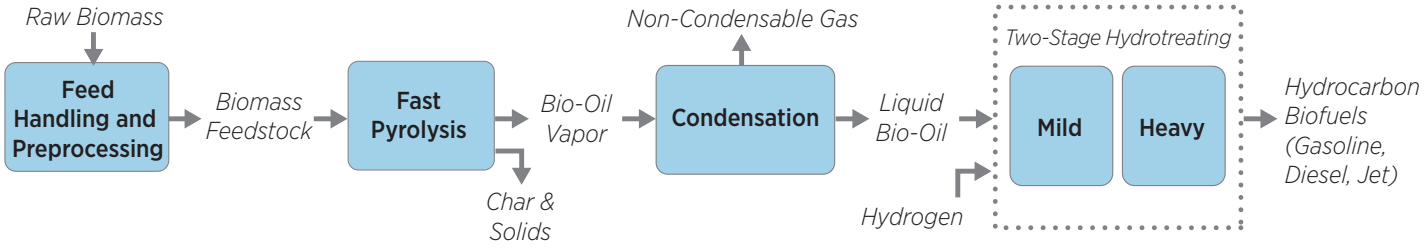
Fast Pyrolysis and Hydroprocessing

In the fast pyrolysis and hydrotreating pathway, biomass is rapidly heated in a fluidized bed reactor to yield vapors, which are condensed into a liquid bio-oil. This bio-oil is subsequently hydroprocessed to produce hydrocarbon biofuel blendstocks.

Process Block Diagram



Process Design Details

- Biomass containing 30 percent weight (wt%) water is dried to about 10 wt% moisture and, and the size is reduced to 2–6 millimeters to produce an acceptable biomass pyrolysis feedstock.
- The biomass feedstock is rapidly heated to approximately 500ºC in less than one second—usually in a fluidized bed reactor and in the absence of oxygen (i.e., fast pyrolysis).
- The bio-oil vapor exits the reactor and bulk solid particulates, and char are removed via cyclones.
- The bio-oil vapor is cooled and condensed to produce a raw, liquid bio-oil with an approximately 75% yield on a dry-weight basis.
- The bio-oil is hydrotreated in two stages:
  - The first stage—mild hydrotreating—is primarily for the mitigation of reactive and destabilizing components. This helps ease processing requirements in the second stage. This proceeds at conditions up to 2,500 pounds per square inch gauge (psig) and 240ºC, as well as in the presence of excess hydrogen and a cobalt molybdenum (CoMo) catalyst.
  - The second stage—heavy hydrotreating—is used to remove most of the remaining oxygen in the bio-oil and to process the bio-oil molecules into acceptable hydrocarbon transportation fuel blendstocks. This proceeds at conditions up to 2,015 psig and 370ºC, as well as in the presence of excess hydrogen and a a hydrotreating catalyst—such as CoMo.
- The oil that results from two-stage hydrotreating is distilled into four fractions: (1) light gases used for fuel and feed to the hydrogen plant, (2) naphtha boiling range material used as a fuel blendstock, (3) diesel range boiling material used as a fuel blendstock, and (4) a heavier-than-diesel fraction that is hydrocracked to produce additional naphtha and diesel blendstocks.
- An aqueous phase containing less than 2% carbon is separated from the hydrocarbon oil after hydrotreating. This stream is treated prior to discharge to a publicly owned water treatment facility.

Rationale for Selection

Conventional fast pyrolysis, followed by hydrotreating, offers a near-term possibility for producing transportation fuels from biomass. Currently, the Bioenergy Technologies Office has a pyrolysis performance goal of $3 per gallon of hydrocarbon fuel blends by 2017.

Next Steps

The existing fast pyrolysis techno-economic analysis will be updated in 2013 to reflect new cost data and developments in catalysts and processing conditions.

U.S. DEPARTMENT OF ENERGY

Energy Efficiency & Renewable Energy

DOE/EE - 0808 • November 2012

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 10% post consumer waste.