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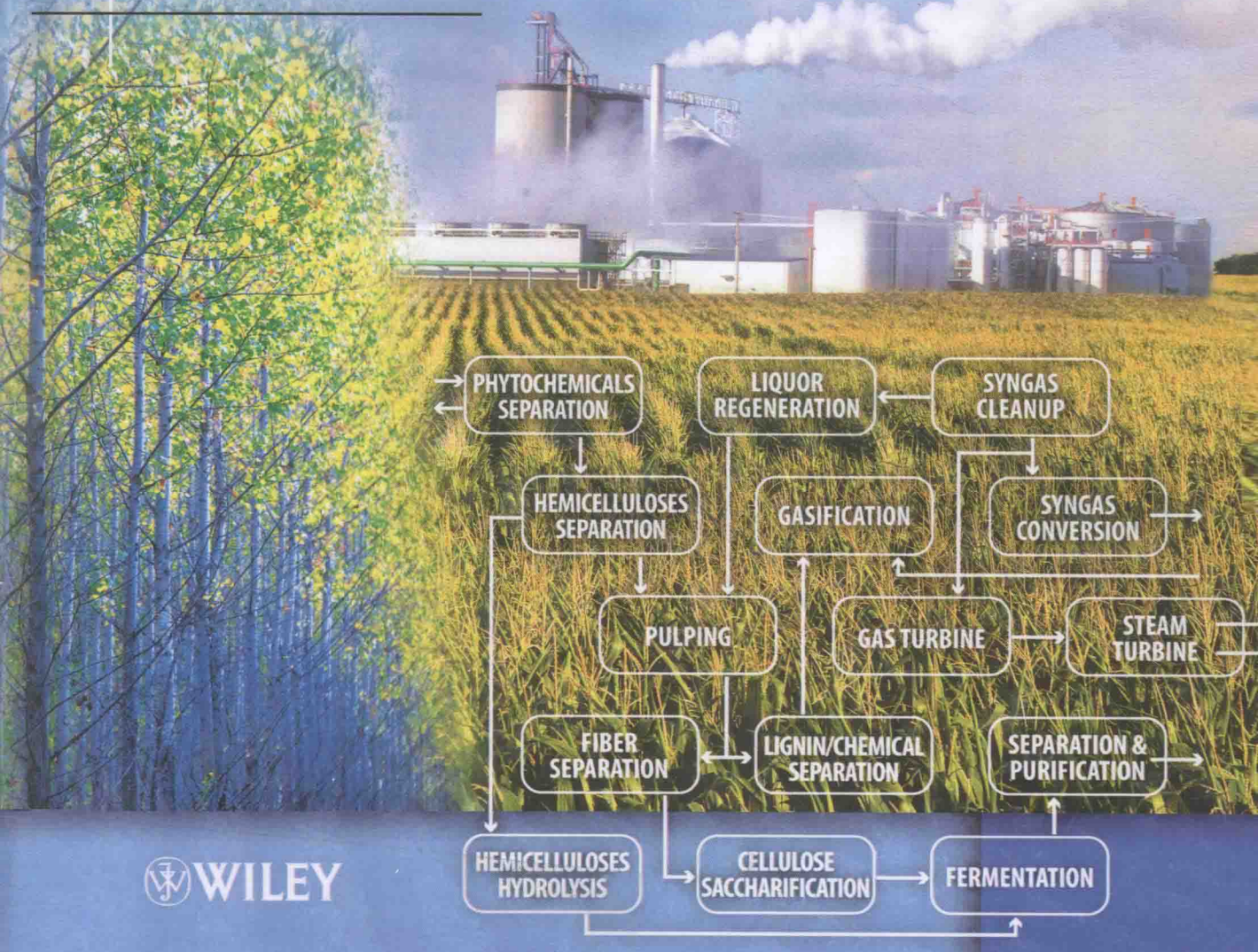
# Separation and Purification Technologies in **Biorefineries**

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# Separation and Purification Technologies in Biorefineries

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# Preface

The depletion of fossil resources, global climate change, and a growing world population all make it imperative that we find alternative, renewable sources of materials, chemicals, transportation fuels, and energy to address increasing global demand. Biorefineries will be an integral part of the future sustainable bioeconomy. In addition to sustainable biomass resources and effective biomass conversion technologies, separation and purification technologies will play a very important role in the successful development and commercial implementation of biorefineries. Due to the widely varying characteristics and composition of biomass, and the varying associated potential conversion technologies, biorefineries offer very interesting challenges and opportunities associated with the separation and purification of complex biomass components and the manufacture of valuable products and co-products. Generally, separation and purification processes can account for a large fraction (about 20–50%) of the total capital and operating costs of biorefineries. Significant improvement in separation and purification technologies can greatly reduce overall production costs and improve economic viability and environmental sustainability.

Examples of separation and purification needs in biorefineries include pre-extraction of value-added phytochemicals from lignocellulosic biomass, separation of biomass components (including cellulose, hemicellulose, lignin and extractives), extraction and purification of hemicellulose prior to pulping, separation of valuable chemicals from biomass hydrolyzate, removal of fermentation inhibitors enabling improved conversion efficiency and yield, concentrating process streams for varying end products and applications, integration of separation and purification technologies with bioprocessing, as well as downstream product separation and purification, syngas clean-up, purification of reactants, purification of glycerol from biodiesel production for production of intermediates such as succinic acid, and separation and purification of products such as ethanol, butanol, and lactic acid (there are many more examples).

In this book, technical experts from around the world offer their perspectives on the different separation and purification technologies that pertain to biorefineries. They provide basic principles, engineering design and specific applications in biorefineries, and also highlight the immense challenges and opportunities. There are significant opportunities for developing totally new approaches to separation and purification especially suitable for biorefineries and their full integration in the overall biorefineries. For example, adsorption with a molecular sieve is efficient in breaking the ethanol–water or butanol-water azeotrope for biofuel dehydration. Membrane separation, especially ultrafiltration and nanofiltration, represents a promising procedure for recovery of hemicelluloses from hydrolyzates and lignin from spent liquor. Hybrid separation systems such as extractive-fermentation and fermentation-membrane pervaporation are promising approaches to the removal of product inhibition, and hence to the improvement of process performance. Fermentation, bipolar membrane electrodialysis, reactive distillation, and reactive absorption are suitable for separation of products obtained by esterification, as in biodiesel production. Integrated bioprocessing—consolidated bioprocessing integrating pre-treatment, bioprocessing, separation, and purification—offers tremendously exciting new opportunities in future biorefineries.

The editors are grateful to all the contributors for making this very timely book possible. We hope that it will serve as a good resource for industrial and academic researchers, scientists, and engineers as we all work together to address the challenges, develop innovative solutions, and contribute to the development of sustainable biorefineries.

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