Gas-To-Liquids (GTL) Technologies for Production of Fuels and Chemicals from Lignocellulosic Biomass

Mario R. Eden
Department Chair
Joe T. & Billie Carole McMillan Professor
Director, NSF-IGERT on Integrated Biorefining
Department of Chemical Engineering
Auburn University

The large amounts of underutilized woody biomass available (14.6 million tons annually in Alabama alone) can contribute significantly to societal goals for energy security and economic viability if technological advances are achieved in the thermochemical conversion platforms. In this work, we are developing viable hydrocarbon production strategies by integration of biomass fractionation technologies followed by technically well-informed application of thermochemical conversion approaches and associated catalyst structures.

Our multidisciplinary team has established significant synergies in our research efforts particularly in catalyst development and characterization, chemical/fuels production and process systems engineering. This work leverages ongoing research by taking advantage of a unique set of testbeds in the Auburn University Center for Bioenergy and Bioproducts consisting of biomass fractionation and several conversion technologies, most notably a pilot-scale gasification unit that will be used to produce the synthesis gas for supercritical phase Fischer-Tropsch synthesis and high value chemical co-production.

Biomass fractionation technology coupled with a pilot-scale gasification unit enables systematic analysis of the downstream conversion viability and potential for value addition for each feedstock constituent, i.e. cellulose, hemicelluloses and lignin. As a specific example, we have studied an innovative supercritical phase Fischer-Tropsch Synthesis (SCF-FTS) process developed at AU using biomass derived syngas with particular attention on the impact of novel nanoscale catalysts on reaction performance. This dense supercritical media enables significant enhancement of middle distillate products while drastically reducing undesired methane formation, thus improving the overall carbon utilization. Additionally, we have demonstrated that the use of properly selected Fe-based catalysts in supercritical fluid reaction media results in a product stream consisting of more than 30% aldehyde species plus significant concentrations of 1-olefins. This affords higher value than conventional FTS approaches. We have also studied Higher Alcohol Synthesis (HAS) under supercritical conditions and this process has been found to be particularly well suited for biomass derived syngas.

Synergistic collaboration between experts in chemical engineering and biosystems engineering allows for a systems level approach to the optimization of the biomass to hydrocarbon chemical/fuel lifecycle including design/characterization of the enabling catalysts. Our team employs a holistic methodology utilizing a systematic and flexible process integration/optimization based framework to identify product distributions and processing routes for integrated biorefineries.

This presentation will provide an overview of the biorefining activities at Auburn University with particular emphasis on the fundamentals of thermochemical conversion and gas-to-liquids technologies for the production of fuels and chemicals.