DOE Award Number: DE-EE0000405

Award Recipient: University of Washington

Name of Project: Development of the University of Washington Biofuels and Biobased Chemicals Process Laboratory

Principal Investigator: Richard Gustafson

Executive Summary

The funding from this research grant enabled us to design and build a bioconversion steam explosion reactor and ancillary equipment such as a high pressure boiler and a fermenter to support the bioconversion process research. This equipment has been in constant use since its installation in 2012. Following are research projects that it has supported:

- Investigation of novel chip production method in biofuels production
- Investigation of biomass refining following steam explosion
- Several studies on use of different biomass feedstocks
- Investigation of biomass moisture content on pretreatment efficacy.
- Development of novel instruments for biorefinery process control

Having this equipment was also instrumental in the University of Washington receiving a $40 million grant from the US Department of Agriculture for biofuels development as well as several other smaller grants.

The research that is being done with the equipment from this grant will facilitate the establishment of a biofuels industry in the Pacific Northwest and enable the University of Washington to launch a substantial biofuels and bio-based product research program.

Comparison of accomplishments and goals

The goal of the project was to install a steam explosion reactor and ancillary equipment to conduct bioconversion research. The reactor has been installed and is working perfectly. All the goals of the project have been met.

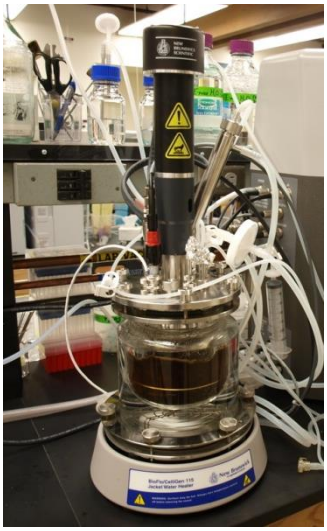
Project Activities

The University of Washington biofuels and bio-based chemicals process laboratory is completely functional. The high-pressure steam explosion biomass reactor is in place and is fully operational. Experimental results show that the reactor produces pretreated biomass with exceptional uniformity and low inhibitor concentrations. A photograph of the installed steam reactor and boiler is given below. In addition, photographs of poplar wood feedstock and pretreated biomass produced in the reactor is given below. The steam reactor has already been used by four graduate students, a post-doctoral fellow, and several undergraduates for their industry/government supported research. We also use the reactor as part of the Bioresource Science and Engineering undergraduate program.

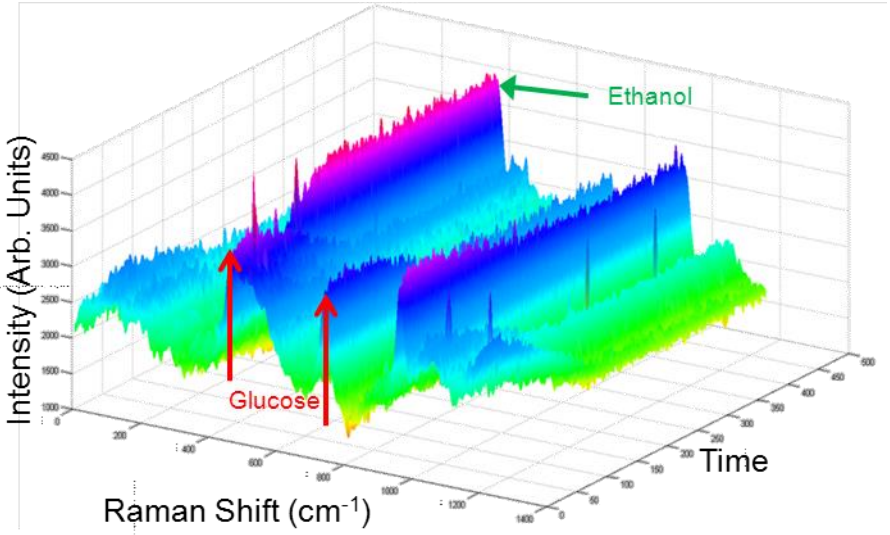
University of Washington High Pressure Steam Reactor and Dedicated Boiler

Poplar wood chips pretreated in the steam reactor to form biomass suitable for biofuel production.

The final piece of equipment for the laboratory is a fermenter. The fermenter is up and running. It has excellent control capabilities and has proven to be very versatile; we can use it for both fermentation and hydrolysis research. The reactor is being used on a project with the Applied Physics Laboratory to develop Raman probes to monitor hydrolysis and fermentation. The figures below show the fermenter and output from the Raman analysis.



Fermenter used for UW biofuels research



Output from Raman probe showing consumption of glucose and production of ethanol in UW fermenter.

Products Developed Under the Award

Publications:

Vajzovic, A., Bura, R., Kohlmeier, K., and Doty L.S., (2012) Novel endophytic yeast *Rhodotorula mucilaginosa* strain PTD3 II: production of xylitol and ethanol in the presence of inhibitors, Journal of Industrial Microbiology and Biotechnology 39 (10) 1453-1463.

Ewanick, S., Thompson, W, J., Marquardt, B., J., and Bura, R., (2013) Real-time understanding of lignocellulosic fermentation by Raman spectroscopy, Biotechnology for Biofuels, 6: 28.

Ewanick, S., Schmitt, E., Gustafson, R., and Bura, R., (2014) Use of Raman spectroscopy for continuous monitoring and control of lignocellulosic biorefinery processes, Pure and Applied Chemistry, in press

Morales-Vera, R., Bura, R., Gustafson, R., and Dooley, J., The influence of particle size on bioconversion of hybrid poplar for sugar production, submitted to "Bioresource Technology" (2014)

Technologies/Techniques

The steam reactor has been used to develop technologies to improve the efficacy of steam explosion pretreatment. These technologies are described in the publications listed above and that are forthcoming. Some of the process improvements and technologies that resulted from this equipment include:

- Presteaming (soaking) of biomass prior to steam explosion pretreatment
- Refining of biomass following pretreatment
- New methods of producing wood chips for use in steam explosion pretreatment
- New sensors for fermentation and hydrolysis in the production of biofuels
- Advanced control systems for biofuels production