

JOURNAL REVIEW

Five Decades of Transport Phenomena

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Surveying the progress made in transport phenomena in the past half-century is an impossible task. Fully half of the publications in the chemical engineering journals have something to do with transport phenomena, and, in addition, there are many other disciplines where transport phenomena arise. In this summary we try to give the flavor of the developments by citing typical textbooks, review articles, and research publications—but the choices are often capricious. To some extent we try to put the emphasis on works that involve two or more of the transport mechanisms.

In reviewing the *AIChE Journal* for the last 50 years, the author must confess to having a feeling of nostalgia as he came across names like Allan Colburn, Olaf Hougen, W. R. ("Bob") Marshall, R. L. ("Bob") Pigford, T. K. ("Tom") Sherwood, and R. H. ("Dick") Wilhelm; he had to pause and contemplate the many contributions of these fine people. We have indeed profited in many ways from the contributions and wisdom of our predecessors.

[Note: The references in §1 are numbered. In subsequent sections the references are labeled with lowercase letters. If a reference is made to another section, both the section and letter are given; thus, 16f means "reference f" of §16.]

§1. The Status of Transport Phenomena Fifty Years Ago

The subject of transport phenomena is a very old one,¹ with some of the topics dating back several centuries. By 1955, much of the theory for homogeneous fluid mixtures had been developed. The equations of change were well known from continuum mechanics, and because of the development of the thermodynamics of irreversible processes during the two preceding decades,²⁻⁴ the linear expressions for the fluxes as functions of the driving forces were also well understood. Consequently, the existence of the cross effects (thermal diffusion, the diffusion-thermo effect, and the relations among the multicomponent diffusivities) had been firmly established.

In addition, the Chapman-Enskog kinetic theory of dilute

monatomic gases had been presented in great detail by Chapman and Cowling⁵ for pure gases and binary mixtures. The analogous kinetic theory for multicomponent mixtures had also been worked out by Curtiss and Hirschfelder⁶ and calculations based on the theory had been made for the Lennard-Jones 6-12 potential.⁷ Some work had also been done on the kinetic theory of polyatomic molecules, loaded spheres, rough spheres, and rigid ovaloids. A beginning had been made on the kinetic theory of monatomic liquids.⁸ These molecular theories give flux expressions that are consistent with those obtained from the thermodynamics of irreversible processes.

Also, a number of analytical solutions of the equations of change were available. In fluid dynamics, the field of inviscid flow had been well developed, and, for viscous Newtonian flow, there were many analytical solutions that were useful in engineering and the applied sciences. For heat conduction, there was the first edition of Carslaw and Jaeger's excellent compilation of thousands of solutions of the heat-conduction equation.⁹ For heat conduction, convection, and radiation, there was the book by Gröber and Erk,¹⁰ as well as several others. For diffusion, the situation was rather bleak, since that subject was newer than fluid dynamics and heat transfer, and is more difficult. There were books by Joshi¹² and Barrer¹³ on diffusion in solids, and for liquids and gases, the Eucken-Jakob treatise¹⁴ provided some guidance. But these references were incomplete inasmuch as the distinctions among the reference frames for the mass and molar fluxes were not made clear, and the nature of the driving forces for diffusion was not carefully discussed. In addition, the heat generated by viscous dissipation was usually omitted from the energy equation.

As far as turbulent flows are concerned, considerable effort had been expended to provide an understanding of this very difficult subject. The status of this topic as of 50 years ago was pretty well summarized by Prandtl¹⁵ and Schlichting,¹⁶ who considered both isothermal and nonisothermal systems.

The macroscopic balances were part of the everyday tools of the civil, mechanical, aeronautical, and chemical engineers. These balances could be found in many handbooks, although the origins of some of the equations were difficult to trace, and often the assumptions inherent in them were not given or had been forgotten. Actually, it was probably this part of the subject

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David Baud



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Durability and Reliability of Medical Polymers Mike Jenkins, Artemis Stamboulis, 2012-08-13 Given the widespread use of polymers in medical devices the durability and reliability of this material in use is an area of critical importance Durability and reliability of medical polymers reviews the performance of both bioresorbable and non bioresorbable medical polymers Part one provides a review of the types and properties of bioresorbable medical polymers The effect of molecular structure on properties is discussed along with the processing of bioresorbable and other polymers for medical applications Transport phenomena and the degradation of bioresorbable medical polymers are reviewed before an exploration of synthetic bioresorbable polymers and their use in orthopaedic tissue regeneration Part two goes on to explore the durability and reliability of non bioresorbable medical polymers and wear processes in polymer implants and ageing processes of biomedical polymers in the body are discussed in depth before an investigation into manufacturing defects and the failure of synthetic polymeric medical devices With its distinguished editors and international team of expert contributors Durability and reliability of medical polymers is an essential tool for all materials scientists researchers and engineers involved in the design development and application of medical polymers whilst also providing a helpful overview of the subject for biologists chemist and clinicians Comprehensively examines the performance of both bioresorbable and non bioresorbable medical polymers Discusses the processing of bioresorbable and other polymers for medical applications before reviewing the degradation of bioresorbable medical polymers Explores the durability and reliability of non bioresorbable medical polymers and discusses wear processes in polymer implants and ageing processes of biomedical polymers in the body

Fundamentals of Multiphase Heat Transfer and Flow Amir Faghri, Yuwen Zhang, 2019-09-13 This textbook presents a modern treatment of fundamentals of heat and mass transfer in the context of all types of multiphase flows with possibility of phase changes among solid liquid and vapor It serves equally as a textbook for undergraduate senior and graduate students in a wide variety of engineering disciplines including mechanical engineering chemical engineering material science and engineering nuclear engineering biomedical engineering and environmental engineering Multiphase Heat Transfer and Flow can also be used to teach contemporary and novel applications of heat and mass transfer Concepts are reinforced with numerous examples and end of chapter problems A solutions manual and PowerPoint presentation are available to instructors While the book is designed for students it is also very useful for practicing engineers working in technical areas related to both macro and micro scale systems that emphasize multiphase multicomponent and non conventional geometries with coupled heat and mass transfer and phase change with the possibility of full numerical simulation **Transport Phenomena** R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot, 2006-12-11 The market leading transport phenomena text has been revised Authors Bird Stewart and Lightfoot have revised Transport Phenomena to include deeper and more extensive coverage of heat transfer enlarged discussion of dimensional analysis a new chapter on flow of polymers systematic

discussions of convective momentum energy and mass transport and transport in two phase systems If this is your first look at Transport Phenomena you ll quickly learn that its balanced introduction to the subject of transport phenomena is the foundation of its long standing success About the Revised 2nd Edition Since the appearance of the second edition in 2002 the authors and numerous readers have found a number of errors some major and some minor In the Revised 2nd Edition the authors have endeavored to correct these errors A new ISBN has been assigned to the Revised 2nd Edition in order to more easily identify the most correct version For Bird s corrigenda please click here and see Transport Phenomena in the Books section

Current Trends and Future Developments on (Bio-) Membranes Angelo Basile,Kamran

Ghasemzadeh,Adolfo Iulianelli,2021-12-03 Transport Phenomena in Membranes illustrates many aspects of mass transport in different membranes used in separation processes along with their advantages when compared with other types of separation methods This book focuses on introducing and analyzing transport phenomena in membranes and overviewing achievements in the development of mass transport mechanisms of various membranes Hence this book is a key reference text for R D managers in industry interested in the development of membrane technologies as well as academic researchers and postgraduate students working in the wider area of the strategic treatment separation and purification processes This book is intended to act as a resource for a wide range of people in various separation fields including students and researchers consultants and engineers operators and managers who have an interest in membrane technology Describes developments in transport phenomena in different membrane processes Provides a comprehensive reference book in the membrane field for students and engineers Describes membrane separation fundamentals and relates them to various potential applications

Journal de physique ,1999 **Applied Mechanics Reviews** ,1974 **Biochemical and Environmental Bioprocessing**

M Jerold,V Sivasubramanian,2019-07-25 The rapid growth of industries has resulted in the generation of high volume of solid and liquid waste Today there is a need of Clean and Green technology for the sustainable waste management Biochemical and Environmental Bioprocessing Challenges and Developments explore the State of art green technologies to manage the waste and to recover value added products Microbes play an important role in the bioremediation Bioprocess engineering an interdisciplinary connects the Science and Technology The bioconversion and bioremediation is essentially required for the management of various hazardous substances in the environment This book will give an intensive knowledge on the application of Biochemical and Bioprocess technologies for the eco friendly management of pollution This book serves as a fundamental to the students researchers academicians and Engineers working in the area of Environmental Bioremediation and in the exploration of various bioproducts from waste Features Reviews various biological methods for the treatment of effluents from Industries by using biomass and biopolymers Highlights the applications of various bioreactors like Anaerobic Sequential Batch Reactor Continuously stirred anaerobic digester Up flow anaerobic sludge blanket reactor Fluidized and expanded bed reactors Presents the cultivation of algae in Open Pond Closed

loop System and Photo bioreactors for bioenergy production Discusses the intensified and integrated biorefinery approach by Microwave Irradiation Pyrolysis Acoustic cavitation Hydrodynamic cavitation Electron beam irradiation High pressure Autoclave reactor Steam explosion and photochemical oxidation Outlines the usage of microbial fuel cell MFC for the production bioelectricity generation in different modules Tubular MFC Stacked MFC Separate electrode modules Cutting edge research of synthesis of biogenic nanoparticles and Pigments by green route for the health care and environment management **Transport Phenomena In Thermal Control** Guang-Jyh Hwang,1989-08-01 A collection of research papers into transport phenomena in thermal control closely related to several important aspects of cooling technology Articles provide overviews of current advances and details of individual technologies including electronic and turbine cooling and Marangoni convection *New York Review of the Telegraph and Telephone and Electrical Journal* ,1906 *Boston Journal of Chemistry and Popular Science Review* ,1879

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