

UNIVERSITY OF CENTRAL FLORIDA
Integrated Florida Bio-Energy Production with Carbon Capture and Sequestration

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Description: The aim of this project is to produce liquid hydrocarbon fuels derived from Florida based biomass utilizing a two-step process. In the first step, biomass or biomass-derived pyrolysis oils are gasified with oxygen and steam to synthesis gas (syngas) comprised of mostly hydrogen, carbon monoxide and carbon dioxide gas. For this step, an oxygen source is employed (e.g. oxygen concentrator, electrolytic unit, etc.) for biomass gasification. Use of pure (or nearly pure) oxygen for gasification of biomass allows higher overall process energy conversion efficiency by eliminating nitrogen dilution in the syngas. In the second step, syngas from step 1 is fed into a Fischer Tropsch (FT) synthesis unit and converted to liquid hydrocarbon fuels, e.g., diesel fuel. The process can be employed with any lignocellulosic material including crop residues, forest waste, yard clippings, and energy crops. The technology also provides a means for sequestering carbon in the form of a high-value soil enhancing bio-char (terra preta) by simple modification of the gasification step 1.

Budget: \$648,000

Universities: UCF/FSEC

Progress Summary

In this reporting period, we designed and built a larger scale Fischer-Tropsch (FT) synthesis reactor using a cobalt based catalyst. A large number of bench-scale screening of various Fe, Co and Mo based FT catalysts had been conducted prior to choosing cobalt as the FT catalyst of choice.

The larger scale reactor was fabricated out of a 1" OD, 3.5' long stainless steel tube. Fig. 1 shows the schematic of the FT reactor having several heating mantles and five thermocouples placed in various locations inside the reactor for monitoring and controlling the reaction bed temperatures. A total of 20g of 20%Co-SiO₂ (20-35 mesh) mixed with 500g of SiC (30 mesh) particles was used as bed material. The bed material was placed inside the reactor in ten small batches to allow a more even distribution of cobalt catalyst throughout. The catalyst bed was reduced in pure H₂ for a day before each experimental run.

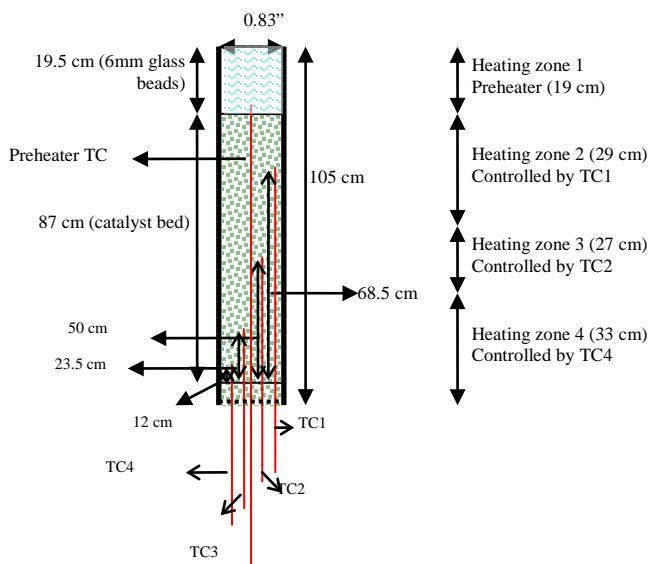


Fig. 1. Schematic diagram of the FT reactor.

Fig. 2 shows the effect of flow rate of the gas (H₂:CO ratio of 2:1) on conversion, selectivity and space-time yields at 220°C and 100 psig reactor temperature and pressure, respectively. Syngas flow rates above 652 mL/min give higher concentration of CH₄ and light gases and lower liquid hydrocarbon yields. The increased CH₄ and light gas selectivity appears to be due to the development of hot spots in the catalyst bed.

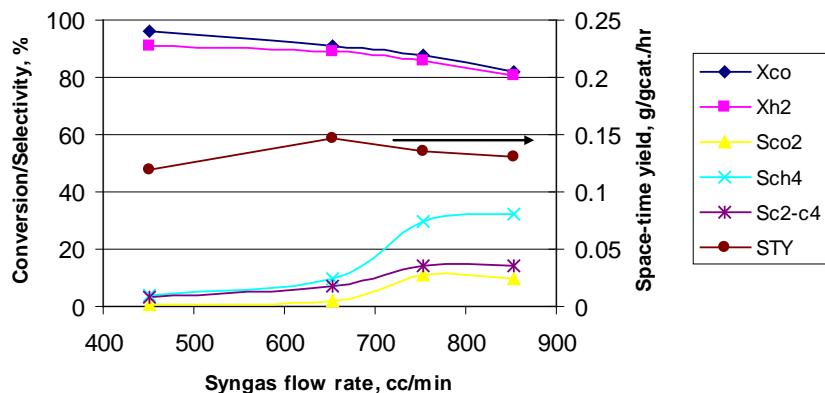


Fig. 2. Effect of syngas flow rate on the conversion, selectivity and space-time yields for H₂:CO ratio of 2:1 and at 220°C and 100 psig.

Several tests were conducted with syngas H₂:CO ratio of 1:1. It was possible to increase the syngas flow rate substantially without any increase in CH₄, light gas and CO₂ selectivity – resulting in space-time yields of liquid hydrocarbons greater than the ones obtained with syngas of H₂:CO ratio of 2:1. To date, the maximum liquid hydro-carbon yield obtained has been about 5.1 g/hr.

We also tested a syngas composition containing CO₂. Results obtained to-date indicates that the presence of CO₂ has the effect of reducing the partial pressure of the reactants leading to lower liquid hydrocarbon yields. This can be compensated by increasing the total pressure of the reactor. The presence of CO₂ also led to lower CH₄ and light gas selectivity.