Integrated Biorefinery Optimization through Biomass Fractionation, Gasification and Advanced Catalytic Conversion Processes

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Project Location: Department of Chemical Engineering, Auburn University, Department of Biosystems Engineering, Auburn University

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1. Planned Activities:
This SunGrant project consists of five interrelated research topics: Biomass Fractionation, Biomass Gasification, Supercritical Phase Fischer-Tropsch Synthesis, Catalyst Characterization, as well as Process and Product Design, Integration and Optimization. Each of these research topics have specific tasks that were outlined in the project description. In the previous report (submitted in August 2012), the plans for the next quarter were listed as:

A. Biomass Fractionation:
   I. Fractionation Optimization Studies
   II. Production Runs under Optimized Conditions
   III. Lignin Precipitation and Purification

B. Biomass Gasification:
   I. Characterize Woody Biomass Lignin from Fractionation Studies
   II. Sustained Optimized Production (Fractionated Feedstock)

C. Supercritical Phase Fischer-Tropsch Synthesis:
   I. Incorporate Product Upgrading Catalysts in SCF-FTS Reactor
   II. Sustained Fuels Production from Simulated Syngas
   III. Sustained Runs on Biomass Derived Syngas from Gasification Studies

D. Catalyst Characterization:
   I. Utilize Advanced Analytical Techniques for Catalyst Characterization

E. Process and Product Design, Integration and Optimization:
   I. Development of Process Simulation Models
   II. Process Integration and Optimization of Fuels Production Systems
III. Evaluation of Economic and Environmental Performance Metrics
IV. Life Cycle Analysis of Products and Production Routes
V. Development of Optimal Fuel Mixture Design Techniques
VI. Molecular Design of Fuels Additives

2. **Actual Accomplishments:**
   Our earlier efforts focused primarily on gasification studies using a downdraft gasifier. In the previous progress report, we introduced some new experiments performed using a bench-scale bubbling fluidized bed gasifier. During this quarter, we are continuing these efforts and will report on the results in subsequent reports.

   Efforts on evaluating the performance of the triple-bed reactor system for Fischer-Tropsch Synthesis with integrated product upgrading are also continuing. Product analyses are being performed and will be reported in subsequent reports.

3. **Explanation of Variance:** N/A

4. **Plans for Next Quarter:**
   We are wrapping up the project over the next couple of months. The no-cost extension we were granted earlier this year has allowed us to make significant progress towards achieving all of the project objectives.

5. **Budget:**
   a. Funds Expended to Date (End of Reporting Period): $246,868
   b. Remaining Balance of Funds: $3,131

6. **Patents:** N/A

7. **Publications / Presentations:**
   The PIs have published or had accepted a total of 15 refereed publications during the course of this project, 7 of which were included with the annual report submitted in April 2011. In addition, the PIs and their students have given 35 presentations during this project.
   **Publications:**
   3. Suchithra T. Gopakumar, Sushil Adhikari, Ram B. Gupta, Maobing Tu and Steven Taylor. Production of hydrocarbon fuels from biomass using catalytic pyrolysis under...
helium and hydrogen environments. Bioresource Technology (accepted for publication).


Presentations:
Meeting of American Society of Agricultural and Biological Engineers, June 20-June 23, 2010, Pittsburgh, PA.


Advanced Catalytic Conversion”, Invited Lecture, 2nd International Congress on Sustainability Science and Engineering, Tucson, AZ.


27. Avanti Kulkarni, Sushil Adhikari and Sushil Bhavnani, 2012. Gasification of torrefied biomass using a bench scale fluidized bed gasifier presented at Annual International Meeting of American Society of Agricultural and Biological Engineers, July 29- August 1, Dallas, TX.


