Contents

1 Production of Bioenergy in the Framework of Circular Economy: A Sustainable Circular System in Ecuador

Vega-Quezada Cristhian, Blanco María and Romero Hugo

1.1 Introduction
1.1.1 Energy and Bioenergy
1.1.2 Ecuadorian Case

1.2 A Sustainable Circular System in Ecuador
1.2.1 Biogas
1.2.1.1 CO₂ Emissions
1.2.1.2 Potential Electricity Power
1.2.2 Biodiesel
1.2.2.1 Biodiesel in Ecuador
1.2.3 Microalgae Biodiesel
1.2.3.1 Biomass Production
1.2.3.2 Lipid Extraction

1.3 Microalgae versus Palm Oil in Ecuador
1.3.1 Palm Oil
1.3.2 Microalgae Oil
1.3.2.1 Microalgae in Open Ponds
1.3.2.2 Microalgae in Laminar Photobioreactor

1.4 Discussion
1.5 Conclusion
Acknowledgements
References

2 The Impact of Biomass Feedstock Composition and Pre-treatments on Tar Formation during Biomass Gasification


2.1 Introduction
2.2 Tar Composition
 Contents

2.3 Tar Formation Cell Wall Polymers and Ash Composition 37
   2.3.1 The Impact of Plant Type and Blending Upon Tar Production 38
   2.3.2 Blending 39
   2.3.3 Ash Composition 40
2.4 Thermochemical Pre-treatments for Gasification 41
   2.4.1 Torrefaction 41
   2.4.2 Slow Pyrolysis 42
   2.4.3 Intermediate Pyrolysis 43
   2.4.4 Fast Pyrolysis 43
2.5 Processing Options that Exploit Conversion Route Integration 45
2.6 Conclusion 48
Acknowledgements 50
References 50

3 Key Pretreatment Technologies for An Efficient Bioethanol Production from Lignocellulosics 55
 Archana Mishra and Sanjoy Ghosh

  3.1 Introduction 56
  3.2 Pretreatment Methods for Lignocellulosic Biomass 58
     3.2.1 Parameters for Effective Pretreatment of Lignocellulosics 59
     3.2.2 Important Pretreatment Methods 61
        3.2.2.1 Physical or Mechanical Methods 61
        3.2.2.2 Physico-chemical Methods 62
        3.2.2.3 Chemical Methods 67
        3.2.2.4 Biological Methods 74
  3.3 Conclusion and Future Perspectives 75
References 78

4 Present Status on Enzymatic Hydrolysis of Lignocellulosic Biomass for Bioethanol Production 85
 Arindam Kuila, Vinay Sharma, Vijay Kumar Garlapati, Anshu Singh, Lakshmishri Roy and Rintu Banerjee

  4.1 Introduction 86
  4.2 Hydrolysis/Saccharification 87
     4.2.1 Cellulase 87
     4.2.2 Screening of Cellulase-producing Microorganisms 88
     4.2.3 Cellulase Production 90
     4.2.4 Factors Affecting the Cellulase Mediated Hydrolysis 90
4.3 Future prospects of enzymatic hydrolysis 93
References 93

5 Biological Pretreatment of Lignocellulosic Biomaterials 97
Sandeep Kaur Saggi, Geetika Gupta and Pinaki Dey
5.1 Introduction 97
  5.1.1 Different Source for Bioethanol Production 99
  5.1.2 Lignocellulosic Materials 100
  5.1.3 Cellulose 101
  5.1.4 Hemicellulose 102
  5.1.5 Xylan 103
  5.1.6 Lignin 104
  5.1.7 Lignin Carbohydrate Interactions 106
5.2 Pretreatment 106
  5.2.1 Pretreatment 106
5.3 Microbial Pretreatment Process 107
  5.3.1 Fungi 107
  5.3.2 Bacteria 112
5.4 Conclusion 113
References 113

6 Anaerobic Digestion and the Use of Pre-treatments on Lignocellulosic Feedstocks to Improve Biogas Production and Process Economics 121
Laura Williams, Joe Gallagher, David Bryant and Sreenivas Rao Ravella
6.1 Introduction 121
6.2 Feedstocks Available for AD 124
  6.2.1 Lignocellulosic Feedstock Analysis and Substrate Suitability 124
  6.2.2 Substrate Parameters and Co-digestion 129
6.3 Feedstock Pre-treatment to Improve AD 130
  6.3.1 Available Pre-treatment Processes 131
  6.3.2 Pre-treatment Effects on Substrate 133
  6.3.3 Effects of Pre-treatment on Methane Yields 134
6.4 Pre-treatment and Optimizing AD 136
  6.4.1 Advances in Pre-treatment Methods and AD Conditions 136
  6.4.2 Value-added Products and AD 138
6.5 Conclusion 140
Acknowledgments 141
References 141
7 Algae: The Future of Bioenergy

Nivas Manohar Desai

7.1 Introduction

7.2 Technological Innovations for Algae Cultivation, Harvesting and Drying

7.2.1 Cultivation Practices

7.2.1.1 Open Cultivation Systems

7.2.1.2 Closed Cultivation Systems (Photobioreactors)

7.2.1.3 Algal Turf Scrubber (ATS)

7.2.1.4 Sea-based Cultivation Systems

7.2.2 Harvesting of Biomass

7.2.2.1 Settling Ponds

7.2.2.2 Filtration

7.2.2.3 Centrifugation

7.2.2.4 Flotation

7.2.2.5 Flocculation

7.2.2.6 Electrolytic Coagulation

7.2.3 Energy Efficiencies of Harvesting Processes

7.2.4 Algal Drying

7.3 Algae-based Bioenergy Products

7.3.1 Biofuel and Biodiesel

7.3.2 Biogas (Biomethane Production)

7.3.3 Bioethanol

7.3.4 Biohydrogen

7.3.4.1 Direct Biophotolysis

7.3.4.2 Indirect Biophotolysis

7.3.4.3 Photo Fermentation

7.4 Concluding Remarks

Acknowledgement

References

Index