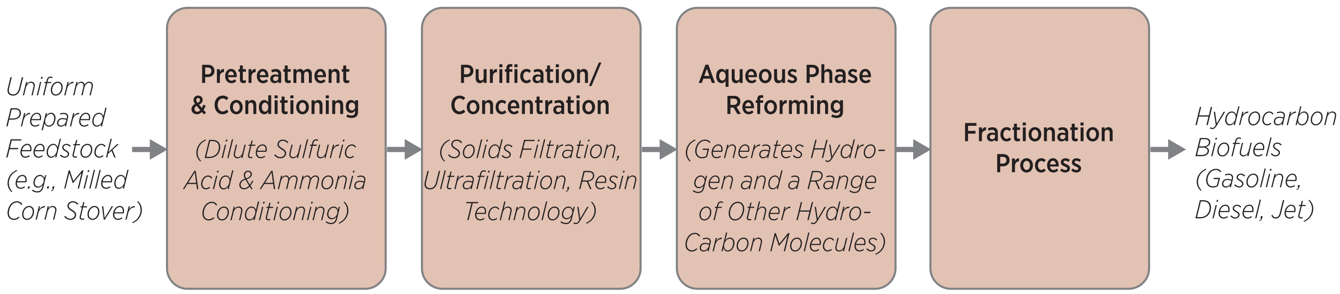
Catalytic Upgrading of Sugars to Hydrocarbons

In the catalytic upgrading of sugars to hydrocarbons pathway, biomass-derived sugars—separated from feedstock through a series of chemical and biochemical processes—are upgraded via aqueous phase reforming into hydrocarbons for fuels and co-product commodities.

Process Block Diagram



Process Design Details

- Biomass is reduced in size and preprocessed into a uniform-prepared feedstock (UPF) and delivered to the feed handling at a rate of 2,000 dry metric tons per day.
- UPF is treated with a dilute sulfuric acid catalyst at mild conditions to liberate the hemicellulose sugars and break down the biomass cell walls.
- Caustics are added to the entire pretreated slurry to raise the pH level from approximately one to roughly five, and enzymatic hydrolysis is performed in parallel batch-type bioreactors.
- Solid materials are removed utilizing solid/liquid separation techniques; purification and concentration are achieved using ultra-filtration and resin technologies.
- Liquid biomass sugars are exposed to catalytic conversion in an aqueous phase reforming process to generate hydrogen and a range of hydrocarbon molecules.
- Hydrocarbon molecules are separated in a fractionation column into "drop-in" fuel components for gasoline, jet fuel, diesel fuel, or bio-derived paraxylene for polyethylene-terephthalate-saturated polyester polymers.

Rationale for Selection

The biochemical conversion methods and technologies employed in the catalytic upgrading pathway offers an opportunity for improved utilization of biomass-derived carbon sources as an alternative to conventional biological pathways. The catalytic conversion of the aqueous phase biomass-derived compounds has been the focus of numerous scientific investigations into hydrogen production. Research and development is needed to understand issues related to operational characteristics, catalyst loading, and catalyst performance, as well as other technical issues. The hydrocarbon fuel intermediates resulting from this pathway can be used as blendstock for conventional transportation fuels, targeting the Bioenergy Technologies Office goal of $3 per gallon for hydrocarbon fuel blends—assuming a reasonable co-product value can be established (e.g., lignin as a low-cost source material for carbon fiber production).

Next Steps

Additional modeling is necessary to quantify baseline costs associated with this process. Experimental data need to be incorporated into the model to benchmark and verify progress and accomplishments. Techno-economic analysis models for the catalytic upgrading pathway will be initiated in 2014.

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