

CONTENTS

Foreword		ix
Preface to the Russian Edition		xi
Chapter 1	The Importance of Catalytic Phenomena	1
	1.1. The Basic Peculiarities of Catalysis	1
	1.2. The Role of Catalysis in the Chemical and Petroleum-Processing Industries	3
	1.3. Catalysis in the Living Nature	14
	References	16
Chapter 2	The Nature of Catalyst Action	17
	2.1. General Factors Determining the Rate of Chemical Transformation	17
	2.2. The Effect of Deviation from Equilibrium Energy Distribution on the Rate of Chemical Reaction	25
	2.3. New Reaction Pathways in the Presence of Catalysts	28
	2.4. Classification of Catalytic Processes	38
	References	42
Chapter 3	General Regularities of Heterogeneous Catalysis	43
	3.1. Interatomic Bond in Solids used as Catalysts	43
	3.2. Comparison of Rates of Homogeneous and Heterogeneous Catalytic Reactions	47
	3.3. Intermediate Interaction in Heterogeneous Catalysis	48
	3.4. Geometrical Correspondence	51
	3.5. Significance of Structural Distortions	53
	3.6. Specific Catalytic Activity	53
	3.7. Possibilities for Prediction of Catalytic Activity	57
	3.8. Catalytic Activity and Energy of Intermediate Interaction with Catalyst	58
	3.8.1. The Brönsted-Polanyi Correlation	59
	3.8.2. Energy of Intermediate Interaction with Catalyst	63
	3.8.3. Main Steps of Intermediate Interaction at Heterogeneous Catalysis	73

	3.8.4. Optimal Heats of Reactant and Product Chemisorption	79
	3.9. The Role of Radicals in Heterogeneous Catalysis	85
	3.10. Heterogeneous-Homogeneous Catalysis	86
	References	88
Chapter 4	Catalytic Activity and Methods of Determining it	93
	4.1. Effect of Transfer Processes	93
	4.2. Effect of Reversibility	95
	4.3. Measure of Catalyst Quantity	98
	4.4. Dependence of Catalytic Activity on Reaction Mixture Composition and Temperature	98
	4.5. Selectivity	99
	4.6. Methods of Measuring Catalytic Activity	102
	4.6.1. Statical Methods	102
	4.6.2. Flow Methods	107
	4.7. Pulse Methods	120
	4.8. Research into Catalyst of Varying Activity	121
	References	123
Chapter 5	Basic Mechanisms of Heterogeneous Catalysis	125
	5.1. General Notions of the Mechanism of Oxidation on Solid Catalysts	125
	5.2. Isotope Exchange of Oxygen	130
	5.3. Catalytic Oxidation of Hydrogen	135
	5.3.1. Hydrogen Oxidation on Oxide Catalysts	135
	5.3.2. Hydrogen Oxidation on Metals	138
	5.4. Catalytic Oxidation of Carbon Monoxide	141
	5.4.1. Oxidation of CO on Oxide Catalysts	141
	5.4.2. CO Oxidation on Metals	143
	5.4.3. Conversion of CO with Water Vapour	150
	5.5. Complete Oxidation of Hydrocarbons on Oxide Catalysts	151
	5.6. Partial Oxidation of Organic Compounds	154
	5.7. Oxidation of Sulfur Dioxide	159
	5.8. Isotope Exchange of Nitrogen	160
	5.9. Ammonia Synthesis	163
	References	166
Chapter 6	Kinetics of Heterogeneous Catalytic Reactions	173
	6.1. Evolution of Ideas on Regularities of the Kinetics of Heterogeneous Catalytic Reactions	174
	6.2. Molecularity of Complex Reactions	182
	6.3. Effect of the Interaction between the Reacting System and the Catalyst on the Reaction Kinetics	185
	6.3.1. Change of Catalyst Properties under the Action of the Reaction Medium	186
	6.3.2. Possible Range of Changes of Steady-State Catalyst Composition in a Catalytic Process	189

6.3.3. Kinetics of Heterogeneous Catalytic Reactions with Account Taken of the Reaction Medium Effect	192
6.3.4. Control of Unsteady States of a Catalyst by Reaction Medium	200
6.4. Taking into Account the Effect of Heat and Mass Transfer in Kinetic Research	205
6.4.1. Transfer Processes between the Gas Flow and the External Surface of Catalyst Grains	205
6.4.2. Influence of Internal Transfer Processes on the Reaction Rate	211
6.4.3. Kinetics of Reversible Catalytic Reactions in the Region of Internal Diffusion	216
6.4.4. Effect of Catalyst Pore Structure on Internal Transfer Processes during a Catalytic Reaction	222
References	226
Chapter 7 Conclusion	231
Index	233