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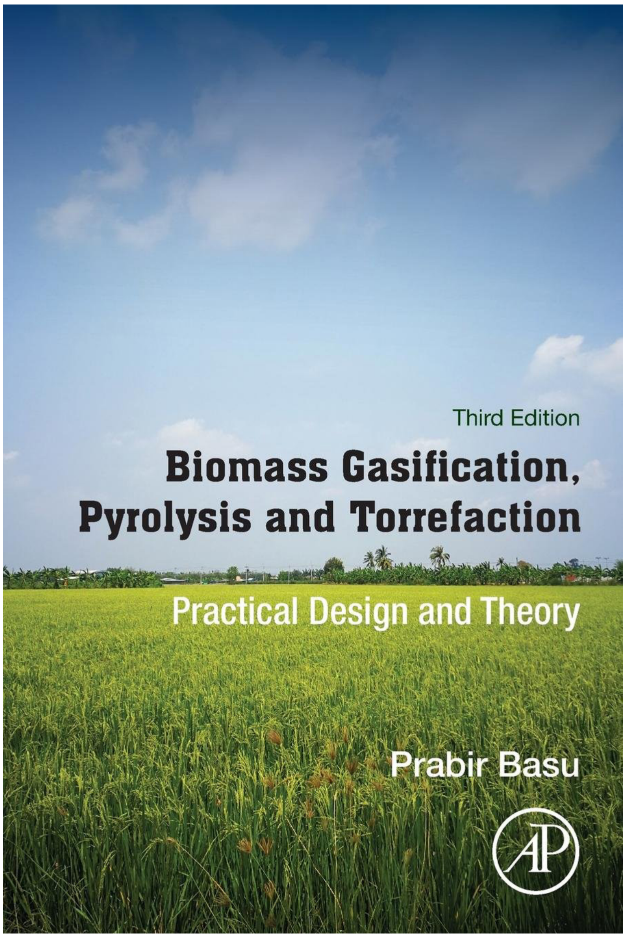
BOOKS REVIEW



BIOMASS GASIFICATION, PYROLYSIS AND TORREFACTION - PRACTICAL DESIGN AND THEORY

Third edition

Edited by Prabir Basu

The increasing costs of adverse effects caused by accelerated climate change are compelling the entire economy to rely on processes capable of minimizing GHG emissions. In recent decades, the energy-production sector has shifted from a fossil fuel-based production towards processes based on renewable resources. Although this issue has only recently been addressed with any degree of urgency, primary solutions to the problem have been available since long before the industrial revolution. Among these, biomass thermal conversion is indicated as playing a key role in the so-called energy transition, being acknowledged by the scientific community as a carbon-neutral process for energy production.

In particular, torrefaction is aimed at the production of a solid product (known as "torrefied biomass" or generally as biochar), characterized by high energy density and often reused as solid fuel in co-firing processes with coal. Conversely, the main objective of the pyrolytic process is to maximize the production of a liquid product (i.e. Biooil), consisting of a mixture of water and complex hydrocarbons, used for fuel or chemical production. However, both can be considered as steps of the same biomass heating process in an oxygen-restricted environment. The gasification process moreover is defined as an additional step that makes use of a gasifying medium -such as steam, air or oxygen- to obtain gaseous products characterized by exploitable heating value. Further, when the biomass undergoing gasification features a high water content (e.g. algae or raw sewage), the use of supercritical water as conversion medium, in the so-called Hydrothermal Conversion of Biomass, may avoid extra costs incurred through the use of large amounts of energy in the preliminary drying phase.

However, although still relatively low, a growing number of industrial-scale installations are currently implementing this process. Therefore, the major challenge is to transfer the results already available in the pertinent literature to the experts involved with the aim of increasing awareness of the reliability of existing plant-design criteria.

The book "Biomass Gasification, Pyrolysis and Torrefaction" (third edition), edited by Prabir Basu, addresses this issue, revising and expanding on the previous versions by collecting recently updated information focused on design features and operational parameters of biomass conversion reactors and related equipment. The book includes 14 chapters and 3 appendices for a total of 564 pages.

Chapter 1 provides the reader with an introduction to the topic discussed, presenting the state of art with regard to biomass sources, an overview on the thermal conversion processes discussed and an interesting analysis on the environmental sustainability of the technologies mentioned. Chapter 2 proposes a brief focus on issues related to biomass management capable of influencing the economic viability of related full-scale projects throughout their life-cycle, e.g. local availability of biomass and capital costs of full-scale plant. Extensive knowledge of the physical-chemical characterization of available biomass is mandatory in determining reliable reactor design parameters: Chapter 3 lists the relevant biomass characteristics to be collected prior to the design step, including Thermal conductivity, Ignition Temperature, Heating value and Ash content.

Chapters 4 to 9 provide an in-depth delineation of the theoretical thermo-chemical principles, up-to-date technologies, design-criteria and possible yield-optimization of Torrefaction, Pyrolysis, Gasification and Hydrothermal

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Conversion reactors. In particular, Chapter 6 deals with the significant issue of tar residue management by illustrating how to minimize the related detrimental effects on reactor operations.

Chapter 10 represents the novelty of this edition. Authored by Dr. Bishnu Acharya, it provides insights into suitable treatment technologies (e.g. wet scrubbing or filtration) for undesirable products contained in the gas derived from pyrolizers and gasifiers (i.e. condensable gases, particulate matter, ammonia and sulfides).

There is currently widespread interest in partially replacing coal with biomass in existing large thermoelectrical installations with the aim of reducing related GHG emissions, thanks to the carbon-neutral nature of biomass. However, several major incompatibilities have been highlighted in previous or ongoing industrial trials. Chapter 11 discusses the potentialities and issues of the so-called co-firing process in coal combustion plants, involving both raw and torrefied biomass.

Products derived from the thermo-chemical conversion of biomass can also be exploited as chemical feedstocks, thanks to a growing market demand determined by the current shift of manufacturing industries and transportation sectors towards "green-renewable chemicals" and "green-fuels". The theories underpinning the processes involved in converting gasification products and pyrolytic biooils into synthetic fuels and chemicals are introduced in Chapter 12.

Chapter 13 discusses the best available options for auxiliary reactor equipment to be used in the storage, handling and feeding of solid biomass, and to fine tune industrial plant design schemes. Finally, Chapter 14 provides an important contribution by presenting the most suitable analytical techniques to obtain data relating to the chemical-physical features of biomass, as listed in Chapter 3.

To facilitate the readers comprehension three appendixes are provided at the end of the book: Appendix A contains biomass definitions, Appendix B supplies values for constants cited throughout the book together with tables for unit conversion and Appendix C summarizes data tabularly for use in progressing with reactor design.

Briefly, the book provides a detailed but user-friendly guidance of the state of art of biomass thermal conversion processes, namely, torrefaction, pyrolysis and gasification. The chapters guide readers through the book, illustrating the theoretical principles, operational parameters and equipment needed in the preliminary design of reactors. The book is mainly intended for professionals, such as sales engineers, project managers and scientists, to assist them in achieving the knowledge required to address the increasing market demand for full-scale technologies or to focus on developing mandatory improvements.

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Dr. Prabir Basu is currently Professor in Mechanical Engineering Department and Head of Circulating Fluidized Bed Laboratory at Dalhousie University, Halifax. Further, he is founding President of Greenfield Research Incorporated and founder of Fluidized Bed Systems Limited, private companies specialized in biomass energy conversion systems and fluidized bed boilers, respectively. Working in the field of energy conversion and environmental studies for 30 years, his current research topics involve projects on the cutting edge of chemical looping gasification, torrefaction and biomass cofiring, amongst others. In addition to more than 200 research papers, he has authored seven monographs in emerging areas of energy and environment, some of which have been translated into Chinese, Italian and Persian.

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