
CONTENTS

Preface	ix
Nomenclature	xiii
Introduction	1
1 The Exergy Concept and Exergy Losses	7
1.1 The Concepts of Exergy and Anergy	7
1.2 Exergy Losses and the Exergy Balance	10
1.3 Main Thermodynamic Applications of Exergy Analysis	27
Problems	39
2 Calculation of Exergy	41
2.1 Reference Level for Calculation of Exergy	41
2.2 Calculation of Physical Exergy	51
2.3 Calculation of Chemical Exergy	54
2.4 Exergy of Thermal Radiation	71
Problems	79
3 Physical and Chemical Exergy of Typical Substances	81
3.1 Exergy of Air and the Components of Air	81
3.2 Thermal Exergy of Combustion Gases	93

3.3	Thermal Exergy of Liquid Water and Steam	99
3.4	Physical Exergy of Refrigerants	101
3.5	Chemical Exergy of Technical Fuels	101
3.6	Exergy of Typical Metallurgical Raw Materials and Products Problems	110 116
4	Exergy Analysis of Typical Thermal and Chemical Processes	117
4.1	Heat Exchangers	117
4.2	Flow Machines	118
4.3	Solution Processes	124
4.4	Combustion Processes	128
4.5	Exergy Losses in Steam Generators and Heating Furnaces	136
4.6	Exergy Analysis of Steam Power Plant	140
4.7	Exergy Analysis of Compression Refrigerators	143
4.8	Exergy Analysis of Heat Transformers	152
4.9	Exergy Analysis of Jet Propulsion	160
4.10	Exergy Analysis of Combined Processes	166
4.11	Solar Collectors Problems	168 169
5	Cumulative Exergy Consumption and Cumulative Degree of Perfection	171
5.1	Definition and Applications of Cumulative Exergy Consumption and of Cumulative Degree of Perfection	171
5.2	Calculation Methods	174
5.3	Cumulative Degree of Perfection for the Manufacture of Some Products Problems	179 191
6	Reduction of External Exergy Losses	193
6.1	Recuperation	193
6.2	Independent Preheating of Combustion Reactants	204
6.3	Utilization of Elevated Pressure of Outlet Gases	209
6.4	Waste Heat Boilers and Evaporative Cooling	211
6.5	Heat Pumps	212
6.6	Application of Waste Heat for Refrigeration Problems	216 218
7	Exergy Analysis of Major Thermal and Chemical Processes	221
7.1	Commercial Electrical Power Generation Stations	221
7.2	Metallurgical Processes	229

7.3	Industrial Chemical Processes Problems	251 269
8	Thermoeconomic Applications of Exergy	271
8.1	Partition of Exergy Consumption and of Production Costs in Combined Processes	271
8.2	Approximate Determination of the Effect of Exergy Carrier Parameters on Its Economic Value	274
8.3	Optimum First Costs Distribution between Two Parts of an Installation	274
8.4	Optimization of the Operational Parameters of an Operating Plant	277
8.5	Determination of Local Costs of Heat and Pressure Losses	278
8.6	Economic Optimization of Complex Thermal Plants Problems	284 291
9	Ecological Applications of Exergy	293
9.1	Coefficient of Ecological Cost	293
9.2	Minimization of Consumption of Natural Resources	295
	Appendix	297
	References and Bibliography	315
	Index	327