

## Contents of Volumes in This Serial

### Volume 1

J. W. Westwater, *Boiling of Liquids*

A. B. Metzner, *Non-Newtonian Technology: Fluid Mechanics, Mixing, and Heat Transfer*

R. Byron Bird, *Theory of Diffusion*

J. B. Opfell and B. H. Sage, *Turbulence in Thermal and Material Transport*

Robert E. Treybal, *Mechanically Aided Liquid Extraction*

Robert W. Schrage, *The Automatic Computer in the Control and Planning of Manufacturing Operations*

Ernest J. Henley and Nathaniel F. Barr, *Ionizing Radiation Applied to Chemical Processes and to Food and Drug Processing*

### Volume 2

J. W. Westwater, *Boiling of Liquids*

Ernest F. Johnson, *Automatic Process Control*

Bernard Manowitz, *Treatment and Disposal of Wastes in Nuclear Chemical Technology*

George A. Sofer and Harold C. Weingartner, *High Vacuum Technology*

Theodore Vermeulen, *Separation by Adsorption Methods*

Sherman S. Weidenbaum, *Mixing of Solids*

### Volume 3

C. S. Grove, Jr., Robert V. Jelinek, and Herbert M. Schoen, *Crystallization from Solution*

F. Alan Ferguson and Russell C. Phillips, *High Temperature Technology*

Daniel Hyman, *Mixing and Agitation*

John Beek, *Design of Packed Catalytic Reactors*

Douglass J. Wilde, *Optimization Methods*

### Volume 4

J. T. Davies, *Mass-Transfer and Interfacial Phenomena*

R. C. Kintner, *Drop Phenomena Affecting Liquid Extraction*

Octave Levenspiel and Kenneth B. Bischoff, *Patterns of Flow in Chemical Process Vessels*

Donald S. Scott, *Properties of Concurrent Gas-Liquid Flow*

D. N. Hanson and G. F. Somerville, *A General Program for Computing Multistage Vapor-Liquid Processes*

### Volume 5

J. F. Wehner, *Flame Processes—Theoretical and Experimental*

J. H. Sinfelt, *Bifunctional Catalysts*

S. G. Bankoff, *Heat Conduction of Diffusion with Change of Phase*

George D. Fulford, *The Flow of Liquids in Thin Films*

K. Rietema, *Segregation in Liquid-Liquid Dispersions and Its Effect on Chemical Reactions*

**Volume 6**

- S. G. Bankoff, *Diffusion-Controlled Bubble Growth*  
John C. Berg, Andreas Acrivos, and Michel Boudart, *Evaporation Convection*  
H. M. Tsuchiya, A. G. Fredrickson, and R. Aris, *Dynamics of Microbial Cell Populations*  
Samuel Sideman, *Direct Contact Heat Transfer between Immiscible Liquids*  
Howard Brenner, *Hydrodynamic Resistance of Particles at Small Reynolds Numbers*

**Volume 7**

- Robert S. Brown, Ralph Anderson, and Larry J. Shannon, *Ignition and Combustion of Solid Rocket Propellants*  
Knud Østergaard, *Gas-Liquid-Particle Operations in Chemical Reaction Engineering*  
J. M. Prausnitz, *Thermodynamics of Fluid-Phase Equilibria at High Pressures*  
Robert V. Macbeth, *The Burn-Out Phenomenon in Forced-Convection Boiling*  
William Resnick and Benjamin Gal-Or, *Gas-Liquid Dispersions*

**Volume 8**

- C. E. Lapple, *Electrostatic Phenomena with Particulates*  
J. R. Kittrell, *Mathematical Modeling of Chemical Reactions*  
W. P. Ledet and D. M. Himmelblau, *Decomposition Procedures for the Solving of Large Scale Systems*  
R. Kumar and N. R. Kuloor, *The Formation of Bubbles and Drops*

**Volume 9**

- Renato G. Bautista, *Hydrometallurgy*  
Kishan B. Mathur and Norman Epstein, *Dynamics of Spouted Beds*  
W. C. Reynolds, *Recent Advances in the Computations of Turbulent Flows*  
R. E. Peck and D. T. Wasan, *Drying of Solid Particles and Sheets*

**Volume 10**

- G. E. O'Connor and T. W. F. Russell, *Heat Transfer in Tubular Fluid-Fluid Systems*  
P. C. Kapur, *Balling and Granulation*  
Richard S. H. Mah and Mordechai Shacham, *Pipeline Network Design and Synthesis*  
J. Robert Selman and Charles W. Tobias, *Mass-Transfer Measurements by the Limiting-Current Technique*

**Volume 11**

- Jean-Claude Charpentier, *Mass-Transfer Rates in Gas-Liquid Absorbers and Reactors*  
Dee H. Barker and C. R. Mitra, *The Indian Chemical Industry—Its Development and Needs*  
Lawrence L. Tavlarides and Michael Stamatoudis, *The Analysis of Interphase Reactions and Mass Transfer in Liquid-Liquid Dispersions*  
Terukatsu Miyauchi, Shintaro Furusaki, Shigeharu Morooka, and Yoneichi Ikeda, *Transport Phenomena and Reaction in Fluidized Catalyst Beds*

**Volume 12**

- C. D. Prater, J. Wei, V. W. Weekman, Jr., and B. Gross, *A Reaction Engineering Case History: Coke Burning in Thermoform Catalytic Cracking Regenerators*  
Costel D. Denson, *Stripping Operations in Polymer Processing*  
Robert C. Reid, *Rapid Phase Transitions from Liquid to Vapor*  
John H. Seinfeld, *Atmospheric Diffusion Theory*

**Volume 13**

Edward G. Jefferson, *Future Opportunities in Chemical Engineering*

Eli Ruckenstein, *Analysis of Transport Phenomena Using Scaling and Physical Models*

Rohit Khanna and John H. Seinfeld, *Mathematical Modeling of Packed Bed Reactors: Numerical Solutions and Control Model Development*

Michael P. Ramage, Kenneth R. Graziani, Paul H. Schipper, Frederick J. Krambeck, and Byung C. Choi, *KINPTR (Mobil's Kinetic Reforming Model): A Review of Mobil's Industrial Process Modeling Philosophy*

**Volume 14**

Richard D. Colberg and Manfred Morari, *Analysis and Synthesis of Resilient Heat Exchanger Networks*

Richard J. Quann, Robert A. Ware, Chi-Wen Hung, and James Wei, *Catalytic Hydrometallation of Petroleum*

Kent Davis, *The Safety Matrix: People Applying Technology to Yield Safe Chemical Plants and Products*

**Volume 15**

Pierre M. Adler, Ali Nadim, and Howard Brenner, *Rheological Models of Suspensions*

Stanley M. Englund, *Opportunities in the Design of Inherently Safer Chemical Plants*

H. J. Ploehn and W. B. Russel, *Interactions between Colloidal Particles and Soluble Polymers*

**Volume 16**

*Perspectives in Chemical Engineering: Research and Education*

Clark K. Colton, *Editor*

Historical Perspective and Overview

L. E. Scriven, *On the Emergence and Evolution of Chemical Engineering*

Ralph Landau, *Academic-Industrial Interaction in the Early Development of Chemical Engineering*

James Wei, *Future Directions of Chemical Engineering*

Fluid Mechanics and Transport

L. G. Leal, *Challenges and Opportunities in Fluid Mechanics and Transport Phenomena*

William B. Russel, *Fluid Mechanics and Transport Research in Chemical Engineering*

J. R. A. Pearson, *Fluid Mechanics and Transport Phenomena*

Thermodynamics

Keith E. Gubbins, *Thermodynamics*

J. M. Prausnitz, *Chemical Engineering Thermodynamics: Continuity and Expanding Frontiers*

H. Ted Davis, *Future Opportunities in Thermodynamics*

Kinetics, Catalysis, and Reactor Engineering

Alexis T. Bell, *Reflections on the Current Status and Future Directions of Chemical Reaction Engineering*

James R. Katzer and S. S. Wong, *Frontiers in Chemical Reaction Engineering*

L. Louis Hegedus, *Catalyst Design*

Environmental Protection and Energy

John. H. Seinfeld, *Environmental Chemical Engineering*

T. W. F. Russell, *Energy and Environmental Concerns*

Janos M. Beer, Jack B. Howard, John P. Longwell, and Adel F. Sarofim, *The Role of Chemical Engineering in Fuel Manufacture and Use of Fuels*

#### Polymers

Matthew Tirrell, *Polymer Science in Chemical Engineering*

Richard A. Register and Stuart L. Cooper, *Chemical Engineers in Polymer Science: The Need for an Interdisciplinary Approach*

#### Microelectronic and Optical Materials

Larry F. Thompson, *Chemical Engineering Research Opportunities in Electronic and Optical Materials Research*

Klavns F. Jensen, *Chemical Engineering in the Processing of Electronic and Optical Materials: A Discussion*

#### Bioengineering

James E. Bailey, *Bioprocess Engineering*

Arthur E. Humphrey, *Some Unsolved Problems of Biotechnology*

Channing Robertson, *Chemical Engineering: Its Role in the Medical and Health Sciences*

#### Process Engineering

Arthur W. Westerberg, *Process Engineering*

Manfred Morari, *Process Control Theory: Reflections on the Past Decade and Goals for the Next*

James M. Douglas, *The Paradigm After Next*

George Stephanopoulos, *Symbolic Computing and Artificial Intelligence in Chemical Engineering: A New Challenge*

#### The Identity of Our Profession

Morton M. Denn, *The Identity of Our Profession*

### Volume 17

Y. T. Shah, *Design Parameters for Mechanically Agitated Reactors*

Mooson Kwauk, *Particulate Fluidization: An Overview*

### Volume 18

E. James Davis, *Microchemical Engineering: The Physics and Chemistry of the Microparticle*

Selim M. Senkan, *Detailed Chemical Kinetic Modeling: Chemical Reaction Engineering of the Future*

Lorenz. T. Biegler, *Optimization Strategies for Complex Process Models*

### Volume 19

Robert Langer, *Polymer Systems for Controlled Release of Macromolecules, Immobilized Enzyme Medical Bioreactors, and Tissue Engineering*

J. J. Linderman, P. A. Mahama, K. E. Forsten, and D. A. Lauffenburger, *Diffusion and Probability in Receptor Binding and Signaling*

Rekesh K. Jain, *Transport Phenomena in Tumors*

R. Krishna, *A Systems Approach to Multiphase Reactor Selection\**

David T. Allen, *Pollution Prevention: Engineering Design at Macro-, Meso-, and Microscales*

John H. Seinfeld, Jean M. Andino, Frank M. Bowman, Hali J. L. Forstner, and Spyros Pandis, *Tropospheric Chemistry*

**Volume 20**

Arthur M. Squires, *Origins of the Fast Fluid Bed*

Yu Zhiqing, *Application Collocation*

Yochu Li, *Hydrodynamics*

Li Jinghai, *Modeling*

Yu Zhiqing and Jin Yong, *Heat and Mass Transfer*

Mooson Kwauk, *Powder Assessment*

Li Hongzhong, *Hardware Development*

Yochu Li and Xuyi Zhang, *Circulating Fluidized Bed Combustion*

Chen Junwu, Cao Hanchang, and Liu Taiji, *Catalyst Regeneration in Fluid Catalytic Cracking*

**Volume 21**

Christopher J. Nagel, Chonghun Han, and George Stephanopoulos, *Modeling Languages: Declarative and Imperative Descriptions of Chemical Reactions and Processing Systems*

Conghun Han, George Stephanopoulos, and James M. Douglas, *Automation in Design: The Conceptual Synthesis of Chemical Processing Schemes*

Michael L. Mavrouniotis, *Symbolic and Quantitative Reasoning: Design of Reaction Pathways through Recursive Satisfaction of Constraints*

Christopher Nagel and George Stephanopoulos, *Inductive and Deductive Reasoning: The Case of Identifying Potential Hazards in Chemical Processes*

Kevin G. Joback and George Stephanopoulos, *Searching Spaces of Discrete Solutions: The Design of Molecules Possessing Desired Physical Properties*

**Volume 22**

Chonghun Han, Ramachandran Lakshmanan, Bhavik Bakshi, and George Stephanopoulos, *Non-monotonic Reasoning: The Synthesis of Operating Procedures in Chemical Plants*

Pedro M. Saraiva, *Inductive and Analogical Learning: Data-Driven Improvement of Process Operations*

Alexandros Koulouris, Bhavik R. Bakshi, and George Stephanopoulos, *Empirical Learning through Neural Networks: The Wave-Net Solution*

Bhavik R. Bakshi and George Stephanopoulos, *Reasoning in Time: Modeling, Analysis, and Pattern Recognition of Temporal Process Trends*

Matthew J. Realf, *Intelligence in Numerical Computing: Improving Batch Scheduling Algorithms through Explanation-Based Learning*

**Volume 23**

Jeffrey J. Sirola, *Industrial Applications of Chemical Process Synthesis*

Arthur Westerberg and Oliver M. Wahnschafft, *The Synthesis of Distillation-Based Separation Systems*

Ignacio E. Grossman, *Mixed-Integer Optimization Techniques for Algorithmic Process Synthesis*

Subash Balakrishna and Lorenz T. Biegler, *Chemical Reactor Network Targeting and Integration: An Optimization Approach*

Steve Walsh and John Perkins, *Operability and Control in Process Synthesis and Design*