

# Contents

<b>1</b>	<b>The Heat Engine, the Prime Movers, and the Modern</b>	
	<b>Closed Energy Conversion Systems .....</b>	<b>1</b>
1.1	The Thermodynamic Characteristics of the Heat Engine.....	2
1.1.1	Some Special Combinations of Heat Sources and Heat Engines .....	6
1.2	The Heat Pump and the Refrigeration Machines .....	8
1.3	The Conversion Energy Systems and the Thermodynamic Cycles .....	14
1.4	The Cogeneration of Thermal and Electrical Power .....	16
1.5	The Traditional External Combustion Prime Movers.....	21
1.6	The Steam Cycle .....	24
1.6.1	The Thermodynamic of the Rankine cycle .....	25
1.6.2	The Regenerative Rankine Cycle.....	29
1.6.3	The Importance of the Condensation Pressure.....	32
1.6.4	The Superheating and the Repeated Superheating.....	37
1.6.5	Supercritical Cycles .....	39
1.6.6	The Steam Cycle for the Nuclear Power Plants.....	40
1.7	The Closed Gas-Turbine Cycle .....	44
1.7.1	The Isentropic Transformation for the Perfect Gas .....	46
1.7.2	The Thermodynamics of the Ideal Closed Gas Cycle .....	48
1.7.3	Compressor and Turbine Efficiency .....	55
1.7.4	Efficiency of the Recuperator and the Effect of the Pressure on the Design of Heat Exchangers .....	58
1.7.5	The Thermodynamic of the Real Cycles .....	63
1.7.6	Final Considerations on the Choice of Working Fluid and Pressure Levels in the Gas Cycle.....	66
1.7.7	Examples of Several Plants that Have Been Built and Examples of the Engines Proposed .....	69

1.8	The Stirling Engine .....	74
1.8.1	The Thermodynamic Analysis of the Stirling Engine .....	78
1.8.2	Some Final Considerations .....	91
	References .....	93
<b>2</b>	<b>The Thermodynamic Properties of the Working Fluids .....</b>	<b>95</b>
2.1	The Thermodynamic Plane of the Substances .....	96
2.2	The Simplified Thermodynamic Systems and the Equations of State .....	97
2.3	The Volumetric Equation of State for the Pure Fluids .....	99
2.4	The Evaluation of the Thermodynamic Properties of a Real Gas .....	103
2.5	The Molecular Complexity of the Fluid and the Shape of the Limit Curve .....	109
2.6	The Equations of State for Mixtures .....	111
	References .....	114
<b>3</b>	<b>The Organic Rankine Cycle .....</b>	<b>117</b>
3.1	A Brief History of the Organic Rankine Engines .....	119
3.2	The Characteristics of Candidate Working Fluids According to the Applications .....	125
3.3	The Thermodynamic Aspects of the Organic Rankine Cycles .....	128
3.4	The Connections Between the Thermodynamics and the Machines .....	132
3.5	The Heat Recovery: Basic Thermodynamic Considerations .....	139
3.6	Some Examples of Applications of Organic Rankine Engines .....	150
3.7	Multicomponent Working Fluids for Organic Rankine Cycles .....	168
	References .....	173
<b>4</b>	<b>The Real Gas Closed Cycles .....</b>	<b>177</b>
4.1	Carbon Dioxide Power Cycles .....	180
4.2	Organic Real Gas Cycles .....	190
4.3	Real Gas Stirling Engines .....	198
	References .....	203
<b>5</b>	<b>The Binary Cycles .....</b>	<b>205</b>
5.1	The Binary Liquid Metal–Steam Cycle .....	208
5.2	The Binary Potassium and Rubidium–Steam Cycle .....	212
	References .....	217
<b>A</b>	<b>The Fluid Machines and the Balance Equations .....</b>	<b>219</b>
A.1	The Mass Balance .....	219
A.2	The Energy Balance .....	223
A.3	The Energy Balance with Chemical Reactions .....	231
A.4	The Entropy Balance .....	232
	References .....	233

<b>B The Exergy or the Available Energy Function .....</b>	<b>235</b>
B.1 The Exergy Balance .....	238
References .....	248
 <b>C Irreversibilities in the Thermodynamic Cycles and in the Thermal Machines .....</b>	 <b>249</b>
C.1 Irreversibilities, Both Internal and Towards the External Environment .....	249
C.2 Definition of the Characteristics of the Cooling Well and the Heat Source .....	250
C.3 Introduction to the Thermodynamic Analysis of Losses .....	252
C.4 The Losses in Steam Cycles and in Gas-Turbine Cycles .....	255
C.5 Significance of the Thermodynamic Losses and Investigation of the Indirect Effects of the Irreversibilities .....	258
C.6 Alternative Methods for Evaluating the Influence of Losses .....	261
C.7 Final Considerations .....	262
References .....	263

Closed Power Cycles

Thermodynamic Fundamentals and Applications

Invernizzi, C.M.

2013, XVI, 264 p. 146 illus., Hardcover

ISBN: 978-1-4471-5139-5