustrations drawn from the engineering, environmental, and biological sciences. The theories of heat conduction and transfer are utilized not so much to draw analogies but rather to make fruitful use of existing solutions not seen in other texts on the subject. Both an introductory resource and a reference, this important text serves environmental, biomedical, and engineering professionals, as well as anyone wishing to gain a grasp on this subject and its increasing relevance across a number of fields. It fills a void in traditional chemical engineering literature by providing access to the principles and working practices that allow mass transfer theory to be applied to separation processes.

This textbook is targeted to undergraduate students in chemical engineering, chemical technology, and biochemical engineering for courses in mass transfer, separation processes, transport processes, and unit operations. The principles of mass transfer, both diffusional and convective have been comprehensively discussed. The application of these principles to separation processes is explained. The more common separation processes used in the chemical industries are individually described in separate chapters. The book also provides a good understanding of the construction, the operating principles, and the selection criteria of separation equipment. Recent developments in equipment have been included as far as possible. The procedure of equipment design and sizing has been illustrated by simple examples. An overview of different applications and aspects of membrane separation has also been provided. 'Humidification and water cooling', necessary in every process indus-try, is also described. Finally, elementary principles of 'unsteady state diffusion' and mass transfer accompanied by a chemical reaction are covered. SALIENT FEATURES : □ A balanced coverage of theoretical principles and applications. □ Important recent developments in mass transfer equipment and practice are included. □ A large number of solved problems of varying levels of complexities showing the applications of the theory are included. □ Many end-chapter exercises. □ Chapter-wise multiple choice questions. □ An Instructors manual for the teachers.

This broad-based book covers the three major areas of Chemical Engineering. Most of the books in the market involve one of the individual areas, namely, Fluid Mechanics, Heat Transfer or Mass Transfer, rather than all the three. This book presents this material in a single source. This avoids the user having to refer to a number of books to obtain information. Most published books covering all the three areas in a single source emphasize theory rather than practical issues. This book is written with emphasis on practice with brief theoretical concepts in the form of questions and answers, not adopting stereo-typed question-answer approach practiced in certain books in the market, bridging the two areas of theory and practice with respect to the core areas of chemical engineering. Most parts of the book are easily understandable by those who are not experts in the field. Fluid Mechanics chapters include basics on non-Newtonian systems which, for instance find importance in polymer and food processing, flow through piping, flow measurement, pumps, mixing technology and fluidization and two phase flow. For example it covers types of pumps and valves, membranes and areas of their use, different equipment commonly used in chemical industry and their merits and drawbacks. Heat Transfer chapters cover the basics involved in conduction, convection and radiation, with emphasis on insulation, heat exchangers, evaporators, condensers, reboilers and fired heaters. Design methods, performance, operational issues and maintenance problems are highlighted. Topics such as heat pipes, heat pumps, heat tracing, steam traps, refrigeration, cooling of electronic devices, NOx control find place in the book. Mass transfer chapters cover basics such as diffusion, theories, analogies, mass transfer coefficients and mass transfer with chemical reaction, equipment such as tray and packed columns, column internals including structural packings, design, operational and installation issues, drums and separators are discussed in good detail. Absorption, distillation, extraction and leaching with applications and design methods, including emerging practices involving Divided Wall and Petluk column arrangements, multicomponent separations, supercritical solvent extraction find place in the book.

Multicomponent Mass Transfer

Essentials and Applications of Food Engineering

Heat Transfer

Principles and Operations

PRINCIPLES OF MASS TRANSFER AND SEPERATION PROCESSES

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.

Fundamentals and Operations in Food Process Engineering deals with the basic engineering principles and transport processes applied to food processing, followed by specific unit operations with a large number of worked-out examples and problems for practice in each chapter. The book is divided into four sections: fundamentals in food process engineering, mechanical operations in food processing, thermal operations in food processing and mass transfer operations in food processing. The book is designed for students pursuing courses on food science and food technology, including a broader section of scientific personnel in the food processing and related industries.

CD-ROM contains: the limited academic version of Engineering equation solver (EES) with homework problems.

Longitudinal Dispersion in Two-phase Continuous-flow Operations

Polymer Processing

Solutions Manual to Accompany Mass-transfer Operations, Third Edition

Simultaneous Mass Transfer and Chemical Reactions in Engineering Science

A HEAT TRANSFER TEXTBOOK

**This text covers the design of food processing equipment based on key unit operations, such as heating, cooling, and drying. In addition, mechanical processing operations such as separations, transport, storage, and packaging of food materials, as well as an introduction to food processes and food processing plants are discussed. Handbook of Food Processing Equipment is an essential reference for food engineers and food technologists working in the food process industries, as well as for designers of process plants. The book also serves as a basic reference for food process engineering students. The chapters cover engineering and economic issues for all important steps in food processing. This research is based on the physical properties of food, the analytical expressions of transport phenomena, and the description of typical equipment used in food processing. Illustrations that explain the structure and operation of industrial food processing equipment are presented. style="font-size: 13.3333330154419px;">The materials of construction and fabrication of food processing equipment are covered here, as well as the selection of the appropriate equipment for various food processing operations. Mechanical processing equipment such as size reduction, size enlargement, homogenization, and mixing are discussed. Mechanical separations equipment such as filters, centrifuges, presses, and solids/air systems, plus equipment for industrial food processing such as heat transfer, evaporation, dehydration, refrigeration, freezing, thermal processing, and dehydration, are presented. Equipment for novel food processes such as high pressure processing, are discussed. The appendices include conversion of units, selected thermophysical properties, plant utilities, and an extensive list of manufacturers and suppliers of food equipment.**

Addresses the use of rigorous multicomponent mass transfer models for the simulation and design of process equipment. Deals with the basic equations of diffusion in multicomponent systems. Describes various models and estimations of rates of mass and energy transfer. Covers applications of multicomponent mass transfer models to process design. Includes appendices providing necessary mathematical background. Contains a large number of numerical examples worked out in detail.

A problem-solving approach that helps students master new material and put their knowledge into practice The Second Edition of the acclaimed Principles and Modern Applications of Mass Transfer Operations continues to provide a thorough, accessible text that gives students the support and the tools they need to quickly move from theory to application. This latest edition has been thoroughly revised and updated with new discussions of such developing topics as membrane separations, ion exchange, multistage batch distillation, and chromatography and other adsorptive processes. Moreover, the Second Edition now covers mass transfer phenomena in biological systems, making the text appropriate for students in biochemical engineering as well as chemical engineering. Complementing the author's clear discussions are several features that help students quickly master new material and put their knowledge into practice, including: Twenty-five to thirty problems at the end of each chapter that enable students to use their newfound knowledge to solve problems Examples and problems that help students become proficient working with Mathcad Figures and diagrams that illustrate and clarify complex concepts and processes References facilitating further in-depth research into particular topics Ten appendices filled with helpful data and reference materials Ideal for a first course in mass transfer operations, this text has proven to be invaluable to students in chemical and environmental engineering as well as researchers and university faculty.

Handbook of Food Processing Equipment

Mass Transfer

Volume I: Two-Phase Systems. Volume II: Three-Phase Systems

Mass-transfer Operations

Unit Operations in Environmental Engineering

*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*

*Introduction - Conduction - Convection - Radiation - Heat Exchange Equipments - Evaporation - Diffusion - Distillation - Gas Absorption - Liquid Liquid Extraction - Crystallisation - Drying - Appendix I Try yourself - Appendix II Thermal conductivity data - Appendix III Steam tables*

*Clear and complete description of diffusion in fluids, for undergraduate students in chemical engineering.*

**Principles and Modern Applications of Mass Transfer Operations**

**Mass Transfer with Chemical Reaction in Multiphase Systems**

**Mass Transfer and Separation Processes**

**Solution and Tables for Cocurrent Flow**

**Basic Equations of the Mass Transport Through a Membrane Layer**

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.

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, electrodialysis, 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 discolouration 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.

This is a unique book with nearly 1000 problems and 50 case studies on open-ended problems in every key topic in chemical engineering that helps to better prepare chemical engineers for the future. The term "open-ended problem" basically describes an approach to the solution of a problem and/or situation for which there is not a unique solution. The Introduction the general subject of open-ended problems is followed by 22 chapters, each of which addresses a traditional chemical engineering or chemical engineering-related topic. Each of these chapters contain a brief overview of the subject matter of concern, e.g., thermodynamics, which is followed by sample open-ended problems that have been solved (by the authors) employing one of the many possible approaches to the solutions. This is then followed by approximately 40-45 open-ended problems with no solutions (although many of the authors' solutions are available for those who adopt the book for classroom or training purposes). A reference section is included with the chapter's contents. Term projects, comprised of 12 additional chapter topics, complement the presentation. This book provides academic, industrial, and research personnel with the material that covers the principles and applications of open-ended chemical engineering problems in a thorough and clear manner. Upon completion of the text, the reader should have acquired not only a working knowledge of the principles of chemical engineering, but also (and more importantly) experience in solving open-ended problems. What many educators have learned is that the applications and implications of open-ended problems are not only changing professions, but also are moving so fast that many have not yet grasped their tremendous impact. The book drives home that the open-ended approach will revolutionize the way chemical engineers will need to operate in the future.

Mass Transfer Operations

Transport Processes and Unit Operations

Solutions Manual to Accompany Mass-transfer Operations

Transfer Operations

Handbook of Heat and Mass Transfer: Heat transfer operations

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.

Macroscopic balances; Dimensional analysis; Application of the macroscopic balances to flow measurement; Momentum transfer in fluid flow; Momentum transfer coefficients; Momentun transfer applications; Heat transfer coefficients and applications; Mass transfer; Design equations for mass transfer; Mass transfer applications.

The authors have written a practical introductory text exploring the theory and applications of unit operations for environmental engineers that is a comprehensive update to Linvil Rich's 1961 classic work, "Unit Operations in Sanitary Engineering". The book is designed to serve as a training tool for those individuals pursuing degrees that include courses on unit operations. Although the literature is inundated with publications in this area emphasizing theory and theoretical derivations, the goal of this book is to present the subject from a strictly pragmatic introductory point-of-view, particularly for those individuals involved with environmental engineering. This book is concerned with unit operations, fluid flow, heat transfer and mass transfer. Unit operations, by definition, are physical processes although there are some that include chemical and biological reactions. The unit operations approach allows both the practicing engineer and student to compartmentalize the various operations that constitute a process, and emphasizes introductory engineering principles so that the reader can then satisfactorily predict the performance of the various unit operation equipment.

Unit Operations-II

Diffusion

Solution Methods and Chemical Engineering Applications

Mass Transfer-II

WORKED EXAMPLES IN MASS TRANSFER

**This new third edition provides a modern, unified treatment of the basic transport processes of momentum, heat, and mass transfer, as well as a broad treatment of the unit operations of chemical engineering. Coverage includes the latest membrane separation processes; discussion of bioprocesses; comprehensive treatment of the transport processes of momentum, heat, and mass transfer; adsorption processes; and more. A useful, up-to-date reference for practicing chemical engineers, agricultural engineers, food scientists, environmental engineers, biochemical engineers, and others who work in the process industries.**

**With a detailed analysis of the mass transport through membrane layers and its effect on different separation processes, this book provides a comprehensive look at the theoretical and practical aspects of membrane transport properties and functions. Basic equations for every membrane are provided to predict the mass transfer rate, the concentration distribution, the convective velocity, the separation efficiency, and the effect of chemical or biochemical reaction taking into account the heterogeneity of the membrane layer to help better understand the mechanisms of the separation processes. The reader will be able to describe membrane separation processes and the membrane reactors as well as choose the most suitable membrane structure for separation and for membrane reactor. Containing detailed discussion of the latest results in transport processes and separation processes, this book is essential for chemistry students and practitioners of chemical engineering and process engineering. Detailed survey of the theoretical and practical aspects of every membrane process with specific equations Practical examples discussed in detail with clear steps Will assist in planning and preparation of more efficient membrane structure separation**

**Simultaneous Mass Transfer and Chemical Reactions in Engineering Science: Solution Methods and Chemical Engineering Applications illustrates how mathematical analyses, statistics, numerical analysis and computer programming can summarize simultaneous mass transfer and chemical reactions in engineering science for use in solving problems in quantitative Chemical and Biochemical Engineering design and analysis. The book provides statistical methodologies and R recipes for advective and diffusive problems in various geometrical configurations. The R-package Reactran is used to showcase transport models in aquatic systems (rivers, lakes, oceans), porous media (floc aggregates, sediments, ...) and even idealized organisms (spherical cells, cylindrical worms, ...). Presents the basic science of diffusional process and mass transfer, along with simultaneous biochemical and chemical reactions Provides a current working knowledge of simultaneous mass transfer and reactions Describes useful mathematical models on the quantitative assessment of simultaneous mass transfer and reactions Focuses on the analysis of systems of simultaneous mass transfer and reactions, discussing the existence and uniqueness of solutions to well-known theoretical models**

**A Future Chemical Engineering Education Approach**

**Fundamentals of Heat and Mass Transfer**

**Fundamentals and Operations in Food Process Engineering**

**Principles and Applications, Second Edition**

**Chemical Engineering Practice**

**Mass-transfer Operations**McGraw-Hill Science, Engineering & MathematicsSolutions Manual to Accompany Mass-transfer OperationsMass TransferPrinciples and OperationsPHI Learning Pvt. Ltd.

**About the Book: Salient features: A number of complex problems along with the solutions are provided Objective type questions for self-evaluation and better understanding of the subject Problems related to the practical aspects of the subject have been worked out Checking the authenticity of dimensional homogeneity in case of all derived equations Validation of numerical solutions by cross checking Plenty of graded exercise problems from simple to complex situations are included Variety of questions have been included for the clear grasping of the basic principles Redrawing of all the figures for more clarity and understanding Radiation shape factor charts and Heisler charts have also been included Essential tables are included The basic topics have been elaborately discussed Presented in a more better and fresher way Contents: An Overview of Heat Transfer Steady State Conduction Conduction with Heat Generation Heat Transfer with Extended Surfaces (FINS) Two Dimensional Steady Heat Conduction Transient Heat Conduction Convection Convective Heat Transfer Practical Correlation Flow Over Surfaces Forced Convection Natural Convection Phase Change Processes Boiling, Condensation, Freezing and Melting Heat Exchangers Thermal Radiation Mass Transfer**

**The phenomenon of "mass transfer with chemical reaction" takes place whenever one phase is brought into contact with one or more other phases not in chemical equilibrium with it. This phenomenon has industrial, biological and physiological importance. In chemical process engineering, it is encountered in both separation processes and reaction engineering. In some cases, a chemical reaction may deliberately be employed for speeding up the rate of mass transfer and/or for increasing the capacity of the solvent; in other cases the multiphase reaction system is a part of the process with the specific aim of product formation. Finally, in some cases, for instance "distillation with chemical reaction", both objectives are involved. Although the subject is clearly a chemical engineering undertaking, it requires often a good understanding of other subjects, such as chemistry and fluid mechanics etc., leading to publications in diversified areas. On the other hand, the subject has always been a major field and one of the most fruitful for chemical engineers.**

**Solving Problems in Food Engineering**

**Open-Ended Problems**