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Energy Policy Seminar Series

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Techno-Economic and Life Cycle Analysis of Alternative Production Routes for Biomass Based Chemicals

Abstract: This talk concentrates on the integrated design, techno-economic and the life-cycle analysis of the production of chemicals from the lignocellulose biomass. The idea of bio-refinery has been proposed that uses different conversion technologies to produce multiple products. The success of bio-refinery is highly dependent on its mature technology and its applicability to produce not only high volume low cost fuel but also to produce low volume high cost chemicals.

Bio-based products acceptance in the market depends on the competitiveness of economics and sustainability when compared to oil-based chemicals and products. In our previous work, we investigated a novel hydrolysis process for the productions of sugars and the subsequent production of para-Xylene and compared it with two other hydrolysis process (Concentrated acid hydrolysis and Dilute acid hydrolysis) using techno-economic and life cycle assessment. In our present work, we integrate the novel hydrolysis process with the subsequent production of furans from "one pot" reactor to produce other high value chemicals such as surfactants, butadiene, 2-methyl styrene etc. and high value jet fuels and combine it with the production process of para-Xylene and phthalic anhydride.

A detailed flowsheet is developed and simulated using Aspen Plus®. The steps for the production of different chemicals and fuels are integrated with the novel hydrolysis process with the subsequent production of furans from "one pot" reactor into a single flowsheet. Next, heat integration and economic analysis is carried out to calculate the minimum selling price of each of the products. Furthermore, sensitivity analysis is performed to analyze the bottlenecks of the entire process. Life Cycle Analysis is carried out on SimaPro® to investigate the process sustainability with respect to carbon production and water consumption and to compare with the oil-based chemicals and fuels. Finally, an optimization framework is developed for the overall process flowsheet to produce different chemicals from biomass, based on the minimum selling price and the fluctuating need of the market. The optimization will include the change of production of the chemicals based on the demand of the market to maximize the overall profit of the bio-refinery.

—Coffee/tea will be served prior to the lecture—