

Sustainable Production, Life Cycle Engineering and Management
Series Editors: Christoph Herrmann, Sami Kara

Sebastian Thiede

Energy Efficiency in Manufacturing Systems

 Springer

Contents

List of Figures	XI
List of Tables.....	XVII
List of Symbols and Abbreviations	XIX
1 Introduction	1
1.1 Sustainability as New Paradigm in Manufacturing.....	1
1.2 Motivation	4
1.3 Objectives and Work Structure.....	6
2 Theoretical Background.....	9
2.1 Production and Production Management.....	9
2.2 Energy and Energy Supply	12
2.3 Energy Consumption in Manufacturing.....	16
2.3.1 Forms of Energy Consumption in Manufacturing.....	16
2.3.2 Consumers of Energy	19
2.3.3 Energy Consumption Behaviour of Production Machines	21
2.4 Description of Selected Relevant Energy Flows in Manufacturing	23
2.4.1 Electricity	23
2.4.2 Compressed Air Generation	25
2.4.3 Steam Generation	28
2.5 Energy Efficiency in Manufacturing	30
2.5.1 Definition	30
2.5.2 Potentials and Fields of Action.....	31
3 Derivation of Requirements and Methodological Approach	35
3.1 Requirements from Industrial/Business Perspective	35
3.2 Requirements from Scientific/Technical Perspective	37
3.3 Research and Methodological Approach.....	41
3.4 Simulation Background	45
4 State of Research.....	51
4.1 Background for Selection and Evaluation of Existing Approaches	51
4.2 Evaluation of Relevant Research Approaches	57
4.3 Discussion and Comparison.....	82
4.4 Derivation of Research Demand.....	86

5	Concept Development.....	89
5.1	Synthesis of Requirements into Concept Specifications.....	89
5.2	Abstraction of Conceptual Framework	94
5.3	Description of Simulation Approach	97
5.3.1	Implementation and General Functional Principle	97
5.3.2	Process Module	100
5.3.3	TBS Module – Compressed Air	108
5.3.4	TBS Module – Steam Generation.....	114
5.3.5	PPC Module	117
5.3.6	Evaluation/Visualisation (EV) Module	119
5.3.7	Main Level – MS Module	127
5.4	Application Cycle	129
5.4.1	Application Cycle Synthesis	130
5.4.2	Step 1: Objective and System Definition	132
5.4.3	Step 2: Total Energy Consumption and Contract Analysis	133
5.4.4	Step 3: Identification of Energy Consumers.....	135
5.4.5	Step 4: Data Metering and Processing.....	137
5.4.6	Step 5: Modelling	139
5.4.7	Step 6: Validation.....	140
5.4.8	Step 7: Scenario Building.....	141
5.4.9	Step 8: Simulation Runs	141
5.4.10	Step 9: Evaluation	142
5.4.11	Step 10: Implementation.....	144
6	Application of Concept.....	145
6.1	Aluminium Die Casting	145
6.2	Weaving Mill.....	153
6.3	PCB Assembly.....	161
6.4	Application in Education of Production Engineers.....	168
7	Summary and Outlook	171
7.1	Summary.....	171
7.2	Concept Evaluation.....	172
7.3	Outlook	175
References	179	
Own References	191	
Appendix	195	
Index	197	