CONTENTS

		Page
Pre	face	ix
List	t of Common Symbols	xi
1.	Energy Outlook	
	Introduction	1
	I. Scope of the Problem II. Thormodynamic Efficiencies	1
	III The Fundamental Strategy	12
	Notes	10
2.	The Second Law of Thermodynamics Revisited	
	Differences between Lows	18
	I. Definitions	20
	II. Available Energy and Fuel	27
	Summary	30
	Notes	30
3.	Thermodynamics and Economics	22
	Introduction	32
	I. Ocheral Considerations	32
	III Pricing Other Utilities	58 47
	Summary	51
	Notes	51
4.	Characterizing Energy Use	
	Introduction	52
	I. Understanding Energy Use	52
	II. Missing Data	60
	III. An Illustrative Onsite Audit	62
	IV. An Illustrative Steam Power Balance	69
	Notes	71 73
5	Ontimum Developmenes of Existing Essilities	
5.	Introduction	74
	I. Principle 1—Minimize Waste	74
	II. Combustion Principles	75
	III. Illustrative Problems – Combustion Efficiency	83
	IV. Steam Trap Principles	85
	V. Principle 2 – Manage Energy Use Effectively	92
	Summary	105
	Notes	106
6.	Facilities Improvement – An Overall Site Approach	10-
	Introduction	107
	Outrizing the Energy Audit	108
	II. Overall Sile Interactions III Total Site Cogeneration Potential	115
	Problem · Maximum Potential Fuel Utilization	124
	IV. The Linear Programming Approach	133
	Summary	136
	Notes	138

7.	Methodology of Thermodynamic Analysis : General Considerations	
	Introduction	139
	Sign Conventions	140
	I. Detailed Procedures	140
	II. Illustrative Examples	155
	Summary	163
	Notes	164
8.	Detailed Thermodynamic Analysis of Common Unit Operations	
	Introduction	165
	I. Heat Exchange	165
	II. Expansion—Pressure Letdown	173
	III. Mixing	177
	IV. Distillation – A Combination of Simple Processes	181
	V. Combustion Air Preheating	185
	Summary	187
	Notes	187
9.	Use of Thermodynamic Analysis to Improve Energy Efficiency	
	Introduction	189
	I. Overall Strategy	190
	II. Reducing Available Energy (Work) Losses	199
	III. Accepting inevitable inefficiencies	222
	V Posseerch Guidence	220
	Summary	231
	Problem · Phthalic Anhydride Process Improvement	240
	Notes	244
10	Thermodynamics and Economics Part II: Canital-Cost Relationships	
10.	Background Information	245
	I. The Entire Plant Energy System Is Pertinent	248
	II. Investment Optimization	261
	III. Defining the Limits of Current Technology	270
	IV. Fundamental Process Improvements	273
	Summary	276
	Notes	277
11.	Systematic Design Methods	
	Introduction	278
	I. Process Synthesis	279
	II. Applications to Cogeneration Systems	295
	III. Thermoeconomics	296
	IV. Systematic Optimization	304
	Thermoeconomics Summary Notes	308 308
12.	Guidelines and Recommendations for Improving Process Operations	310
	I Chemical Reactions	311
	II. Separations	313
	III. Heat Transfer	314
	IV. Process Machinery	315
	V. System Interactions and Economics	316
	VI. A Checklist of Energy Conservation Items	319
	VII. Shortcomings of Guidelines	323
	Notes	323
Ind	ex	325