Biomass Conversion Methods

Some of the methods include:

Pyrolysis

Fast Pyrolysis

Hydrothermal Liquefaction

Biomass Gasification

STF Combination Process

Pyrolysis subjects the biomass to a thermal decomposition process that occurs at atmospheric pressure and elevated temperatures, in an inert atmosphere. The process involves heating organic materials such as biomass, or wood in the absence of oxygen. Since pyrolysis is carried out at atmospheric pressure, it results in large equipment that cannot be economically deployed for large-scale operation.

Fast pyrolysis is a thermal decomposition process that rapidly heats dry biomass feedstocks such as perennial grass, corn stover, or wood to about 500° C in the absence of oxygen and then quickly cools them in a reactor. This process converts biomass into liquid biofuel and other energy products. Fast pyrolysis can convert up to 75% of biomass input into bio-crude oil, yielding about 135 gallons of bio-oil per ton of biomass. Fast Pyrolysis is also an atmospheric operation with similar large-scale limitations.

Hydrothermal liquefaction (HTL) is a thermal depolymerization process that converts wet biomass and other macromolecules into crude-like oil under moderate temperature (200 - 350° C) and high pressure (several thousand psi). The process is used to convert biomass into liquid fuels by processing in a hot, pressurized water environment for sufficient time (several minutes) to break down the solid biopolymeric structure to mainly liquid components. The crude-like oil has high energy.

Carbon and hydrogen of an organic material, such as biomass, are thermo-chemically converted into hydrophobic compounds with low viscosity and high solubility. Depending on the processing conditions, the crude bio-oil can be upgraded to transportation fuels, such as diesel, gasoline, or jet fuels in a conventional refinery designed to process fossil crude oil. HTL can also be used to convert sewage sludge into bio-oil. HTL can convert up to 80% of biomass input into bio-crude oil even from a wet biomass feedstock, exceeding the yield from a Fast Pyrolysis process. A solid stream of by-product carbon is generated in the process which can either be used as a soil amendment (Terra Preta) or can be converted to synthesis gas using the gasification process.

Biomass Gasification is a mature technology pathway that uses a controlled process involving heat, steam, and oxygen to convert biomass to synthesis gas, without combustion. The process involves the partial oxidation of biomass at high temperatures (800-1300°C) in the presence of a limited amount of oxygen. The resulting gas mixture, contains carbon monoxide, hydrogen, and methane. The synthesis gas can be used as a fuel for combustion gas turbines or as a feedstock for the production of chemicals such as ammonia, methanol, hydrogen, dimethyl-ether (DME), methane, or transportation fuels made by Syn Gas to Gasoline process, or via the Fischer-Tropsch process.

Biomass gasification has several advantages over other biomass conversion technologies such as fast pyrolysis and hydrothermal liquefaction. Here are some of them:

<u>Feedstock Flexibility</u>: Biomass gasification can use a wide range of feedstocks such as wood chips, agricultural residues, municipal solid waste, and energy crops. In our STF Combination process, we use the hydro char (a byproduct from the HTL process) in a repurposed coal gasifier operating at a high pressure and high temperature.

<u>High Efficiency</u>: Biomass gasification can achieve high energy conversion efficiencies of up to 80%.

<u>Versatility</u>: The synthesis gas can be used for various applications such as electricity generation, heating, and transportation fuels, and other commodities specified above.

The STF Combination Process captures the advantages of both the HTL and the gasification process. The exotherm heat recovered from the gasification process is used as the heat source needed to process the biomass slurry feed in the following HTL process. The combination process results in a greater yield of transportation fuels from a given mass of biomass (either wet or dry) and is not constrained by scale of operation limitation as is the case for pyrolysis, fast pyrolysis, or low-pressure gasification. Operating both the HTL and the gasifier at pressure results in lower CAPEX for large-scale operations compared to low-pressure operation.