Renewable Petrochemicals from Biomass by Catalytic Fast Pyrolysis

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Lignocellulosic biomass has tremendous potential as a feedstock to make renewable fuels and petrochemicals from biomass. The current impediment to the utilization of our biomass resources is that most processes to convert biomass are not currently economical because of long residence times, the need for expensive enzymes, high pressures and many complicated processing steps. Pyrolysis based approaches are proving to be the cheapest and most efficient method to convert solid biomass into renewable fuels and chemicals due to these processes short residence times, low pressures and simple processing steps. Pyrolysis is the thermal decomposition of biomass, and can be used to produce a mixture of organic molecules that can be condensed into a bio-oil or pyrolysis oil. The bio-oil is the cheapest liquid fuel made from biomass on the market today. However, the bio-oil is a low quality product that is acidic, insoluble with petroleum based fuels, has a high oxygen content and phase separates with time. Furthermore, attempts to upgrades this oil typically require large amounts of expensive hydrogen.

Zeolite catalyst can be added directly into the pyrolysis reactor to produce aromatics and olefins directly from solid biomass in a process called catalytic fast pyrolysis. The advantage of this approach is that high value aromatics and olefins can be produced directly from solid biomass in a single catalytic reactor using inexpensive zeolite based catalysts. In a specially designed fluidized bed reactor the pyrolysis vapors enter into the zeolite pores where they undergo a series of dehydration, decarbonylation and oligomerization reactions to produce aromatics and olefins. The shape, pore structure, and active sites of the zeolite catalysts are critical in obtaining high yields of the desired aromatic products. Using the power of catalysis, reaction engineering, conceptual process design combined with fundamental understanding of the catalytic and pyrolytic chemistry we have been able to tune this process to achieve high yields of the desired aromatics and olefins from solid lignocellulosic biomass.

Pyrolysis based technologies have tremendous potential for the conversion of lignocellulosic biomass into renewable fuels and chemicals. As will be demonstrated in this presentation chemistry, chemical catalysis and chemical engineering are critical 21st century needs to help make renewable energy and chemicals a practical reality.