Quarterly Update
National Bioenergy Center Biochemical Platform Integration Project
Biomass
Biomass Program—Sustainable Fuels, Chemicals, Materials, and Power

October - December 2008, #21

The Biochemical Process Integration Task focuses on integrating the processing steps involved in enzyme-based lignocellulose conversion technology. This project supports the U.S. Department of Energy's efforts to foster development, demonstration, and deployment of "biochemical platform" biorefineries that economically produce commodity sugars and fuel ethanol, as well as a variety of other fuel and chemical products, from abundant renewable lignocellulosic biomass.

The National Renewable Energy Laboratory manages this project for DOE's Office of the Biomass Program. Information on the Biomass Program is available at Biomass Program.

To discuss the contents of this update, or for further information on the Biochemical Process Integration Task, contact Dan Schell at NREL, phone (303) 384-6869, email dan_schell@nrel.gov

31st Symposium on Biotechnology for Fuels and Chemicals

The next Symposium will be held at the Intercontinental Hotel in San Francisco, CA, May 3-6, 2009. Meeting information can be found at the following web site: http://www.simhq.org/meetings/sbfc2009/index.html. A list of the technical session topics is as follows:

Sunday, May 3
Session 1 – Plant Science and Technology
Session 2 – Microbial Science and Technology I
Poster Session, Part 1

Monday, May 4
Session 3 – Biomass Pretreatment and Fractionation
Session 4 – Translational Genomics for Bioenergy Feedstocks
Session 5 – Enzyme Science and Technology I
Session 6 – Microbial Science and Technology II
Poster Session, Part 2

Tuesday, May 5
Session 7 – Biorefinery Deployment
Session 8 – Biofuels Logistics and Sustainability
Evening Special Topics:
Topic A: International Commercialization of 2nd Generation Biofuels
Topic B: Development and Commercialization of Algal-Based Biofuels

Wednesday, May 6
Session 9 – Bioprocessing and Separations Technology
Session 10 – Enzyme Science and Technology II
Session 11 – Emerging Biofuels and Chemicals
Session 12 – Biomass Recalcitrance

R&D Progress

Understanding the Impact of Corn Stover Compositional Variability on Pretreatment Performance

Corn stover is a potential large-volume lignocellulosic biomass feedstock that can be converted to fuels and chemicals. While most research efforts are focused on improving conversion yields, little is known about how the large compositional variability inherit in corn stover affects conversion yields. This study focused on assessing the impact of stover compositional variability on xylose conversion yields during dilute-acid pretreatment and on the enzymatic cellulose digestibility of the resulting treated solids. We pretreated seven compositionally diverse corn stovers obtained from various locations throughout the United States. Each corn stover lot was pretreated at three different conditions in triplicate in a pilot-scale continuous reactor. At a medium pretreatment severity, monomeric xylose yields ranged from 30% to 70% for the different stover lots (see Figure 1A), and corresponding enzymatic cellulose digestibilities ranged from 68% to 95% (see Figure 1B). Similar results were seen at the other pretreatment severities. We found that xylose yields and enzymatic digestibility decreased with increasing acid neutralization capacity or soil content of the stover. Xylose yields also increased to a lesser extent with increasing xylan content of the stover. No other significant correlations between the stover's component concentrations and conversion yields were found. Apparently, the compounds that neutralize acid are predominately associated with external contaminants on the stover (i.e., soil). The same conversion yields could likely be obtained with different stover lots by appropriately adjusting the acid loading during pretreatment to compensate for the neutralizing effect of the external compounds. More details on this work will be presented at the 31st Symposium on Biotechnology for Fuels and Chemicals.

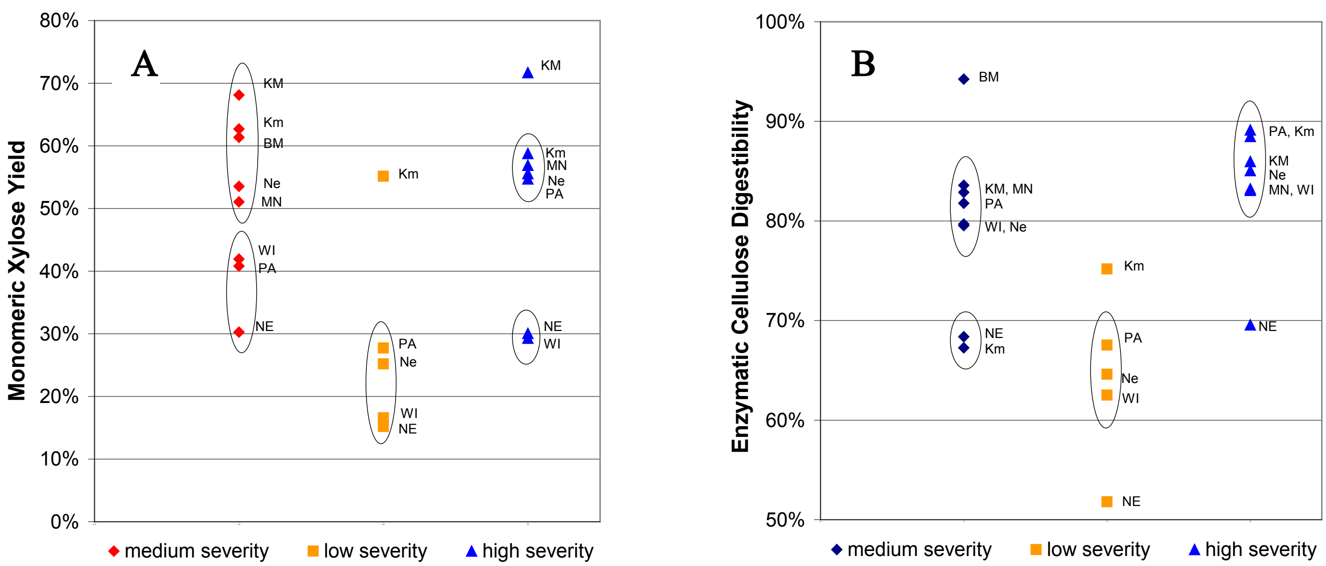

Figure 1. Average monomeric xylose yields (A) and enzymatic digestibilities (B) of various corn stover lots (identified by their two letter codes) pretreated at three different severities. Circled data points are not significantly different from each other at a 95% confidence level.

Efficiency of Lime and Ammonium Hydroxide Conditioning of Dilute-Acid Pretreated Corn Stover Hydrolysates

Dilute-acid pretreatment of lignocellulosic biomass releases hemicellulosic sugars and improves the enzymatic digestibility of the treated solids, but the hydrolysate is often toxic to microorganisms. Several processes have been proposed to reduce hydrolysate toxicity, including treating the liquor with lime or ammonium hydroxide. We investigated the impact of both of these chemicals on the performance of two different process configurations for producing ethanol from corn stover. In one process configuration, the hydrolysate liquor was removed from pretreated slurry and treated with lime or ammonium hydroxide. The liquor was recombined with the solids; the solids were then enzymatically hydrolyzed to glucose with cellulase; and the resulting sugar solution was fermented to ethanol using a glucose-xylose fermenting bacteria, *Z. mobilis*. In the second process configuration, the whole slurry was treated with lime or ammonium hydroxide, and then the procedure used for the first process configuration was followed. Both process configurations were tested at a 15% and 20% (w/w) total solids loading at the enzymatic hydrolysis step. Neither lime nor ammonium hydroxide had a large impact on performance regardless of the process configuration or solids loading. For the first process configuration at a

20% total solids loading, cellulose to glucose yields of 74.3% and 75.6% and ethanol yields of 79.3% and 79.6% were achieved using lime or ammonium hydroxide, respectively. However, compared to lime, using ammonium hydroxide eliminates sugar losses typically seen during the overliming process, the need to dispose of gypsum produced during the neutralization of sulfuric acid with lime, and the potential for deposition of gypsum in downstream process equipment.

Biochemical Process Integration Task Information

Web-based information on the process integration project, including presentations made at past review meetings, are available at the following links (Process Integration Project Information, http://obpreview07.govtools.us/biochem/). A discussion of how Stage Gate management is used in the Biomass Program is also available at this site (Stage Gate Management).

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