Integrated Separations to Improve Biocrude Recovery for Biofuels and Bioproducts
Topic Area 1: SCale Up of Bench Applications (SCUBA)

Principal Investigator: Dr. David C. Dayton, Senior Fellow, RTI International

RTI International has been developing an advanced biofuels technology that integrates catalytic biomass pyrolysis and hydrotreating to produce advanced hydrocarbon biofuels and high-value chemicals. Current efforts are geared toward key technical challenges such as improving carbon efficiency of the integrated process by optimizing the biomass thermochemical conversion step to simultaneously maximize both biocrude intermediate yield and quality. Other efforts include developing strategies for bioproduct recovery and efficient upgrading of biocrude to bio-blendstocks.

RTI continues to focus on optimizing operation of our one ton per day (1TPD) catalytic biomass pyrolysis unit and process conditions (temperature, flow rates, catalyst-to-biomass ratio, and feedstock properties) to increase biocrude yields. Capturing biomass pyrolysis vapors requires separating solids at pyrolysis temperatures, quenching the pyrolysis products that have a broad molecular weight distribution and boiling range, capturing the condensation aerosols, and separating biocrude from water.

Cost-competitive advanced biofuel technology strongly depends on yield, but recovering bioproducts before upgrading intermediates to biofuel provides a higher-value revenue stream to improve the overall process economics in an integrated biorefinery approach. The inherent functionalized nature of biomass offers unique opportunity for the production of bio-based oxygen-containing chemicals that are not easily synthesized from petroleum feedstocks. Therefore, deoxygenation of catalytic biomass pyrolysis vapors to produce a low oxygen content biocrude may be a missed opportunity for bioproducts.

The outcome of the project is to demonstrate the technical feasibility of producing biofuel at a minimum selling price of $2.50/gasoline gallon equivalent (GGE) by 2030 when supplemented by the recovery of higher value bioproducts. The primary goal is to enhance biomass carbon efficiency by (1) improving separation of solids from the vapor product stream, (2) enhancing rapid quenching and collection of pyrolysis vapors, (3) separating highly oxygenated bioproducts from the liquid intermediates, and (4) upgrading the remainder into advanced biofuel. A laboratory separation process will be scaled up and integrated into RTI's 1TPD catalytic biomass pyrolysis unit to enhance biocrude collection efficiency by at least 25%, with roughly 10 wt% of the biocrude intermediate recovered as chemical building blocks for bioproducts and the remainder upgraded into biofuels.

The proposed project seeks to address technical issues across the entire value chain from feedstock, through conversion, to biofuels and bioproducts, with the goal of demonstrating the integration of separations with catalytic fast pyrolysis (CFP) to enhance biomass conversion efficiency. Ecostrat has over 20 years of experience sourcing and supplying over 5 million tons of wood fiber and organic feedstock in markets across North America. In this project they will evaluate biomass supply chain logistics to optimize biorefinery size and location as a function of sustainable, cost-competitive feedstock resource availability, market dynamics, and regional infrastructure. RTI will focus on scale-up and integration of separation processes in the 1TPD biomass pyrolysis unit to enhance biocrude collection and fractionation for subsequent bioproduct recovery and upgrading to bio-blendstocks. Coprocessing strategies for upgrading biocrude fractions with petroleum intermediates into finished fuels that meet ASTM specifications will be explored, while biocrude fractionation will support recovering high value market-compatible bioproducts.