

## BIOMASS

The Biochemical Process Integration Task focuses on integrating the processing steps 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 ethanol or other fuels, as well as commodity sugars and a variety of other chemical products, from 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, e-mail [dan.schell@nrel.gov](mailto:dan.schell@nrel.gov).

### 34<sup>th</sup> Symposium on Biotechnology for Fuels and Chemicals

This year's symposium will be held at the Sheraton New Orleans, New Orleans, Louisiana, on April 30–May 3, 2012. Meeting information can be found at the following website: <http://www.simhq.org/sbfc>. Program topic areas are listed below.

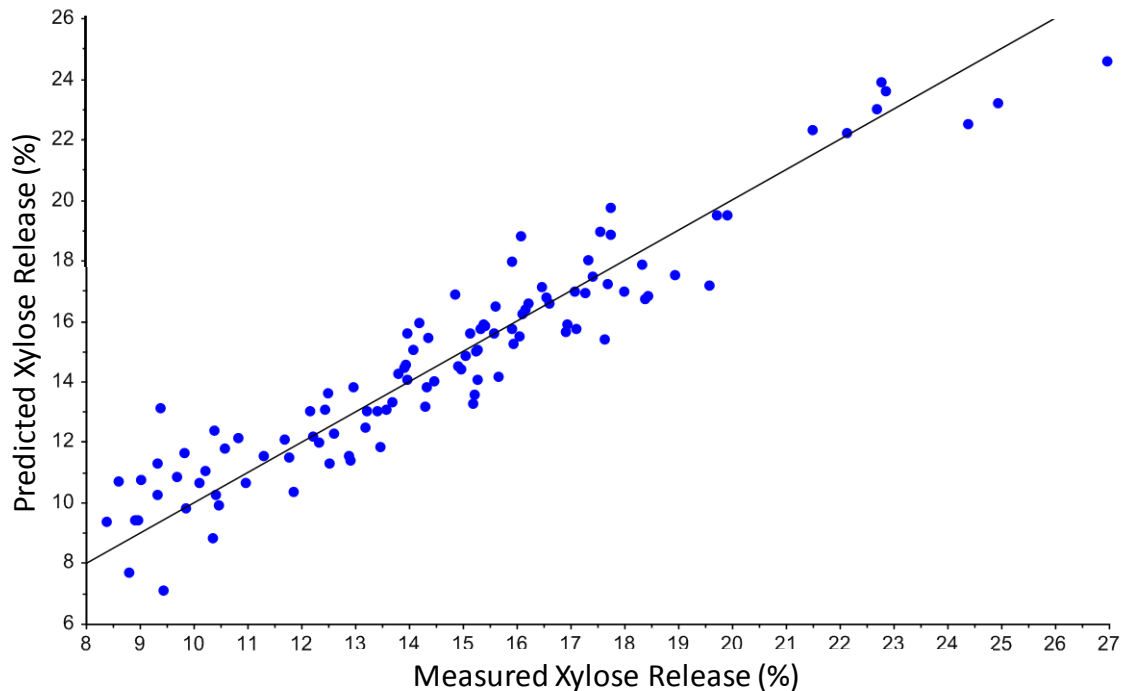
- Yeast and Fungal Science & Technology
- Bacterial Science & Technology I-II
- Algae Science & Technology
- Enzyme Science & Technology I-III
- Pretreatment & Fractionation I-III
- Biomass Recalcitrance
- Plant Science & Technology
- Biomass Supply & Sustainability
- Biomass Physicochemical Analysis
- Bioprocessing & Separations Technology
- Biofuels and Biorefinery Economics & Commercialization
- Biobased Chemicals
- Emerging Biofuels

## R&D Progress

### Feasibility of NIR Spectroscopy-Based Rapid Feedstock Reactivity Screening

We tested the feasibility of using near-infrared (NIR) spectra of raw feedstocks to provide a rapid, robust, and reproducible assessment of conversion yields achieved when pretreating these feedstocks with dilute sulfuric acid. The feedstocks tested included sorghum, corn stover, switchgrass, miscanthus, and native cool season grasses. We correlated the NIR spectra of the as-received feedstocks to sugar release (mass of monomeric sugar produced as a fraction of the total biomass sample mass) and conversion yields (mass of monomeric sugar produced as a fraction of the theoretical sugar mass in the biomass sample) from pretreatment. We obtained satisfactory correlations for glucose and xylose release (see Fig. 1) and glucose yield, but not for xylose yield. We believe the unsatisfactory performance of the xylose yield model may be caused by the lack of variability in these samples; the xylose yield data were much less variable than the glucose yield, glucose release, or xylose release data. We also attempted to correlate NIR spectra and sugar release results to pretreatment data produced by a high-throughput robotics platform at NREL for a set of switchgrass samples.

However, we were unsuccessful likely because of the lack of compositional variability of this material. This year we will examine a wider range of pretreatment conditions and determine if a good correlation with enzymatic digestibility can be developed.



**Figure 1. Predicted versus measured xylose release upon dilute acid pretreatment using a multivariate calibration model based on FT-NIR spectra of various lignocellulosic feedstock samples.**

### Demonstrating Integrated Pilot-Scale Biomass Conversion

In November 2011, we successfully demonstrated integrated dilute acid pretreatment, enzymatic hydrolysis, and fermentation of corn stover in the new pilot-scale equipment recently installed in the new Integrated Biorefinery Research Facility. Corn stover was continuously pretreated at a rate of 24 dry kg/h in a horizontal reactor for 12 hours. The pretreated material was fed to a high-solids, paddle-type mixer and enzymatically hydrolyzed at 20% (w/w) total solids for 4 days. The saccharified slurry was then fed to a 1,500-L fermentor and inoculated with the glucose-xylose fermenting bacterium *Zymomonas mobilis* 8b. The xylan-to-monomeric xylose yield from pretreatment was 68%, which is lower than desired and lower than demonstrated even in this equipment when run previously in a stand-alone fashion. However, we have not fully optimized for performance in the new reactor, and the primary purpose of this activity was to demonstrate fully integrated capability from start to finish. The cellulose-to-glucose yield from enzymatic hydrolysis was 87% and after two days of fermentation a final ethanol titer of 50 g/L was achieved (Fig. 2), with conversion yields of glucose and xylose to ethanol of 95% each. The final ethanol titer was slightly lower than achieved in the past during bench-scale fermentations because less xylose was produced during pretreatment, but the cellulose-to-glucose yield and sugar-to-ethanol yields were both good.

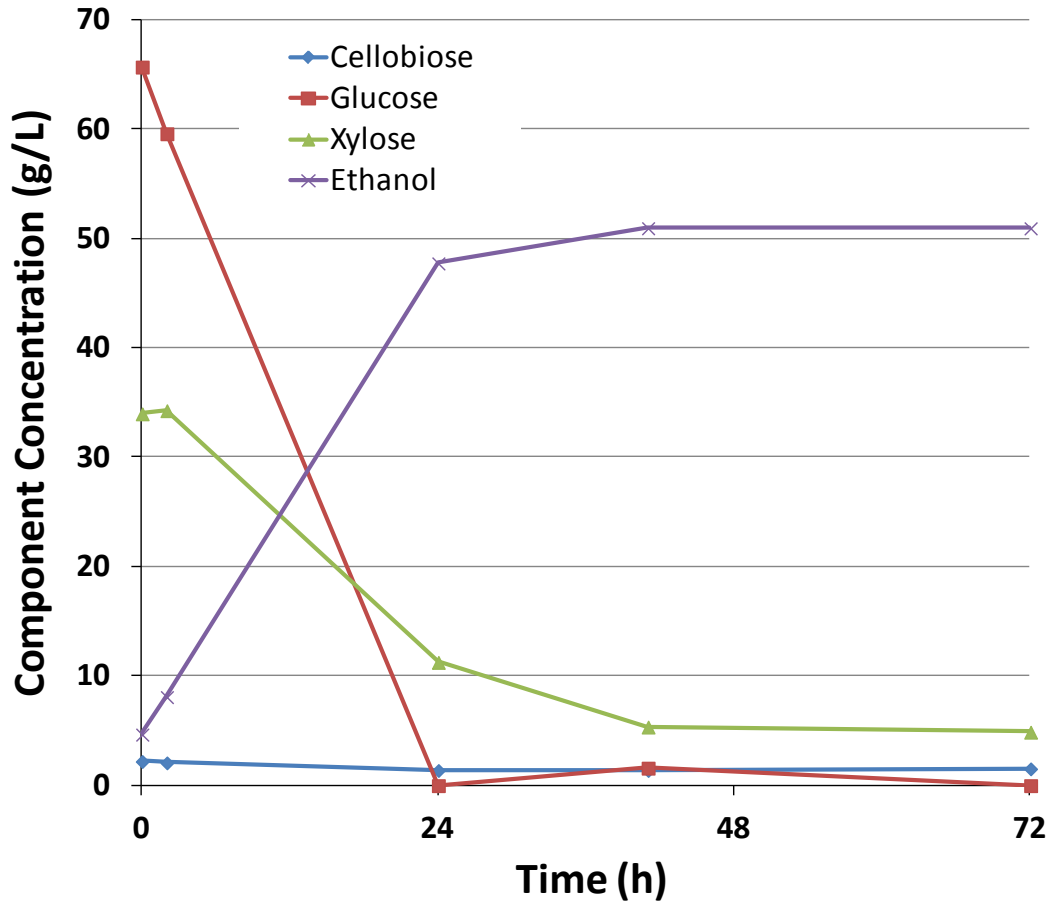


Figure 2. Sugar and ethanol concentrations during cofermentation of saccharified corn stover slurry by *Z. mobilis* 8b.

### Biochemical Process Integration Task Information

Web-based information on the biochemical process integration project, including presentations made at past review meetings, is available at the following links: <http://www.obpreview2009.govtools.us/biochem> and <http://obpreview2011.govtools.us/biochem>.