
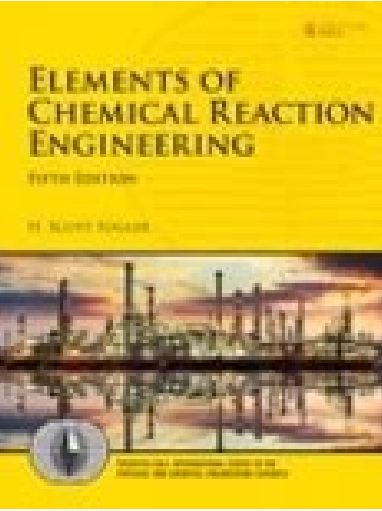
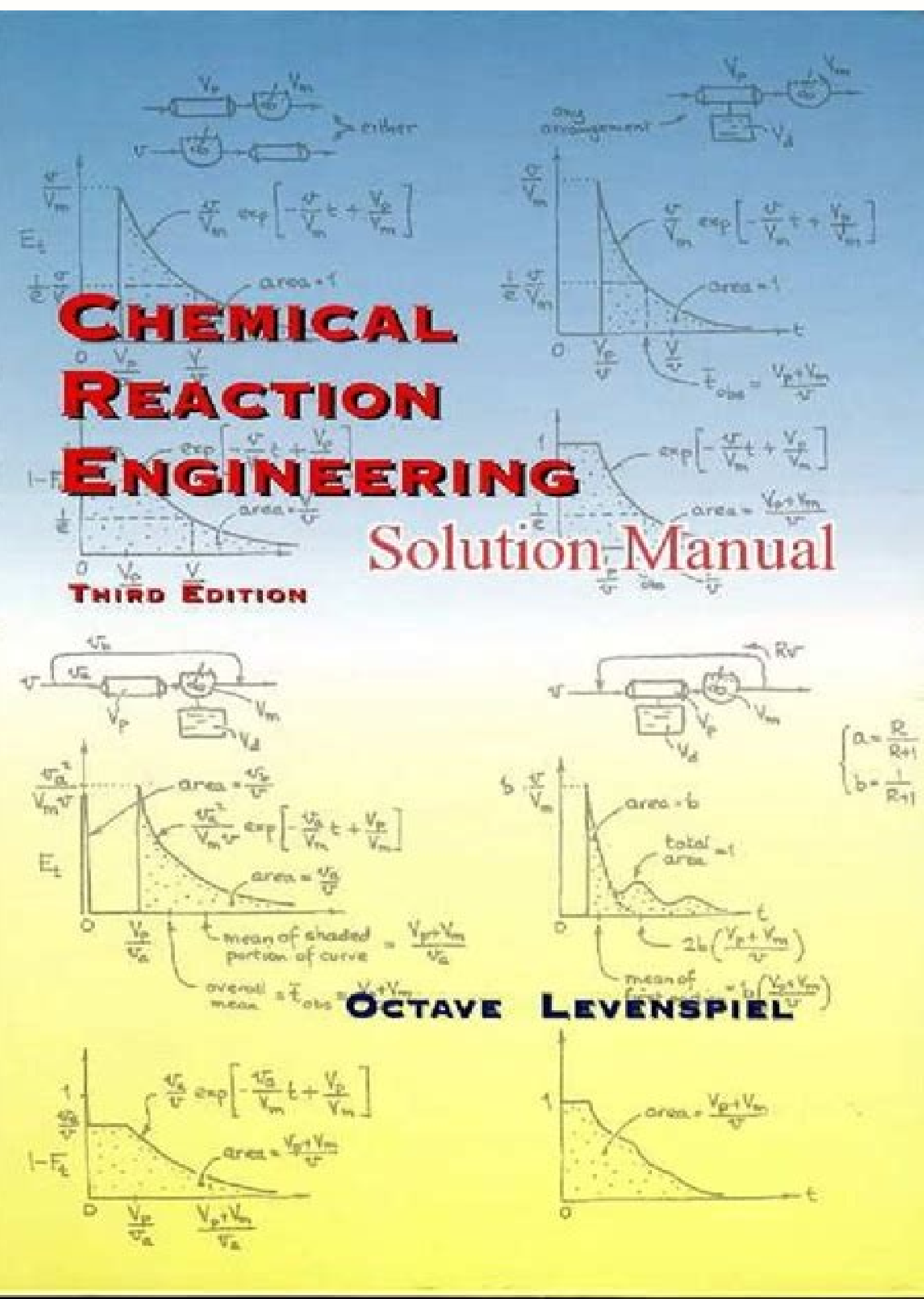


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# Chemical Reaction Engineering

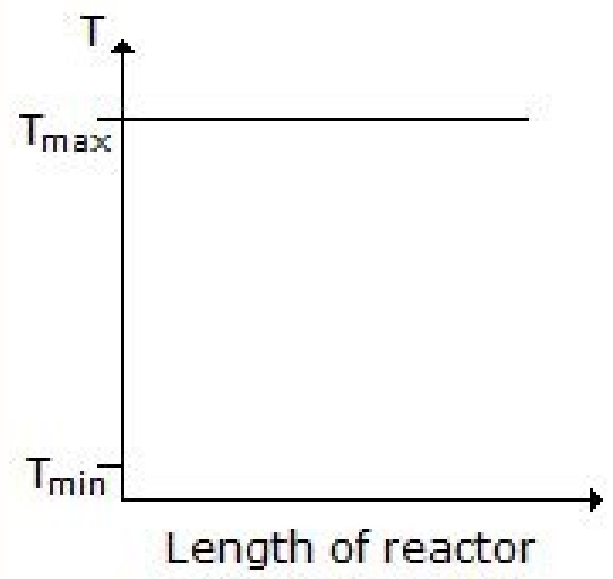
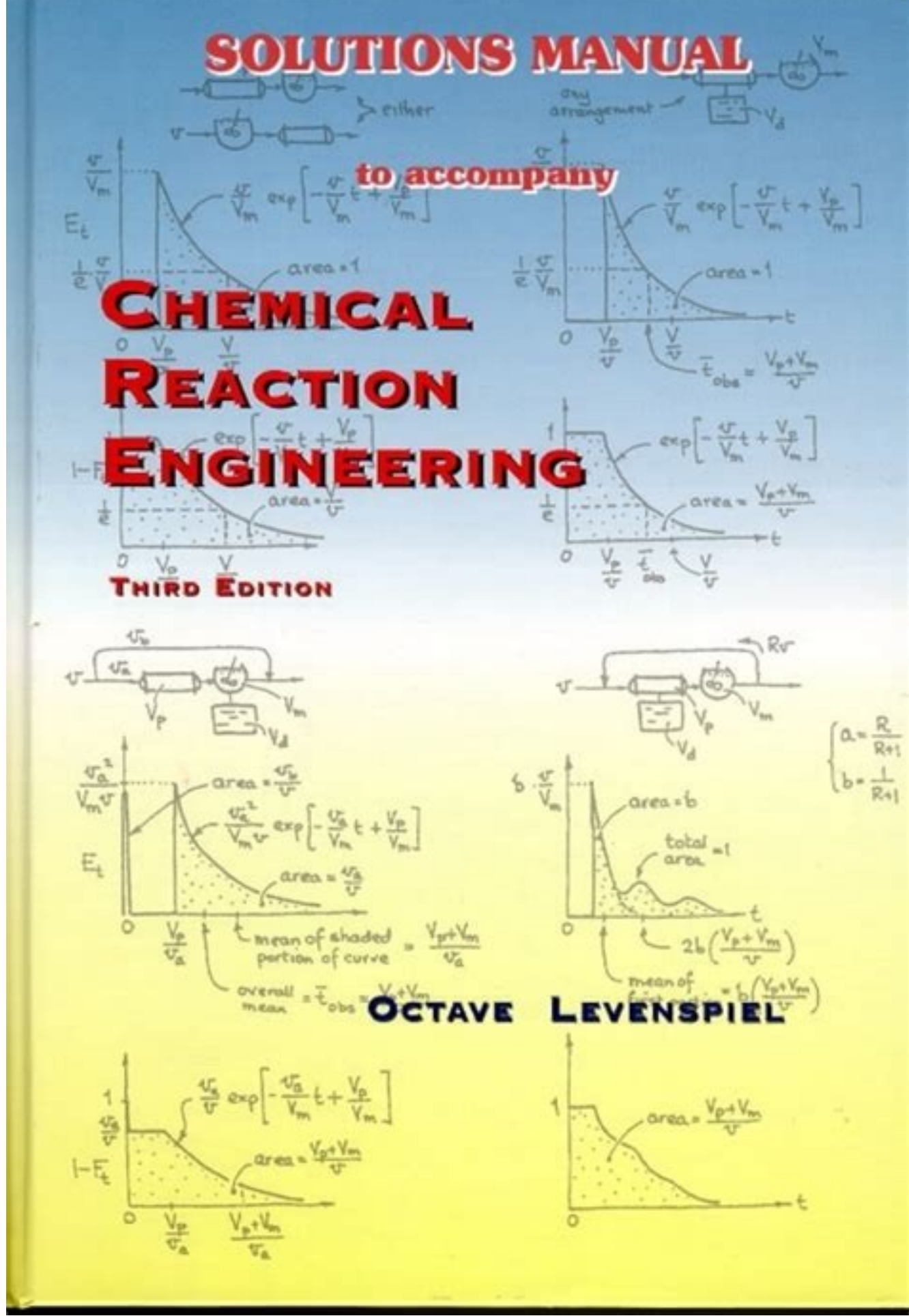
Third Edition

**Octave Levenspiel**  
 Department of Chemical Engineering  
 Oregon State University



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Concept of chemical reaction. Law of chemical equation. Concept of chemical kinetics.

Chemical reactors. But I have added a number of new topics-biochemical systems, reactors with fluidized solids, gadiquid reactors, and more on nonideal flow. The reason for this is my feeling that students should at least be introduced to these subjects so that they will have an idea of how to approach problems in these important areas. Report DMCA O SlideShare utiliza cookies para otimizar a funcionalidade e o desempenho do site, assim como para apresentar publicidade mais relevante aos nossos usuÁrios. This is a teaching book; thus, simple ideas are treated first, and are then extended to the more complex. Embed Size (px) 344 x 292429 x 357514 x 422599 x 487DESCRIPTIONOctave levenspiel, solution manualText of Solution Manual Chemical Reaction Engineering, 3rd Edition(Levenspiel-chemical-reaction-engineering)CoverSolution Manual ISBN: 0-471-31478-1Contentsch1ch2ch3ch4ch5ch6ch7ch8ch9ch10ch11ch12ch13ch14ch15ch17ch18ch19ch20ch21ch22ch23ch24ch25ch26ch27ch29ch30TrUe LIArSearch relatedPage 2Chemical Reaction Engineering Third Edition Octave Levenspiel Department of Chemical Engineering Oregon State University John Wiley & Sons New York Chichester Weinheim Brisbane Singapore Toronto ACQUISITIONS EDITOR Wayne Anderson MARKETING MANAGER Katherine Hepburn PRODUCTION EDITOR Ken Santor SENIOR DESIGNER Kevin Murphy ILLUSTRATION COORDINATOR Jaime Perea ILLUSTRATION Wellington Studios COVER DESIGN Bekki Levien This book was set in Times Roman by Bi-Comp Inc. Sustained yield harvesting principles ensure that the numbers of trees cut each year does not exceed the amount of new growth. This book is printed on acid-free paper. paper) 1. This new edition is divided into five parts. Copyright O 1999 John Wiley & Sons, Inc. Finally, I'd like to acknowledge Professors Keith Levien, Julio Ottino, and Richard Turton, and Dr. Amos Avidan, who have made useful and helpful comments. TÁtulo. Also, emphasis is placed throughout on the of a common design strategy for all systems, homogeneous and heterogeneous. Chemical reaction engineering 1 Octave Levenspiel. Its goal is the successful design and operation of chemical reactors, and probably more than any other activity it sets chemical engineering apart as a distinct branch of the engi- neering profession. Leia nossa PolÁtica de Privacidade e nosso Contrato do UsuÁrio para obter mais detalhes. For the graduate or second course the material in Parts 2 to 5 should be suitable. 1. Leia nosso Contrato do UsuÁrio e nossa PolÁtica de Privacidade. For me, these would be catalytic systems (just Chapter 18) and a bit on nonideal flow (Chapters 11 and 12). Se vocÁA continuar a navegar o site, vocÁA aceita o uso de cookies. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, scanning or otherwise, except as permitted under Sections 107 or 108 of the 1976 United States Copyright Act, without either the prior written permission of the Publisher, or authorization through payment of the appropriate per-copy fee to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, (508) 750-8400, fax (508) 750-4470. In a typical situation the engineer is faced with a host of questions: what information is needed to attack a problem, how best to obtain it, and then how to select a reasonable design from the many available alternatives? - 3rd ed. In fact, I have removed material from here and there that I felt more properly belonged in advanced books. TP157.L4 1999 6601.281-dc21 97-46872 CIP Printed in the United States of America Preface Chemical reaction engineering is that engineering activity concerned with the exploitation of chemical reactions on a commercial scale. The purpose of this book is to teach how to answer these questions reliably and wisely. To develop new ways of thinking new new intuitions is not easy. For the first undergraduate course, I would suggest covering Part 1 (go through Chapters 1 and 2 quickly-don't dawdle there), and if extra time is available, go on to whatever chapters in Parts 2 to 5 that are of interest. iii - Preface I feel that problem-solving-the process of applying concepts to new situa- tions-is essential to learning. Also, my grateful thanks go to Pam Wegner and Peggy Blair, who typed and retyped-probably what seemed like ad infinitum-to get this manu- script ready for the publisher. Requests to the Publisher for permission should be addressed to the Permissions Department, John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158-0012, (212) 850-6011, fax (212) 850-6008, E-Mail: [email protected] Library of Congress Cataloging-in-Publication Data: Levenspiel, Octave. cm. ISBN 0-471-25424-X (cloth : alk. Includes index. The paper in this book was manufactured by a mill whose forest management programs include sustained yield harvesting of its timberlands. To do this I emphasize qualitative arguments, simple design methods, graphical procedures, and frequent comparison of capabilities of the major reactor types. Consequently this edition includes over 80 illustra- tive examples and over 400 problems (75% new) to help the student learn and understand the concepts being taught. This is an introductory book. This approach should help develop a strong intuitive sense for good design which can then guide and reinforce the formal methods, and printed and by the Hamilton Printing Company. Octave Levenspiel Chemical Engineering Department Oregon State University Corvallis, OR, 97331 Fax: (541) 737-4600 Contents Notation /xi Chapter 1 Overview of Chemical Reaction Engineering 11 Part I Homogeneous Reactions in Ideal Reactors 111 Chapter 2 Kinetics of Homogeneous Reactions 113 2.1 Concentration-Dependent Term of a Rate Equation 114 2.2 Temperature-Dependent Term a Rate Equation 127 2.3 Searching for a Mechanism 129 2.4 Predictability of Reaction Rate from Theory 132 Chapter 3 Interpretation of Batch Reactor Data 138 3.1 Constant-volume Batch Reactor 139 3.2 Varying-volume Batch Reactor 167 3.3 Temperature and Reaction Rate 172 3.4 The Search for a Rate Equation 175 Chapter 4 Introduction to Reactor Design 183 vi Contents Chapter 5 Ideal Reactors for a Single Reaction 190 5.1 Ideal Batch Reactors 191 5.2. If you are author or own the copyright of this book, please report to us by using this DMCA report form. Regarding this new edition: first of all I should say that in spirit it follows the earlier ones, and I try to keep things simple. Steady-State Mixed Flow Reactors 194 5.3 Steady-State Plug Flow Reactors 1101 Chapter 6 Design for Single Reactions 1120 6.1 Size Comparison of Single Reactors 1121 6.2 Multiple-Reactor Systems 1124 6.3 Recycle Reactor 1136 6.4 Autocatalytic Reactions 1140 Chapter 7 Design for Parallel Reactions 1152 Chapter 8 Potpourri of Multiple Reactions 1170 8.1 Irreversible First-Order Reactions in Series 1170 8.2 First-Order Followed by Zero-Order Reaction 1178 8.3 Zero-Order Followed by First-Order Reaction 1179 8.4 Successive Irreversible Reactions of Different Orders 1180 8.5 Reversible Reactions 1181 8.6 Irreversible Series-Parallel Reactions 1181 8.7 The Denbigh Reaction and its Special Cases 1194 Chapter 9 Temperature and Pressure Effects 1207 9.1 Single Reactions 1207 9.2 Multiple Reactions 1235 Chapter 10 Choosing the Right Kind of Reactor 1240 Part II Flow Patterns, Contacting, and Non-Ideal Flow 1255 Chapter 11 Basics of Non-Ideal Flow 1257 11.1 E, the Age Distribution of Fluid, the RTD 1260 11.2 Conversion in Non-Ideal Flow Reactors 1273 Contents Yii Chapter 12 Compartment Models 1283 Chapter 13 The Dispersion Model 1293 13.1 Axial Dispersion 1293 13.2 Correlations for Axial Dispersion 1309 13.3 Chemical Reaction and Dispersion 1312 Chapter The Tanks-in-Series Model 1321 14.1 Pulse Response Experiments and the RTD 1321 14.2 Chemical Conversion 1328 Chapter 15 The Convection Model for Laminar Flow 1339 15.1 The Convection Model and its RTD 1339 15.2 Chemical Conversion in Laminar Flow Reactors 1345 Chapter 16 Earliness of Mixing, Segregation and RTD 1350 16.1 Self-mixing of a Single Fluid 1350 16.2 Mixing of Two Miscible Fluids 1361 Part 111 Reactions Catalyzed by Solids 1367 Chapter 17 Heterogeneous Reactions - Introduction 1369 Chapter 18 Solid Catalyzed Reactions 1376 18.1 The Rate Equation for Surface Kinetics 1379 18.2 Pore Diffusion Resistance Combined with Surface Kinetics 1381 18.3 Porous Catalyst Particles 1385 18.4 Heat Effects During Reaction 1391 18.5 Performance Equations for Reactors Containing Porous Catalyst Particles 1393 18.6 Experimental Methods for Finding Rates 1396 18.7 Product Distribution in Multiple Reactions 1402 viii Contents Chapter 19 The Packed Bed Catalytic Reactor 1427 Chapter 20 Reactors with Suspended Solid Catalyst, Fluidized Reactors of Various Types 1447 20.1 Background Information About Suspended Solids Reactors 1447 20.2 The Bubbling Fluidized Bed-BFB 1451 20.3 The K-L Model for BFB 1445 20.4 The Circulating Fluidized Bed-CFB 1465 20.5 The Jet Impact Reactor 1470 Chapter 21 Deactivating Catalysts 1473 21.1 Mechanisms of Catalyst Deactivation 1474 21.2 The Rate and Performance Equations 1475 21.3 Design 1489 Chapter 22 GII. Reactions on Solid Catalyst: Trickle Beds, Slurry Reactors, Three-Phase Fluidized Beds 1500 22.1 The General Rate Equation 1500 22.2 Performanc Equations for an Excess of B 1503 22.3 Performance Equations for an Excess of A 1509 22.4 Which Kind of Contactor to Use 1509 22.5 Applications 1510 Part IV Non-Catalytic Systems 1521 ChPage 3Please donate to us. The pace is leisurely, and where needed, time is taken to consider why certain assumptions are made, to discuss why an alternative approach is used, and to indicate the limitations of the treatment when applied to real situations. Se vocÁA continuar a utilizar o site, vocÁA aceita o uso de cookies. O SlideShare utiliza cookies para otimizar a funcionalidade e o desempenho do site, assim como para apresentar publicidade mais relevante aos nossos usuÁrios. 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