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Opinion Article

Implementation of Bioeconomy, Design, Engineering and Process Optimization of Biorefinery Plants

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DESCRIPTION

The implementation of the bioeconomy, which is based on renewable bio-based resources for the production of materials and energy, is a significant driver to meeting the society's demand for energy and materials in a sustainable manner. The policy objectives of reducing global warming, energy security, the circular economy concept, rural development, and reindustrialization, as well as encouraging innovation and technology development, are a few examples of the diverse motivations for policy and research to hasten the transition to the bioeconomy. The broad spectrum of biomass resources presents excellent prospects for a wide-ranging product portfolio to serve the many demands of society, making biorefining a key component of the burgeoning bioeconomy.

Crops, algae, and residues all types of biomass must be grown and utilized as sustainably as possible. As a result, procedures like biocascading and biorefining must be used. These strategies aid in meeting the projected need for food, feed, chemicals, materials, fuels for transportation, power, and heat. Proteins, sugars, oils, and fibers/lignins are separated from biomass resources to form intermediates that can then be processed further along catalytically supported biochemical and/or thermochemical processes to form marketable bio-based goods and bioenergy. To create bio-based goods such as food or feed components, chemicals, materials, and bioenergy, biomass resources such as land and aquatic crops, agro, forestry, and process residues, as well as post-consumer residues, must be exploited in a resource-efficient, energy-efficient, and sustainable manner (biofuels, power, and heat).

Another goal of the biorefinery is to maximize or optimize the economic, environmental, and social benefits by using all available synergies for sustainable and efficient production. New integrated biorefineries must be built in order to accommodate the biofuel market's anticipated future expansion and the development of new biofuel production techniques. Similar plant concepts to those used in chemical plants or crude oil refineries today will be needed for biomass conversion plants. There are some intriguing possibilities for integrating novel biorefinery concepts into existing industrial complexes, such as lowering the capital costs of the facilities used to create biofuel and subsequently lowering the costs of the chemicals and energy that are produced as a result. The future emergent bioeconomy will require the implementation of biorefinery strategies for sustainable development.

Biorefinery plant design, engineering and process

Optimization: As sustainable sources of fuels and high-value chemicals, biomass materials, such as agricultural crops, forestry products, organic fractions of household and industrial wastes, and aquatic biomass such as algae, have drawn increased research and economic attention. The key forces behind the usage of these biologically-sourced process feedstocks have been the rise in global energy demands and the requirement to lessen reliance on fossil fuel-based production systems, given the adverse environmental effects related to their use. The abundance and lower relative cost of fossil fuels have made it more difficult to produce and use bio-derived products, despite the fact that their benefits are widely acknowledged. Modern organic chemistry processes have led to a surge in the manufacture of chemicals and high-volume, low-value transportation fuels, which together account for more than 90% of all worldwide transportation usage (Bozell). For biomass feedstocks to be competitive with traditional fossil-based feedstocks, improvements must be made to their design, utilization, energy efficiency, and economics of heat, power, fuels, and chemicals. The establishment of biomaterials as a potentially workable and sustainable alternative industrial raw material would follow from this.

The primary driver for the adoption of a biorefinery platform is the substitution of "green" biomass sources for fossil-based

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industrial and energy feedstocks. When compared to fossil-based feedstocks such as coal combustion, the generation of energy from these biomass materials is especially advantageous since sustainable management of the biomass and energy production processes can result in nearly neutral net carbon dioxide (CO_2) emissions. However, achieving such "green" energy objectives calls for financial incentives to assist the conversion of biomaterials into renewable fuels. This financial incentive can be addressed by adopting biorefinery systems that simultaneously produce high-value products because fuel products are often low in value regardless of the biomass feedstock.

The most promising method for converting lignocellulosic biomass sources into a variety of fuels and products is to use biorefineries. All possible processing paths from starting materials to intermediate and finished chemicals that can enter the biorefinery site are included in value chains. Process integration techniques are necessary in this context to assess all conceivable biorefinery structures and identify promising multiple-product biorefinery systems with high energy and material efficiency. Given that biorefinery operations depend on the seasonality of biomass variety availability, the design challenge also calls for the selection and planning of suitable biorenewable feedstocks. Incorporating processes and feedstocks as additional degrees of integration freedom, this work provides new concepts and representations.