FESC
Florida Energy Systems Consortium

Florida State University

Biofuels Through Thermochemical Processes: Approach to Produce Bio-jet Fuel

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Description: The objectives of the proposed research are: to develop technologies to produce biojet and biodiesel fuels from sustainable sources: Bio oils and hydrogen produced from biomass generated synthetic gas.

Scope of Work

1. Produce liquid Biofuels (bio-jet & bio-diesel) from renewable resources of cellulosic biomass and nonedible bio-oils
2. Demonstrate that the Biofuels have comparable performance characteristics to conventional fossil fuels
3. Demonstrate that the new Biofuels do not require major changes in current engine design & operation
4. Demonstrate that Biofuels produced from cellulosic biomass and bio-oils can be economically competitive in current market with fossil fuels

Budget: $347,113
Universities:
External Collaborators: NA

Progress Summary

Task 1: Production of Hydrogen enriched synthetic gas

A gasifier will be designed and built to produce hydrogen enriched synthetic gas. The following parameters will be examined for optimum design of the gasifier.

- Temperature in the bed of the gasifier
- Steam to biomass fed ratio (S/B)
- Bed composition
- presence of additives and/or catalysts in the bed
- of the gasifier
- Space time of the gas in the bed
- Temperature, volume, topology and hydrodynamics
- Feedstock characteristics
- Type and location of the biomass feeding point
- Bed design gasifier topology
- Simultaneous CO_2 capture and utilization (methane reforming)

$$\mathbf{CO_2 + CH_4 \Rightarrow CO + 2H_2}$$

Computational tool utilization for optimum gassifier design

Task 2: Gas clean-up technology

- **Novel application of structured catalyst**
  Particulate control
  Extend catalyst life Improve productivity
  Reduce costs (operation & capital)
- **Use of novel multi functional reactor capable of manipulating**

thermodynamics constraints during operation
Reduce number of operating units
Perform co-current reaction & separation
Significant cost savings

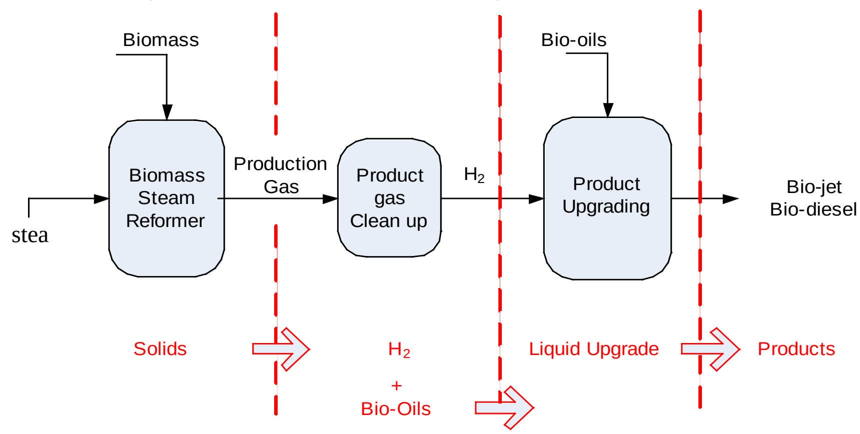
Task 3: Hydroprocessing of Nonedible Bio-oils

- **New catalyst system for mild hydrotreating**
  Minimize hydrogen consumption
  Minimize production of undesirable byproducts
  Design catalyst selective to decarboxylation of bio-oils
- **Novel reactor design**
  Operating and capital cost reduction
  Not feedstock sensitive
- **Draw on existing industrial infrastructure for rapid commercialization and** technology deployment

2010 Annual Report

Novel processing concepts, reactor design and catalyst systems are employed in this integrated approach to convert any cellulosic biomass and any nonedible bio-oils into bio-jet fuel (Figure 1). Feedstock flexibility offers significant cost and logistic advantages to this approach. Unlike other processes which use only the oil derived from a plant, the entire plant can be used as feedstock source and the proposed approach can also convert the more challenging lignocellulosic component.

Figure 1: A schematic of the integrated bio-jet fuel production steps.



Through molecular manipulations, the inherent chemistry of the proposed approach allows the production of "designer biofuels" and offers a means to tailor product properties through saturation of double bonds to give better shelf life, cleaving long chain hydrocarbons to produce the jet cut, controlling aromatics content for better combustion characteristics and isomerization to achieve better performance.

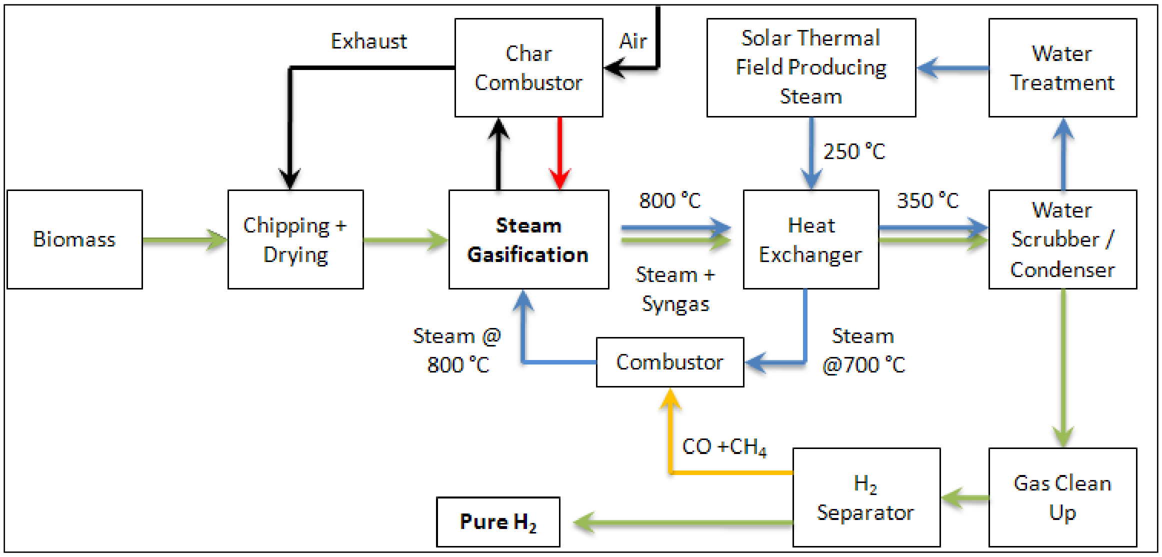


Figure 2: Hydrogen production schematic

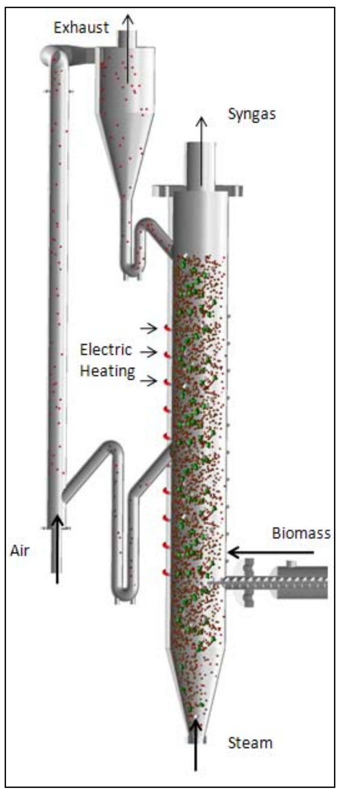


Figure 3: Dual fluidized bed steam gasifier.

Task 1: Production of Hydrogen enriched synthetic gas: Biomass Steam Reformer

- A test loop of the dual fluidized bed steam gasifier, a schematic illustration of which is given in Figure 3, was built and tested using nitrogen and carbon dioxide to verify that the synthesis gas will not move with the fluidized bed.

Figure 4: Cold Test Loop.

- A commercial 10 kW downdraft gasifier was purchased for comparison testing with the dual fluidized bed. The gasifier has been assembled and is in full working order.

Figure 5: 10 kWe commercial downdraft.

- The Steam generator and electric heaters have been acquired and testing is currently being done on system controls

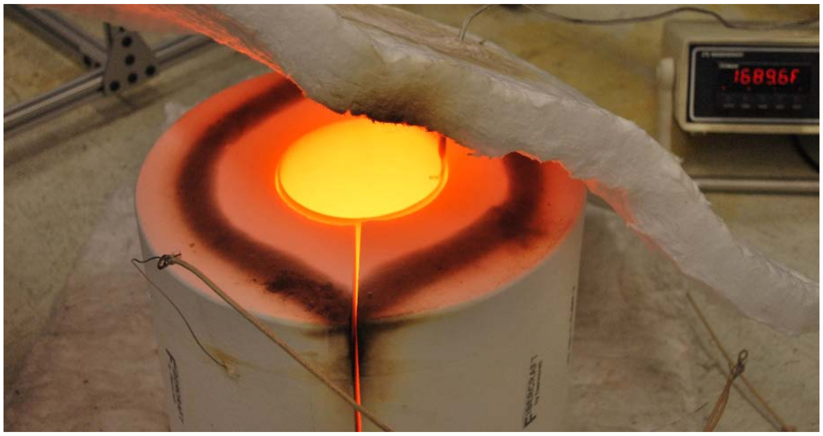


Figure 6: Successful electric heater test reaching core temperature of 1690 F.

- Construction has begun on the updraft gasifier. It is projected to be completed by November 2010.
- An in-line gas chromatograph has been installed and is currently being calibrated to test molar constituents of gas stream.

Figure 7: Installed in-line gas chromatograph

Task 2: Gas clean-up technology

Analytical equipment specification for product gas analysis was completed and custom built Varian GC was purchased. Reactor furnace with special heat equalizing blocks was purchased from ATS and delivered. Wet test meter with pulse generator has been purchased from Ritter to measure product gas. Process plant control systems were evaluated and National Instruments hardware and software have been selected to control the biofuels micro unit.

Task 3: Hydroprocessing of Nonedible Bio-oils

This particular step is being carried out by our industrial partner Energia Technologies Inc, of Oakland, California. Energia Technologies is currently building high pressure and temperature bench scale unit capable of independently testing bio conversion unit. This work is being carried out under a Office of Naval Research STTR phase I program (FSU is a sub contractor to this effort)