



Sustainable Development in Chemical Engineering

Innovative Technologies

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WILEY

Sustainable Development in Chemical Engineering Innovative Technologies

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Preface

This book aims to examine the newest technologies for sustainable development, through a careful analysis not only of the technical aspects but also on the possible fields of industrial development. In other words, the book aims to shed light, giving a broad but very detailed view on the latest technologies aimed at sustainable development, through a point of view typical of an industrial engineer.

The book is divided in four sections (*Energy*, *Process Intensification*, *Bio-Based Platform for Biomolecule Production* and *Soil and Water Remediation*) in order to provide a powerful and organic tool to the readers.

The first chapter (by Piemonte, Basile, De Falco) is devoted to an overview of the main arguments in the book and to provide a useful key lecture to the reader for a more easy understanding of the topics analysed in further chapters.

In the second chapter (De Falco), Concentrated Solar Power (CSP) technology is presented and a particular application, that is, the cogenerative production of electricity and pure hydrogen by means of a steam reforming reactor is studied in depth and assessed in order to make clear the huge potentialities of CSP plants in the industrial sector.

The third chapter (Franco) analyses some aspects in connection with the problem of new renewable energy penetration. The case of Italian energy production is considered as a meaningful reference due to its characteristic size and the complexity. The various energy scenarios are evaluated with the aid of multipurpose software, taking into account the interconnections between different energy uses.

The last chapter (Ding, Østergaard, Morente, and Wu) in the *Energy* section discusses the smart grid as response for integrating Distributed Generation to provide a balancing capacity for mitigating the high volatility of renewable energy resources in the future.

The second section opens with a chapter on Process Intensification (PI) in the chemical industry. In this chapter (Curcio) a description of some process units designed on the basis of PI concepts has been presented, pointing out their major features, the advantages determined by the exploitation of these PI units and, in some cases, on the existing barriers that are currently limiting their spread on an industrial scale.

The sixth chapter (Basile, Iulianelli, Liguori) is devoted to summarizing the importance of PI in the chemical and petrochemical industries focusing on the membrane reactor (MR) role as a new technology. In particular, it illustrates how integration of MRs in the industrial field could constitute a good solution to the reduction of the

reaction/separation/purification steps, thus allowing a reduction in plant size and improving overall process performance.

The first chapter (Chakraborty, Das Mondal, Mukherjee, Bhattacharjee) in the section on the bio-based platform for biomolecule production deals with a wide and detailed review of the science and technology for sustainable biofuel production. In particular, the production processes of bioethanol and biodiesel are analysed deeply, paying attention also to the sustainability of biofuel use issue.

The eighth chapter (Piemonte) depicts the complex world of bioplastics through the analysis of the bioplastics concept and the description of the most important production processes of bioplastics. Particular attention has been paid to the bioplastic footprint on the environment by analysing the environmental impact of two of the most important bioplastics in the world (PLA and Mater-Bi) in comparison with some petroleum-based plastics (PET and PE) in order to answer, if possible, the most important reader's question: *how green are bioplastics?*

The ninth chapter (Martinotti, Allegrone, Cavallo, and Fracchia) focuses on the most recent results obtained in the field of production, optimization, recovery, and applications of biosurfactants. The chapter spans environmental to biomedical applications of biosurfactants, covering agricultural, biotechnological and nanotechnological applications.

The first chapter (Chakraborty, Sikder, Mukherjee, Mandal, and Arockiasamy) of the soil and water remediation section presents a state-of-the-art report on the past and existing knowledge of water remediation technologies for the environmentalist who evaluates the quality of environment, implements and evaluates the remediation alternatives at a given contaminated site. The chapter provides a basic understanding of the bioremediation technologies for water recycling to the reader.

The fourth section continues with a chapter (Sannino and Piccolo) on soil remediation, which reviews innovative sustainable strategies that can be applied to remediate soil contaminated by organic pollutants and based on biological, physical and advanced chemical processes. These approaches are illustrated together with the related technical, environmental and economic aspects which should be considered when selecting the most useful remediation method for given soil conditions.

The book concludes with the last chapter (Chidichimo, Cupelli, De Filpo, Formoso, and Fiore) in the soil and water remediation section, which reports on recent progress in remediation by nanomaterials, describing synthesis and properties of different classes of nanoparticles. The main physico-chemical principles and advantages of using nanoparticles in remediation of wastewaters contaminated by dyes, heavy metals and organic pollutants are discussed. Special attention is given to the modification of nanoparticle surface properties in order to increase efficiency and selectivity. Advances in some particular nanosystems, and perspectives on environment and health impacts by massive use of nanodevices are also reported.

Finally, let us conclude this preface by thanking all the authors who have contributed to the realization of this book, without whom this project would never have been born. We wish to thank them for their participation and patience during the preparation of this

book. We are also grateful that they have entrusted us with editing their contributions as per the requirements of each chapter. We hope that readers will find this book useful.

Powerpoint slides of figures in this book for teaching purposes can be downloaded from <http://booksupport.wiley.com> by entering the book title, author or ISBN.

Vincenzo Piemonte
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Italy
December 2012

Contents

<i>List of Contributors</i>	xiii
<i>Preface</i>	xv
1. Sustainable Development Strategies: An Overview	1
<i>Vincenzo Piemonte, Marcello De Falco, and Angelo Basile</i>	
1.1 Renewable Energies: State of the Art and Diffusion	1
1.2 Process Intensification	4
1.2.1 Process Intensifying Equipment	5
1.2.2 Process Intensifying Methods	6
1.3 Concept and Potentialities of Bio-based Platforms for Biomolecule Production	8
1.3.1 Biogas Platform	9
1.3.2 Sugar Platform	10
1.3.3 Vegetable Oil Platform	10
1.3.4 Algae Oil Platform	11
1.3.5 Lignin Platform	11
1.3.6 Opportunities and Growth Predictions	12
1.4 Soil and Water Remediation	13
1.4.1 Soil Remediation	18
1.4.2 Water Remediation	18
Acknowledgement	18
References	18
2. Innovative Solar Technology: CSP Plants for Combined Production of Hydrogen and Electricity	25
<i>Marcello De Falco</i>	
2.1 Principles	25
2.2 Plant Configurations	28
2.2.1 Solar Membrane Reactor Steam Reforming	29
2.2.2 Solar Enriched Methane Production	31
2.3 Mathematical Models	33
2.3.1 Solar Enriched Methane Reactor Modelling	34
2.3.2 Membrane Reactor Modelling	36
2.3.3 WGS, Separation Units and the Electricity Production Model	38
2.4 Plant Simulations	39

2.4.1	EM Reactor	39
2.4.2	Membrane Reactor	41
2.4.3	Global Plant Simulations and Comparison	45
2.5	Conclusions	46
	Nomenclature	47
	References	48
3.	Strategies for Increasing Electrical Energy Production from Intermittent Renewables	51
	<i>Alessandro Franco</i>	
3.1	Introduction	51
3.2	Penetration of Renewable Energies into the Electricity Market and Issues Related to Their Development: Some Interesting Cases	55
3.3	An Approach to Expansion of RES and Efficiency Policy in an Integrated Energy System	57
3.3.1	Optimization Problems	59
3.3.2	Operational Limits and Constraints	61
3.3.3	Software Tools for Analysis	62
3.4	Analysis of Possible Interesting Scenarios for Increasing Penetration of RES	62
3.4.1	Renewable Energy Expansion in a Reference Scenario	63
3.4.2	Increasing Thermoelectric Generation Flexibility	63
3.4.3	Effects of Introducing the Peak/Off-Peak Charge Tariff	64
3.4.4	Introducing Electric Traction in the Transport Sector: Connection between Electricity and Transport Systems	64
3.4.5	Increasing Industrial CHP Electricity Production	65
3.4.6	Developing the Concept of 'Virtual Power Plants'	66
3.5	Analysis of a Meaningful Case Study: The Italian Scenario	66
3.5.1	Renewable Energy Expansion in a Reference Scenario	68
3.5.2	Increasing Thermoelectric Generation Flexibility	69
3.5.3	Effects of Introducing a Peak/Off-Peak Charge Tariff	69
3.5.4	Introduction of a Connection between Electricity and Transport Systems: The Increase in Electric Cars	70
3.5.5	Increasing Industrial CHP Electricity Production	71
3.6	Analysis and Discussion	74
3.7	Conclusions	75
	Nomenclature and Abbreviations	76
	References	77
4.	The Smart Grid as a Response to Spread the Concept of Distributed Generation	81
	<i>Yi Ding, Jacob Østergaard, Salvador Pineda Morente, and Qiuwei Wu</i>	
4.1	Introduction	81
4.2	Present Electric Power Generation Systems	82

4.3	A Future Electrical Power Generation System with a High Penetration of Distributed Generation and Renewable Energy Resources	83
4.4	Integration of DGs into Smart Grids for Balancing Power	86
4.5	The Bornholm System – A “Fast Track” for Smart Grids	91
4.6	Conclusions	92
	References	93
5.	Process Intensification in the Chemical Industry: A Review	95
	<i>Stefano Curcio</i>	
5.1	Introduction	95
5.2	Different Approaches to Process Intensification	96
5.3	Process Intensification as a Valuable Tool for the Chemical Industry	97
5.4	PI Exploitation in the Chemical Industry	100
5.4.1	Structured Packing for Mass Transfer	100
5.4.2	Static Mixers	100
5.4.3	Catalytic Foam Reactors	100
5.4.4	Monolithic Reactors	100
5.4.5	Microchannel Reactors	101
5.4.6	Non-Selective Membrane Reactors	101
5.4.7	Adsorptive Distillation	102
5.4.8	Heat-Integrated Distillation	102
5.4.9	Membrane Absorption/Stripping	102
5.4.10	Membrane Distillation	103
5.4.11	Membrane Crystallization	104
5.4.12	Distillation-Pervaporation	104
5.4.13	Membrane Reactors	104
5.4.14	Heat Exchanger Reactors	104
5.4.15	Simulated Moving Bed Reactors	105
5.4.16	Gas-Solid-Solid Trickle Flow Reactor	105
5.4.17	Reactive Extraction	106
5.4.18	Reactive Absorption	106
5.4.19	Reactive Distillation	106
5.4.20	Membrane-Assisted Reactive Distillation	106
5.4.21	Hydrodynamic Cavitation Reactors	106
5.4.22	Pulsed Compression Reactor	107
5.4.23	Sonochemical Reactors	107
5.4.24	Ultrasound-Enhanced Crystallization	108
5.4.25	Electric Field-Enhanced Extraction	108
5.4.26	Induction and Ohmic Heating	108
5.4.27	Microwave Drying	109
5.4.28	Microwave-Enhanced Separation and Microwave Reactors	109
5.4.29	Photochemical Reactors	110
5.4.30	Oscillatory Baffled Reactor Technologies	111
5.4.31	Reverse Flow Reactor Operation	111

5.4.32	Pulse Combustion Drying	111
5.4.33	Supercritical Separation	112
5.5	Conclusions	113
	References	113
6.	Process Intensification in the Chemical and Petrochemical Industry	119
	<i>Angelo Basile, Adolfo Iulianelli, and Simona Liguori</i>	
6.1	Introduction	119
6.2	Process Intensification	120
6.2.1	Definition and Principles	120
6.2.2	Components	121
6.3	The Membrane Role	122
6.4	Membrane Reactor	124
6.4.1	Membrane Reactor and Process Intensification	126
6.4.2	Membrane Reactor Benefits	127
6.5	Applications of Membrane Reactors in the Petrochemical Industry	128
6.5.1	Dehydrogenation Reactions	129
6.5.2	Oxidative Coupling of Methane	134
6.5.3	Methane Steam Reforming	135
6.5.4	Water Gas Shift	137
6.6	Process Intensification in Chemical Industry	139
6.6.1	Reactive Distillation	139
6.6.2	Reactive Extraction	140
6.6.3	Reactive Adsorption	140
6.6.4	Hybrid Separation	141
6.7	Future Trends	141
6.8	Conclusion	142
	Nomenclature	143
	References	143
7.	Production of Bio-Based Fuels: Bioethanol and Biodiesel	153
	<i>Sudip Chakraborty, Ranjana Das Mondal, Debolina Mukherjee, and Chiranjib Bhattacharjee</i>	
7.1	Introduction	153
7.1.1	Importance of Biofuel as a Renewable Energy Source	153
7.2	Production of Bioethanol	155
7.2.1	Bioethanol from Biomass: Production, Processes, and Limitations	156
7.2.2	Substrate	157
7.2.3	Future Prospects for Bioethanol	164
7.3	Biodiesel and Renewable Diesels from Biomass	166
7.3.1	Potential of Vegetable Oil as a Diesel Fuel Substitute	168
7.3.2	Vegetable Oil Ester Based Biodiesel	169
7.3.3	Several Approaches to Biodiesel Synthesis	170

7.3.4	Sustainability of Biofuel Use	171
7.3.5	Future Prospects	171
7.4	Perspective	172
	List of Acronyms	172
	References	173
8.	Inside the Bioplastics World: An Alternative to Petroleum-based Plastics	181
	<i>Vincenzo Piemonte</i>	
8.1	Bioplastic Concept	181
8.2	Bioplastic Production Processes	183
8.2.1	PLA Production Process	183
8.2.2	Starch-based Bioplastic Production Process	185
8.3	Bioplastic Environmental Impact: Strengths and Weaknesses	186
8.3.1	Life Cycle Assessment Methodology	186
8.3.2	The Ecoindicator 99 Methodology: An End-Point Approach	187
8.3.3	Case Study 1: PLA versus PET Bottles	189
8.3.4	Case Study 2: Mater-Bi versus PE Shoppers	191
8.3.5	Land Use Change (LUC) Emissions and Bioplastics	193
8.4	Conclusions	195
	Acknowledgements	196
	References	196
9.	Biosurfactants	199
	<i>Maria Giovanna Martinotti, Gianna Allegrone, Massimo Cavallo, and Letizia Fracchia</i>	
9.1	Introduction	199
9.2	State of the Art	200
9.2.1	Glycolipids	201
9.2.2	Lipopeptides	201
9.2.3	Fatty Acids, Neutral Lipids, and Phospholipids	204
9.2.4	Polymeric Biosurfactants	204
9.2.5	Particulate Biosurfactants	205
9.3	Production Technologies	205
9.3.1	Use of Renewable Substrates	205
9.3.2	Medium Optimization	209
9.3.3	Immobilization	211
9.4	Recovery of Biosurfactants	212
9.5	Application Fields	213
9.5.1	Environmental Applications	213
9.5.2	Biomedical Applications	217
9.5.3	Agricultural Applications	220
9.5.4	Biotechnological and Nanotechnological Applications	221
9.6	Future Prospects	225
	References	225

10. Bioremediation of Water: A Sustainable Approach	241
<i>Sudip Chakraborty, Jaya Sikder, Debolina Mukherjee, Mrinal Kanti Mandal, and D. Lawrence Arockiasamy</i>	
10.1 Introduction	241
10.2 State-of-the-Art: Recent Development	242
10.3 Water Management	247
10.4 Overview of Bioremediation in Wastewater Treatment and Ground Water Contamination	250
10.5 Membrane Separation in Bioremediation	252
10.6 Case Studies	256
10.6.1 Bioremediation of Heavy Metals	256
10.6.2 Bioremediation of Nitrate Pollution	258
10.6.3 Bioremediation in the Petroleum Industry	259
10.7 Conclusions	260
List of Acronyms	261
References	262
11. Effective Remediation of Contaminated Soils by Eco-Compatible Physical, Biological, and Chemical Practices	267
<i>Filomena Sannino and Alessandro Piccolo</i>	
11.1 Introduction	267
11.2 Biological Methods (Microorganisms, Plants, Compost, and Biochar)	269
11.2.1 Microorganisms	269
11.2.2 Plants	273
11.2.3 Plant-Microorganism Associations: Mycorrhizal Fungi	275
11.2.4 Compost and Biochar	276
11.3 Physicochemical Methods	277
11.3.1 Humic Substances as Natural Surfactants	278
11.4 Chemical Methods	280
11.4.1 Metal-Porphyrins	282
11.4.2 Nanocatalysts	284
11.5 Conclusions	286
List of Symbols and Acronyms	288
Acknowledgments	289
References	289
12. Nanoparticles as a Smart Technology for Remediation	297
<i>Giuseppe Chidichimo, Daniela Cupelli, Giovanni De Filpo, Patrizia Formoso, and Fiore Pasquale Nicoletta</i>	
12.1 Introduction	297
12.2 Silica Nanoparticles for Wastewater Treatment	298
12.2.1 Silica Nanoparticles: An Overview	298
12.2.2 Preparation of Nanosilica	299
12.2.3 Removal of Dyes by Silica Nanoparticles	299
12.2.4 Removal of Metallic Pollutants by Silica Nanoparticles	303

12.3	Magnetic Nanoparticles: Synthesis, Characterization and Applications	305
12.3.1	Magnetic Nanoparticles: An Overview	305
12.3.2	Synthesis of Magnetic Nanoparticles	306
12.3.3	Characterization of Magnetic Nanoparticles	315
12.3.4	Applications of Magnetic Nanoparticles	316
12.4	Titania Nanoparticles in Environmental Photo-Catalysis	317
12.4.1	Advanced Oxidation Processes	317
12.4.2	TiO ₂ Assisted Photo-Catalysis	320
12.4.3	Developments in TiO ₂ Assisted Photo-Catalysis	324
12.5	Future Prospects: Is Nano Really Good for the Environment?	326
12.6	Conclusions	328
	List of Abbreviations	328
	References	329

<i>Index</i>	349
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Sustainable Development Strategies: An Overview

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1.1 Renewable Energies: State of the Art and Diffusion

Energy is a crucial challenge that scientific and technological communities face with more to come in the future. The environmental impact of fossil fuels, their cost fluctuations due both to economical/political reasons and their reducing availability boost research toward the development of new processes and technologies, which are more sustainable and renewable, such as solar energy, wind, biomass and geothermal.

Governments have facilitated renewable energy production diffusion by means of incentive schemes as the feed-in tariff (FIT) and Green Certificates (GCs), achieving unforeseeable success. In fact, the change in the world energy politics is substantially modifying the energy production network. The European Union target to increase the share of renewable energy sources (RES) in its gross final consumption of energy to 20% by 2020 from the 9.2% in 2006, which seemed unlikely up until recently, is now almost there thanks mainly to the strong increase of wind power, photovoltaics and plant biomass installations, together with the implementation of more efficient energy-consuming technologies in domestic, industrial and transport sectors, able to reduce global energy consumption.

The following charts in Figures 1.1–1.3 report wind power, photovoltaic and biomass-fired power station (by wood, municipal solid wastes and bio-gas) electrical energy production trends in recent years in EU-27 (Ruska and Kiviluoma, 2011): it is a worthy