

Contents

Preface *xi*

Nomenclature *xiii*

Part I Non-ideal Flow Characterization and Chemical Reaction *1*

- 1 Non-ideal Flow and Reactor Characterization** *3*
 - Summary of Residence Time Distribution Properties and Most Important Models *3*
 - Residence Time Distribution *3*
 - RTD in Ideal Reactors *4*
 - Tanks-in-series (TIS) Model *4*
 - Dispersion Model *4*
 - $Bo < 0.01$ *4*
 - $Bo > 0.01$, Closed–Closed Recipient *4*
 - $Bo > 0.01$, Open–Open Recipient *4*
- 2 Chemical Reaction in Non-ideal Reactors** *55*
 - Summary of Most Important Models *55*
 - Calculation of Conversion *55*
 - Tanks-in-series (TIS) Model and Chemical Reaction *55*
 - Dispersion Model and Chemical Reaction *55*
 - From RTD Runs *56*
 - Mass Balance in Ideal Reactors *57*
 - Arrhenius Law for Kinetic Constants *57*
- 3 Transfer Function in Chemical Reactor Design** *123*
 - Summary of the Equations and Concepts *123*
 - Transfer Function *123*
 - Laplace Transform of Some Functions *123*

Transfer Function in Ideal Reactors	124
CSTR	124
PFR	124

Part II Convolution and Unsteady State in Chemical Reactors 139

4 Convolution and Deconvolution of Signals in Chemical Reactor Engineering	141
Summary of Equations and Methods	141
Convolution	141
Deconvolution	143
5 Partial Differential Equations in Chemical Reactor Engineering	157
Summary	157
Finite Differences Method (FDM)	157
First Derivative	157
Second Derivative	157
Stability of the FDM	157
Ideal Reactors Working in Unsteady State	158
CSTR Working in Unsteady State	158
PFR Working in Unsteady State (No Dispersion)	158
PFR Working in Dynamic Regime (With Dispersion)	159

Part III Catalytic and Multiphase Reactor Design 213

6 Reaction Rate in Catalytic Processes	215
Summary of Equations for the Catalytic Reactor Design	215
Rate in Heterogeneous Systems	215
Rate of External Diffusion	216
Dimensionless Numbers and Their Relationship	216
Internal Diffusion Effect	217
Combination of Resistances	218
Process of Absorption (No Reaction)	218
7 Catalytic Reactor Design	253
8 Multiphase Reactor Design	299
Summary of Rate Expressions	299
Process of Absorption (No Reaction)	299
Fluid–Fluid Reaction	299
Fluid–Fluid (Gas–Liquid) Reaction in Catalysts	301

Part IV Biochemical Reactor Design	335
9 Biochemical Reactor Design: Enzymatic Processes	337
Summary of Kinetic Expressions	337
Enzymatic Reactions	337
Michaelis–Menten Kinetics	337
10 Biochemical Reactor Design: Microbial Growth	357
Summary of Kinetic Expressions and Mass Balances in Bioreactors	357
Bibliography	385
Index	387

