Preface

Since the industrial revolution, fossil fuels in the form of crude oil, gasoline, diesel, coal, and natural gas have dominated the global energy sector. The extensive use of fossil fuels is continually leading to the cumulative emission of greenhouse gases, which result in many adverse environmental conditions such as air pollution, acid rain, global warming, and ozone layer depletion. The role of energy conversion and utilization has become significantly important because of the fluctuations in availability of energy resources and the volatility in the fuel prices. Moreover, the crude oil industries based on fossil fuel resources have been facing many technical impediments such as high carbon footprint, shortage of resources, unaccountable greenhouse gas emissions, and subsequent environmental damage. The fuel refineries could be more competitive by increasing the energy efficiency and eliminating wastes that degrade the environment and natural ecosystems.

The consumption of fossil fuels and the emission of greenhouse gases are closely associated with each other. In recent years, there has been a paradigm shift in the global interest from fossil-based energy sources to green fuels. Green fuels, especially biofuels, are produced from wide-ranging organic waste resources that have numerous environmental and socio-economic benefits. Biofuels have tremendous scope in supplementing the aggregating fuel demands, mitigating CO_2 emissions, ensuring energy security and economic sustainability, as well as preventing ecological degradation. Furthermore, when utilized in connection with fossil fuels through several co-processing technologies, biofuels could potentially bring many advantages to existing energy infrastructures. This book provides current information on the production and utilization of fossil fuels and biofuels; co-processing technologies for fossil energy and bioenergy; synthetic crude oil processing; waste-to-energy and chemical generation; conversion of biomass through consolidated thermochemical, hydrothermal and biochemical pathways; reforming technologies; techno-economic analysis; as well as life-cycle assessment studies.

This book, consisting of 12 chapters, is dedicated to the new developments and prospects in energy conversion and utilization as well as fuel processing and upgrading. **Chapter 1** by Kang et al. provides an all-inclusive overview of the comparison between fossil fuels and biofuels from an environmental perspective. The chapter gives special attention to the rapidly increasing worldwide energy demand and its environmental impacts related to greenhouse gas emissions. The chapter also discusses the many potential advantages of biofuels and biorefining technologies over fossil fuel refineries.

Chapter 2 by Ahmad et al. introduces several fossil fuel and biofuel integrated energy systems such as co-firing, co-combustion, co-pyrolysis, co-liquefaction, and co-gasification. The chapter justifies the need of co-processing technologies that could bring many economic and environmental benefits such as mitigation of greenhouse gas emissions, high-energy efficiency, and circular economy.

Chapter 3 by Quereshi et al. throws light on the catalytic conversion of lignocellulosic biomass into value-added chemicals and fuel products. The chapter highlights the generation of 5-hydroxymethylfurfural, 5-ethoxymethylfurfural, levulinic acid, and ethyl levulinate from waste lignocellulosic materials as the platform building block compounds to produce many commodity chemicals and fuels. Several Brønsted and Lewis acid-catalyzed reactions such as depolymerization, isomerization, dehydration, and rehydration involved in the production of such value-added compounds are discussed.

Chapter 4 by Taufiq-Yap and Mansir presents the catalyst-assisted production and characterization of biodiesel from various feedstocks including edible oils, non-edible oils, microalgal oil, and waste cooking oil. The chapter highlights several catalysts used in the production of biodiesel such as homogeneous and heterogeneous catalysts as well as heterogeneous acid and heterogeneous solid base catalysts.

Chapter 5 by Siang et al. recounts the recent advances in hydrogen production by bi-reforming of biogas. The chapter systematically discusses the thermodynamic aspects, mechanisms, and kinetics of bi-reforming methane including the influence of process parameters such as gas hourly space velocity, reaction temperature, and feed composition. The catalysts involved in bi-reforming methane and the effects of catalyst supports and promoters are also described.

Chapter 6 by Abrokwah et al. evaluates the performance of mesoporous supports and metals for hydrogen production by steam reforming of alcohols. The study describes the synthesis and characterization of various high surface area catalytic systems by a one-pot hydrothermal method for steam reforming of methanol and glycerol. The activity and stability tests for the synthesized catalysts during steam reforming of alcohols are methodically reported.

Chapter 7 by Borugadda and Dalai gives an overview of the current developments in the production of liquid transportation fuels by Fischer-Tropsch synthesis. The chapter describes the advantages of integrated routes for biomass-to-gas and gas-to-liquid conversion technologies. The technological advancements, reaction chemistry, catalysis and reactor engineering involved in Fischer-Tropsch process are also discussed.

Chapter 8 by Borugadda et al. describes the production of biolubricant basestocks from structurally modified plant seed oils and their derivatives. The chapter elucidates the chemical composition, structure, and properties of plant seed oils, as well as several essential reactions involved in biolubricant generation such as epoxidation, hydroxylation, di-ester, tri-ester, and tetra-ester formation by esterification and anhydrides addition.

Chapter 9 by Sarangi and Nanda is a synopsis of the recent advances in consolidated bioprocessing for microbe-assisted biofuel production. The chapter describes the involvement of several solventogenic bacteria, filamentous fungi, and yeasts for bioconversion of lignocellulosic biomass and organic wastes for bioethanol and biobutanol production. This chapter also highlights microbial strain development, metabolic engineering, and bioprocess technologies in alcohol-based biofuel production.

Chapter 10 by Yadav et al. reviews the cultivation and conversion of algae for wastewater treatment and biofuel production. The chapter summarizes the aspects of algal metabolism and technologies involved in the cultivation and harvesting of algae. The role of algae in carbon sequestration and wastewater treatment is described along with biofuel production through its conversion by hydrothermal liquefaction.

Chapter 11 by Arun and Dalai is based on life-cycle assessment of biofuels produced from lignocellulosic biomass and algae. The chapter describes different methodologies for life-cycle assessment of biofuels. The impacts of fertilizers used for the cultivation of biofuel feedstocks on the environmental credibility as well as the influence of by-products and co-products of biomass conversion process on the environment are also discussed.

Chapter 12 by Rana et al. is the final chapter of the book, which is a review of synthetic crude processing and the impacts of fine particles on hydrotreating bitumen-derived gas oil. The chapter is a technical appraisal on the upgrading of bitumen, catalytic hydrotreating, and the mechanisms of fine particle deposition. This chapter focuses on significant concepts in the hydrotreating of gas oil with special emphasis on the physicochemical properties and behavior of fine particles present in bitumen-derived gas oil during the industrial hydrotreating process.

This book is a unification of chapters relating to the cutting-edge applications of green technologies that could reinvigorate the conventional oil industries and consolidated biorefineries by positioning them within a competitive energy market. This book also evaluates the potentials of integrated fossil fuel and biofuel refineries in attaining a relatively low carbon footprint, circular economy, and environmental sustainability.

The editors thank all the authors who contributed their scholarly materials to develop this book. Our heartfelt thanks to CRC Press for providing the opportunity to publish this edited volume. We appreciate the sincere efforts by the CRC Press publishing team led by Ms. Renu Upadhyay and Ms. Shikha Garg for their editorial assistance in preparing this book.

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