Tri-reforming of Methane and CO_2: A Novel concept for Catalytic Production of Solid Waste Syngas with Desired H_2/CO Ratios for Liquid Biofuels

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QUARTERLY PROGRESS REPORT

October 1 - November 30, 2010

PROJECT TITLE: Tri-reforming of Methane and CO_2: A Novel concept for Catalytic Production of Solid Waste Syngas with Desired H_2/CO Ratios for Liquid Biofuels

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PROJECT WEBSITE ADDRESS (URL): http://wolan.blog.usf.edu/tri-reforming/

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Work accomplished during this reporting period:
Synthesis of Tri-Reforming Catalyst
Characterization of Tri-Reforming Catalyst
Reaction Engineering

Information Dissemination Activities:
Website

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TAG meetings:
November 17, 2010 University of South Florida

Abstract

This research focuses on converting Municipal Solid Waste (MSW) to liquid fuels using Fischer-Tropsch synthesis (FTS). The process includes novel gasification of MSW via a tri-reforming process which involves a synergetic combination of CO_2 reforming, steam reforming, and partial oxidation of methane. Typical biomass or MSW derived syngas H_2:CO is 1:1. This innovation allows for cost-effective one-step production of syngas in the required H_2:CO of 2:1 for use in the FTS. The USF group has already developed a process that converts this syngas into diesel and jet fuel. This project will focus on the development of an appropriate gasification catalyst to convert MSW to the required syngas composition for production of liquid fuels.

1. Tri Reforming

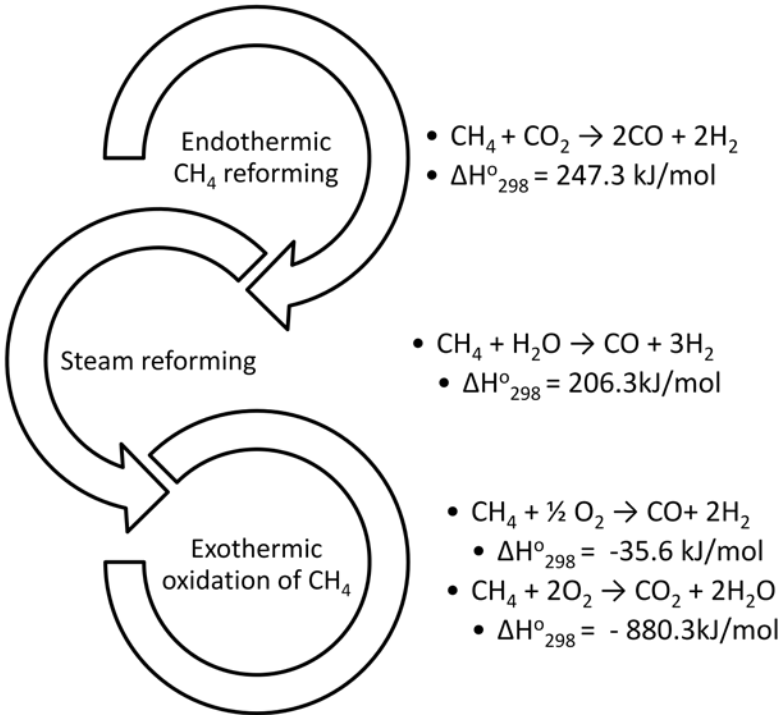

Figure 1. Tri-Reforming

2. Project organization

2.1 Synthesis of Tri-reforming Catalyst

Co-precipitation of precursors provides an industrial scale up opportunity as well as simplicity. Variables that will be observed will be the amount of Nickel Nitrate, Nano-Nicke, amount of Magnesium, and Composition of Cerium and Zirconium Oxide.

Table1. Catalyst Variables

Ni:Mg Ratio	**Cerium Content**
0	0
0	1
0	2
1	0
1	1
1	2
2	0
2	1
2	2

To make the catalyst 1.1 grams of $ZrO(NO_3)_2$ X H_2O was placed on a hotplate to evaporate H2O. Then 6.1762 g of $Ce(NO_3)_3$ $6H_2O$ was added to the $ZrO(NO_3)_2$ X H_2O and both dissolved in H2O. The mixture was then mixed with NH4OH to precipitate the catalyst needed, and then vacuum filtrated. The mixture was left in an oven to dry at 120 degrees Celsius overnight. Further tests and results will be included in the following quarter report.

2.2 Reaction Engineering

The preliminary steps in reaction engineering is to conduct benchmark catalyst test, pass MSW syn gas / component mixture over packed bed, and then measure outlet concentrations after reactor using Mass Spectroscopy.

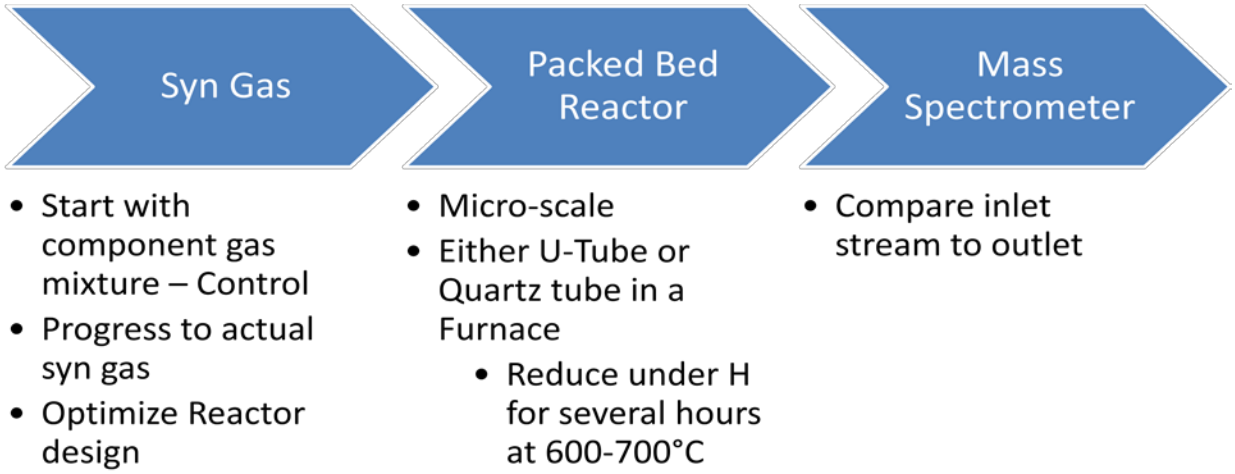

Figure 2. Reaction Engineering

2.2.1 Benchmark Catalyst test

Temperature-programmed reduction (TPR) technique was applied for the characterization of heterogeneous catalysis to find the most efficient reduction conditions. The method used oxidized catalyst precursor and submitted to a programmed temperature rise while a reducing gas mixture of Hydrogen was flowed over it.

The micro reactor was a U-Shaped quartz tube in which approximately 50-100mg of a benchmark catalyst was packed between quartz wool. The flow rate of gas used in the system was 5mL per minute of Hydrogen and 45mL per minute of Helium. The TPR cycle used was to ramp the temperature at 10 degrees Celsius per minute reach the temperature of 850 degrees Celsius. The system was then dwelled at that temperature for 30 minutes. The preliminary results showed comparable results with those found in literature. Further tests and results will be included in the following quarter report.