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Biomass to Fuels: Thermo-chemical or Bio-chemical Conversion?

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The combination of economic and environmental factors, such as soaring crude oil prices, diminishing oil reserves, and changing climate, has created global interest for developing renewable energy sources that could replace fossil fuels [1,2]. Fuels produced from renewable resources such as lignocellulosic biomass have been considered the best potential alternative fuels for replacing fossil fuels in the future. Currently, there are two routes for converting biomass into fuels or other useful bio-products: a) bio-chemical process and b) thermo-chemical process. These two have been intensively studied. But which process is preferred for commercialization in terms of technical and economical feasibility?

The bio-chemical process involves three basic steps: 1) pretreatment to liberate the cellulose and the hemicellulose from the lignin; 2) hydrolysis of the complex polysaccharides to form simple sugars (hexose and pentose); 3) fermentation of the mixed hexose and pentose sugars to produce a fuel [1]. The thermo-chemical conversion process consists of the pyrolysis and/or gasification and subsequent gas cleaning and conditioning processes, followed by the Fischer-Tropsch (F-T) synthesis for the production of synthetic liquid fuels [3].

The bio-chemical process is a complex process, and there are some technical issues and challenges existed, such as low bulk density feedstock, high viscosity substrate, high enzymes cost and low fermentability of some substrate [1,2]. Due to these challenges and issues, the fuels produced from bio-chemical process are more costly than fossil fuels, which make the technology uncompetitive. In order to reduce the process cost, ongoing research activities must discover new ways for eliminating or removing fermentation inhibitors, for reducing the cost of producing enzymes, for identifying inexpensive high quality feedstock, and for engineering robust microbial strains that can simultaneously ferment multiple carbon sugars or hydrolyze cellulose while fermenting multiple carbon sugars [1].

Different thermo-chemical conversion processes include combustion, gasification, liquefaction, hydrogenation and pyrolysis [4,5]. The choice of which actions are used depends upon the type and quantity of the biomass feedstock, the desired type of fuels, the environmental standards, the economic conditions, and the various project specific factors [5].

Compared to the bio-chemical process, the thermo-chemical process has a limited number of processing steps and thus a shorter processing time [6]. The end products are compatible with current fossil fuels and could be introduced into the same distribution system. In addition, the various sub processes use commercially proven technologies that on a large scale have good economics. Despite some remaining issues, the thermo-chemical process is closer to being commercialized than the bio-chemical process.

In light of previously mentioned economic and environmental factors, it is imperative to develop a commercially viable process that can convert biomass into fuels. Building a full scale thermo-chemical processing plant is a potential way to solve the “energy crisis” in the future. Although it is under strenuous investigation for optimization, the thermo-chemical conversion process will become a commercial process for fuels production from biomass.

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