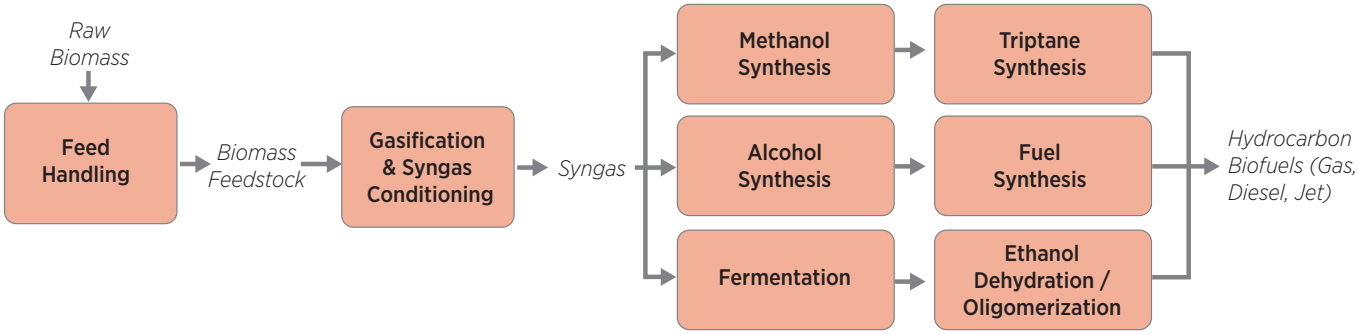
Syngas Upgrading to Hydrocarbon Fuels

In the syngas upgrading to hydrocarbon fuels pathway, biomass feedstocks are gasified to produce a clean syngas, which is used as a feedstock for hydrocarbon biofuel production.

Process Block Diagram



Process Design Details

- Biomass is preprocessed into two-inch chips and dried to about 10 percent weight (wt%) moisture content to produce an acceptable biomass gasification feedstock.
- Indirect gasification of biomass in a fluidized bed reactor (the fluidizing media is usually an olivine or sand-like in nature) through rapid heating typically above around 750ºC produces a syngas, which needs to be conditioned for further utilization.
- Syngas conditioning (tar cracking to produce additional syngas, quenching to remove particulate matter, and scrubbing to remove acid gasses such as carbon dioxide and hydrogen sulfide) is used to produce clean syngas stream.
- Syngas is converted to useful transportation fuel products; three routes are being examined:
  - Catalytic conversion of syngas to methanol, followed by catalytic production of triptane (C_7H_{16}) from methanol. Triptane will be used as a hydrocarbon blend in transportation fuels.
  - Catalytic conversion of syngas to mixed alcohols (C_2–C_4 alcohols, primarily), followed by catalytic conversion to produce hydrocarbon biofuels and oxygenate blendstocks.
  - Fermentation of syngas to ethanol, followed by catalytic conversion of ethanol to produce hydrocarbon biofuel blendstocks. A common fermenting organism is a Clostridium strain.

Rationale for Selection

The gasification platform is extremely amenable to producing drop-in hydrocarbon fuels and products—as syngas is an ideal feedstock for (chemical and biochemical) catalytic conversion. Moreover, the existing fuel and chemical industries currently operate (and are knowledgeable of) gasification and high-temperature reactor systems. This also applies to several other industries that are developing interest and knowledge in producing biofuels (e.g., pulp/paper, catalyst).

Next Steps

Techno-economic and life-cycle analyses will be performed on the three syngas-upgrading processes, which are highlighted above (syngas to methanol to triptyls; syngas to mixed alcohols to hydrocarbons; and syngas fermentation to ethanol, followed by ethanol conversion to hydrocarbons) to determine which of these should be the first pathway to move forward for research and development (R&D) validation. Process and technical barriers, as well as critical R&D needs, will be determined via these initial analyses and refined as more knowledge is developed.

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