

THE THERMOECONOMICS OF ENERGY CONVERSIONS

Yehia M. El-Sayed

Contents

Preface

1	Introduction		
	1.1	The Emerging Concerns	1
	1.2	The Complexity of the Design Space	2
	1.3	The Level of Details of a System Description	3
	1.4	The Interaction of Energy and Materials Requirements	3
	1.5	The History of Thermoeconomics Development	4
	1.6	The Question Posed for Thermoeconomic Analysis	5
	1.7	The Importance of an Integrated Database	5
	1.8	The Main Pillars of Thermoeconomic Analysis	6
	1.9	General References	6
2	Improved Thermodynamic Analysis		
	2.1	The Exergy Function	12
	2.2	The Thermodynamic Analysis of a System	
		in the Steady State	17
	2.3	Tutorial	20
	2.4	References	29
3	Improved Costing Analysis		
	3.1	The Objective Function as a Cost Function	31
	3.2	Making and Operating Resources of an	
		Energy-Conversion Device	31
	3.3	The Quantification of the Making and	
		Operating Resources for a Device	32
	3.4	Making and Operating Resources of a System of Devices	34
	3.5	The Cost Indices c_F , $\{c_{zi}\}$, and $\{c_{ai}\}$	35
	3.6	Combining Second-Law and Costing Analyses	
		(Thermoeconomic Analysis)	35
	3.7	Tutorial	37
	3.8	Selected References	48
4	Enhanced System Optimization		
	4.1	A Two-Level Decomposition Strategy	49
	4.2	Decomposition at the Discipline Level	49
	4.3	Decomposition at the Device Level	52
	4.4	More on the Objective Function and on Decomposition	58
	4.5	Programming Thermoeconomic Analysis	63
	4.6	Tutorial	67
	4.7	Selected References	80

5	The N	Nanipulation of the Design Models of Devices	83		
	5.1 I	Multidisciplinary Problems in General	83		
	5.2	The Communication Between the Disciplines of			
	-	Thermodynamics and Design	83		
	5.3 A	A Heat Exchange Device	84		
	5.4	Tutorial Tutorial	91		
	5.5	Selected References	94		
6	Off-Design Performance Due to Load Variation				
	6.1 I	Managing the Inefficiency of Variable-Load Operation	97		
	6.2 I	Predicting the Part-Load Performance of			
	8	a System of Devices	99		
	6.3 I	Handling the System-Design of Variable-Load Problems	99		
		Optimal Operation of a Facility of Systems			
		of Same Product	105		
		Гutorial	107		
	6.6	Selected References	109		
7	Application Examples				
	7.1	Time-Independent Production	111		
	7.2	Time-Dependent Production	123		
		Closing Remarks	136		
	7.4	Selected References	137		
8	Software, Analyzed Systems and their Flow Diagrams:				
	8.1	Contents of the Compact Disc	139		
		Brief Description of the Six Executable Tools	140		
	8.3	The Analyzed Systems and Their Flow Diagrams	151		
9	Appei	ndices	199		
			199		
Appendix 9.1 Some Useful Forms of the Flow Exergy					
App	endix 9	.2 Thermodynamic and Design Models	205		
App	endix 9	.3 Capital and Performance Equations	211		
App	endix 9	.4 Refreshing Basic Engineering Material	217		
App	endix 9	.5 Selected General Properties	231		
App	endix 9	A Selected Compilation of Heat Transfer Film Coefficients and Friction Factors			
Apr	nendix 9	.7 Glossary	249		

Contents				
Appendix 9.8	Nomenclature	253		
Appendix 9.9	Constants and Conversion Factors	257		

Subject Index

261