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Fuels and Platform Chemicals Production from Lignocellulosic Biomass: Current Status and Future Prospects

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Abstract : A significant disadvantage of fossil fuel energy production is the considerable amount of carbon dioxide (CO_2) released, which is one of the contributors to climate change. Apart from environmental concerns, changing fossil fuel prices have pushed society gradually towards renewable energy sources in recent years. Biomass is a plentiful and renewable resource and a source of carbon. Recent years have seen increased research interest in generating fuels and chemicals from biomass. Unlike fossil-based resources, biomass is composed of lignocellulosic material, which does not contribute to the increase in atmospheric CO_2 over a longer term. These considerations contribute to the current move of the chemical industry from non-renewable feedstock to renewable biomass. This presentation focuses on generating bio-oil and two major platform chemicals that can potentially improve the environment. Thermochemical processes such as pyrolysis are considered viable methods for producing bio-oil and biomass-based platform chemicals. Fluidized bed reactors, on the other hand, are known to boost bio-oil yields during pyrolysis due to their superior mixing and heat transfer features, as well as their scalability. This review and the associated experimental work are focused on the thermochemical conversion of biomass to bio-oil and two high-value platform chemicals, Levoglucosenone (LGO) and 5-Chloromethyl furfural (5-CMF), in a fluidized bed reactor. These two active molecules with distinct features can potentially be useful monomers in the chemical and pharmaceutical industries since they are well adapted to the manufacture of biologically active products. This process took several meticulous steps. To begin, the biomass was delignified using a peracetic acid pretreatment to remove lignin. Because of its complicated structure, biomass must be pretreated to remove the lignin, increasing access to the carbohydrate components and converting them to platform chemicals. The biomass was then characterized by Thermogravimetric analysis, Synchrotron-based THz spectroscopy, and in-situ DRIFTS in the laboratory. Based on the results, a continuous-feeding fluidized bed reactor system was constructed to generate platform chemicals from pretreated biomass using hydrogen chloride acid-gas as a catalyst. The procedure also yields biochar, which has a number of potential applications, including soil remediation, wastewater treatment, electrode production, and energy resource utilization. Consequently, this research also includes a preliminary experimental evaluation of the biochar's prospective applications. The biochar obtained was evaluated for its CO_2 and steam reactivity. The outline of the presentation will comprise the following: Biomass pretreatment for effective delignification Mechanistic study of the thermal and thermochemical conversion of biomass Thermochemical conversion of untreated and pretreated biomass in the presence of an acid catalyst to produce LGO and CMF A thermo-catalytic process for the production of LGO and 5-CMF in a continuously-fed fluidized bed reactor and efficient separation of chemicals Use of biochar generated from the platform chemicals production through gasification

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