Summary for Public Release

Organic components of municipal solid waste (MSW) represent a low or even negative cost feedstock for production of biofuels. Challenges to utilization of MSW include the high moisture content of organic components of MSW, the low quality of easily obtainable bioenergy products, costs and energy consumption associated with transportation, and the heterogeneous and time-varying composition of MSW. We propose development of catalytic technology based on hydrothermal liquefaction to overcome these challenges. The technology will use mild solvent treatment to remove un-reactive components from the biomass fraction of MSW, feeding the remaining reactive carbohydrates along with moist food waste to a hydrothermal reactor, the operation of which is compatible with water loadings of 80% or more. Operating in the presence of a liquid water phase eliminates the need for drying that makes many MSW conversion technologies unviable. The hydrothermal reactor operates at temperatures greater than 200 degrees Celsius, meaning that it supports extremely rapid reactions that are complete within seconds or minutes. Rapid reaction rates mean that the conversion technology can be made compact and modular; in turn, these features allow on-site or highly regionalized operation, thus reducing transportation costs and energy requirements. Slower conversion technologies, chiefly anaerobic digestion, may require days or weeks to complete, making localized deployment impossible or costly. To deal with the complex, time-varying composition of the feed, the hydrothermal reactor will operate in a mode which permits continuous feed of a biomass/food slurry, while the exiting product consists entirely of soluble products. Thus, the time spent by solids present in the feed will depend on their reactivity; less reactive components will spend more time, while highly reactive components will be removed rapidly, thus avoiding over reaction to produce un-desirable solids or gases and providing a natural response to time varying composition. The main product of the hydrothermal reactor is an energy-dense bio-oil, with much greater intrinsic value than biogas produced by anaerobic digestion. Catalytic reactors will be used to increase the value of the bio-oil and make it compatible with the existing fuel infrastructure. The first reactor will aim to reduce loss of valuable products to the water phase that exits the hydrothermal reactor. The second reactor will further reduce the oxygen and nitrogen content of the bio-oil, thereby improving its stability and other fuel properties. Other aspects of the process design will allow for near closed-loop use of water and other resources. Catalysts help reduce process energy requirements. Finally, the catalysts themselves are primarily low cost and stable, meaning that their use is economical. Tasks in this project include developing process models of the hydrothermal reactor and catalytic reactors, optimizing the catalyst, and demonstrating process components. Follow-on work will focus on process design and integration.