Book review

Biorefineries and chemical processes: design, integration and sustainability analysis

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Jhuma Sadhukhan, Kok Siew Ng and Elias Martinez Hernandez (Eds.)
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Increasing environmental awareness, stricter legislations and rising prices have all intensified efforts to shift from fossil fuels to cleaner sources of energy. These have resulted in a rise in the utlilisation of biomass as a sustainable, low-carbon fuel source, and in turn, the development of bio-refineries. This book, entitled *Biorefineries and chemical processes* (edited by Jhuma Sadhukhan, Kok Siew Ng and Elias Martinez Hernandez), addresses the design, integration and sustainability analysis of biorefineries. It gives a comprehensive overview of all aspects of biorefinery design, focusing on including process synthesis and lifecycle assessment for a holistic and integrative approach.

The book is divided into five main sections – Part I provides an introduction to the concept of biorefineries, and its design. The sustainable and efficient conversion of biomass requires a combined knowledge of chemistry, physics, engineering and practical tools. These ideas are presented to the reader, along with an overview of the types of feedstock used, process technologies employed and products generated.

Part II addresses the tools that are useful in the design of sustainable and cost-effective biorefineries. These include economic analysis, lifecycle assessment (LCA), heat integration and utility systems, multi-criteria analysis, value analysis, combined economic value and environmental impact analysis (EVEI) and optimization. Chapters 2–8 are devoted to explaining each tool in detail, and also include relevant problems, along with their solutions.

Part III then moves on to actual process design and synthesis of biomass-based processes. It discusses the different types of conversion processes (such as gasification, pyrolysis, etc.), along with a detailed study of the relevant thermodynamics, kinetics and reactor modelling techniques. Biopolymer synthesis is also been dealt with in depth, accompanied by process design, modelling, integration and LCA. Modelling of CO_2 capture, design of novel flowsheets for processes involving new methods of separation and integration are introduced. Importantly, economic and lifecycle assessments are included wherever an opportunity presents itself.

Part IV describes the different biorefinery processes – Fischer-Tropsch process, methanol synthesis, bio-oil treating in membrane reactors, fuels cells, and even algae biorefineries. It includes flowsheet design, problems, energy calculations, and LCA (wherever applicable). Moreover, kinetic and diffusion modelling for heterogeneously catalysed reactions are discussed in detail, with the production of biodiesel as an example.

Part V is not printed as a separate section in this book, but consists of additional resources that can be found online. This part deals with the interacting systems of biorefineries – that is, the sustainability of the interaction of biorefinery process systems with the material and energy systems. The three chapters in this part deal with minimisation of waste and emissions, energy storage systems, and the optimisation and reuse of water. In addition, a lifecycle-based approach to solving problems is explained with the help of four case studies. However, it would have been more convenient for the reader if this section were also part of the textbook, since it becomes easier to go back to particular sections while reading from a textbook.

This book aims to bridge the gap between engineering and sustainability in bio-based processes, with the help of analytical tools for economic and environmental assessment – and it succeeds in doing so. The reader will also learn how to apply these tools, thanks to the numerous problems elaborated and solved using software like ASPEN, MATLAB and GaBi (for LCA). In conclusion, this

book introduces the reader to the rapidly-developing industry of biorefineries, with a multi-disciplinary approach. It is a good resource for undergraduate and post-graduate students who want to learn about biorefineries; it can also be valuable for researchers who are looking to practically apply these analytical tools in their work.

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