Green Energy and Technology

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Biorefineries

For Biomass Upgrading Facilities

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Preface

A biorefinery is a facility that integrates biomass conversion processes and equipment to produce fuels, power, and value-added chemicals from biomass. The biorefinery concept is analogous to today's crude oil refineries, which produce multiple fuels and products from petroleum. The goal in biorefining is to isolate all the added value from the biomass feedstock, resulting in little or no waste. This will not only improve the economics so that such processes can compete with the petrochemical industry, but will also lower the overall environmental impact. A biorefinery can also be defined as a facility that produces food, feed, materials, chemicals, power and/or heat from biomass. By producing multiple products, a biorefinery can take advantage of the differences in biomass components and intermediates, and maximize the value derived from the biomass feedstock. Biofuels appear to be a "greener" energy substitute for fossil fuels. Since biofuels are renewable, carbon neutral, and available throughout the world, they could contribute to sustainable development and global environmental preservation.

The production of liquid hydrocarbon fuels for the transportation sector is of importance for continued vitality of our industrialized society. Research is being conducted worldwide to develop new technologies for the generation of liquid fuels from renewable resources. Currently, biodiesel is produced by transesterification of vegetable oils and animal fats, and ethanol by fermentation of glucose. Processes for the efficient gasification of biomass to produce CO and H_2 (synthesis gas or syngas) are being developed. The syngas can be further processed to produce methanol or liquid alkanes by Fischer–Tropsch synthesis using well-established industrial processes.

The biorefinery economy is a vision for a future in which biorenewables replace fossil fuels. The transition to a biorefinery economy would require a huge investment in new infrastructure to produce, store and deliver biorefinery products to end users.

Policy drivers for renewable liquid biofuels have attracted particularly high levels of assistance in some countries given their promise of benefits in several areas of interest to governments, including agricultural production, greenhouse gas emissions, energy security, trade balances, rural development and economic opportunities for developing countries.

Current energy policies addressing environmental issues include environmentally friendly technologies that increase energy supplies and encourage cleaner, more efficient energy use, and also air pollution, the greenhouse effect, global warming, and climate change.

There are some barriers to the development of biofuel production, including technological, economical, supply, storage, safety, and policy barriers. Reducing these barriers is one of the driving factors in the government's involvement in biofuel and biofuel research and development. Production costs are uncertain and vary with the feedstock available. The production of biofuels from lignocellulosic feedstocks can be achieved through two very different processing routes: biochemical and thermochemical. There is no clear candidate for "best technology pathway" between the competing biochemical and thermochemical routes. Technical barriers for enzymatic hydrolysis include: low specific activity of current commercial enzymes, high cost of enzyme production, and lack of understanding of enzyme biochemistry and mechanistic fundamentals.

There are many technical and non-technical barriers related to the implementation and commercialization of the biorefinery. Current technical barriers with the use of energy crops are associated with the cost of production and difficulties in harvesting and storing the material grown, especially for crops that have to be harvested within a narrow time period in the autumn. Transportation costs are of prime importance when calculating the overall costs of biomass; hence, local or regional production of biomass is most favorable.

This book on biofuels attempts to address the needs of energy researchers, chemical engineers, chemical engineering students, energy resources specialists, agriculturists, crop cultivators and others interested in a practical tool for pursuing their interests in relation to bioenergy. Each chapter in the book starts with fundamental explanations suitable for a general audience and ends with in-depth scientific details for expert readers. General readers will include people interested in learning about solutions for current fuel and environmental crises. The expert readers will include chemists, chemical engineers, fuel engineers, agricultural engineers, farming specialists, biologists, fuel processors, policy makers, environmentalists, environmental engineers, automobile engineers, college students, research faculty, etc. The book may even be adopted as a textbook for college courses that deal with renewable energy and/or sustainability.

Trabzon, Turkey (April, 2009) Ayhan Demirbas

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