Preface

Energy is inherent to all human activities and its higher consumption per capita correlates well with the higher living standards. Coal, petroleum, and natural gas are energy reserves formed million years ago and are the main raw material for our needs of energy, materials, and chemicals. Recent years have witnessed significant research activity in converting biomass into useful liquid fuels in an attempt to replace totally or partially the oil consumption. Besides bioenergy, researchers are looking for the biorefinery concept perceiving agroindustrial value-chains. In this concept, multiple products could be potentially obtained from biomass including products from its own processing wastes: bioplastics, bioenergy, and biochemicals.

Shifting from fossil fuels to biomass-based fuels requires a deep knowledge of the biomass characteristics (e.g., composition and energy content) and appropriate conversion technology processes (e.g., Fischer–Tropsch, gasification, pyrolysis, combustion, and fermentation) in such a way that the same products obtained from a crude oil refinery could be produced. Both experimental and simulation endeavors are crucial to help understanding the feasibility of an industrial-scale biorefinery-based system. The material contained in this book allows a number of fundamental questions to be tackled such as understanding the best combination of biomass-biorefinery system (with what thermochemical and/or biological and/or catalytic processes in between) for each specific case study and contains tips for evaluating its sustainability. It provides an explanation of the existing methodologies, tools, and metrics to address this pertinent issue.

Chapter 1 presents the definition and examples of biorefinery systems along with basic concepts. Chapter 2 describes the main types of biomass used in the energy field and their composition and lists and discusses the main parameters used to evaluate their energy potential. Chapter 3 focuses on pyrolysis, fermentation, and catalytic conversion technologies with real experimental data. Chapter 4 deals with simulation of the main thermochemical (combustion, pyrolysis, and gasification), biochemical (fermentation), and chemical (fractionation, lignin depolymerization, and platform molecules) processes for biomass processing. Chapter 5 concentrates on the sustainability analysis of biorefinery systems in terms of environmental and socioeconomic indicators, discussing metrics and uncertainty of the concept, configuration and operation. Chapter 6 introduces a systematic methodology for designing integrated biorefineries using process systems engineering tools, which include market analysis, techno-economic assessment, cost accounting, energy integration analysis, life cycle assessment, supply chain analysis, as well as a multi-criteria decision-making framework to put forward the most effective biorefinery strategies that fulfil the needs of the forest industry. Finally, Chap. 7 gives a brief overview of the current conventional and advanced biomass-based biorefineries in the world. While the conventional biorefineries use mature and commercial technology, the advanced biorefineries (e.g., lignocellulosic-based biofuel biorefineries and microalgae-based biorefineries) have different degrees of maturity technology-readiness level and, regardless the process technology, only a few of them have reached the commercial scale although the profitability remains a quest.

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