Quarterly Update

National Bioenergy Center Sugar Platform Integration Project

Biomass

Biomass Program—Sustainable Fuels, Chemicals, Materials, and Power

April-June 2005, #7

The Sugar Processing 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 "sugar platform" biorefineries that produce inexpensive 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 information in this update or for further information on the Sugar Processing Integration Task, contact Dan Schell at NREL, phone (303) 384-6869, email dan_schell@nrel.gov

28th Symposium on Biotechnology for Fuels and Chemicals.

Interest in biomass conversion continues to increase and a lot of enthusiasm was displayed at this year's successful and well attended 27th Symposium on Biotechnology for Fuels and Chemicals held in Denver, CO. Please mark your calendars for next years Symposium on April 30 – May 4, 2006 in Nashville, TN.

R&D Progress Biomass

Work Completed Characterizing Corn Stover Compositional Variability. We recently completed work expanding our corn stover compositional database. This database now incorporates over 2100 new samples that will be used in continuing task work to understand the impact of stover compositional variability on process performance. Compositional diversity has been significantly broadened relative to the original set of samples reported on two years ago, nearly all of which were commercial hybrid varieties. The recently added samples, many of which are from non-commercial corn varieties and more exotic germplasm sources that significantly widens the range for total carbohydrates observed in corn stover. Also, the quality of compositional data was significantly improved by using a more accurate model to correlate near infrared spectroscopic information to wet chemistry-based sample composition. An analysis of available corn stover samples, which captures the great majority of range of compositional variability possible in stover, suggests that there is little potential for increasing the carbohydrate content of corn stover in commercial corn varieties using traditional breeding techniques. The next logical step is to understand the genetic and environmental factors that contribute to compositional variation. A better understanding of these factors should provide insight into how and to what extent stover compositional variability can be managed or controlled through genetic or agronomic approaches. We plan on collaborating with ARS and/or university agronomists who are capable of planning and carrying out well-designed field studies over a number of years.

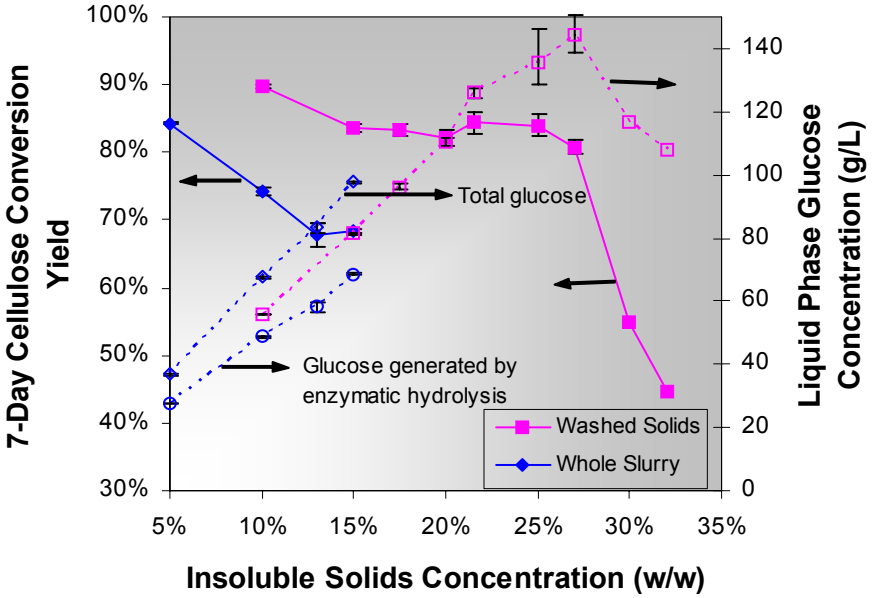
New Analytical Procedure for Analysis of Biomass Extractives. We continue to work on improving the precision and accuracy of biomass compositional analysis, while reducing time and labor requirements. To this end, validation work was recently completed on a new method for determining the extractives content of corn stover. The traditional method was labor and time intensive and used significant quantities of solvents. The new method, which utilizes a Dionex Accelerated Solvent Extractor, reduces the extraction time from 24 to 2 hours, while also decreasing the amount of solvent required by a factor of 10.

Because the new method is more automated, significantly less labor is required. The method has been tested and verified to ensure equivalent accuracy and precision as the traditional extraction procedure. These improvements have been documented in the Laboratory Analytical Procedure (LAP), "Determination of Extractives in Biomass," available at http://www.eere.energy.gov/biomass/analytical_procedures.html.

Pursuing Automated Biomass Compositional Analysis Using Robotic Equipment. We have begun investigating robotic equipment for rapid and automatic compositional analysis of lignocellulosic biomass. Vender representatives visited NREL in April 2005 and were given corn stover feedstock samples to test at their research and development facility. We then visited their facility and observed the robotic workstation processing stover using the LAP for "Determination of Structural Carbohydrates and Lignin in Biomass" (see the link above). Preliminary testing was positive and suggests that robotic equipment can be used to automate this analysis, which would significantly reduce sample analysis time and labor requirements. This capability would enhance our ability to develop infrared spectroscopic methods for rapid compositional analysis of a variety of biomass feedstocks. We will pursue this work as funding and resources permit.

Related Activities Biomass

Progress Achieved in Assessing Enzymatic Cellulose Conversion of Pretreated Corn Stover Slurries. Recently completed work in the Pretreatment and Enzymatic Hydrolysis task investigated enzymatic cellulose hydrolysis of dilute-acid pretreated corn stover slurries. This work explored performance at high insoluble solids concentrations and in the presence of background sugars and other inhibitors produced during acid pretreatment of stover. While cellulose saccharification at high solids levels is attractive to improve process economics, these conditions present a number of challenges for both the reaction and the reactor system. Enzymatic cellulose hydrolysis was explored with both washed solids (no background liquor) and whole slurries (see figure to the left). First, the work demonstrated that mass transfer limitations exist during enzymatic hydrolysis at solid concentration greater than 20% (w/w). This is manifested by decreasing yields and glucose concentrations. Additionally, cellulose conversion yields in the presence of hydrolysate liquors containing up to 70 g/L of sugars



Cellulose conversion yields and corresponding monomeric glucose concentration as a function of initial insoluble solids loading during enzymatic hydrolysis of pretreated corn stover at a cellulase loading of 40 mg protein/g cellulose.

produced during pretreatment are about 25% lower than are obtained using washed solids at the same cellulose concentration. This result suggests that soluble components are affecting performance; however, it may be due to both sugars and/or other inhibitors present in hydrolysate. Future work will test advanced enzyme preparations being produced by Genencor International and Novozymes, and seek to understand and eventually overcome factors limiting enzymatic cellulose conversion in the presence of hydrolysate liquors and at high solids concentrations.

Sugar Processing Integration Task Information. Web-based information on the process integration project, including our presentations from the most recent stage gate interim review meeting, can be found at the following link (Process Integration Project Information). A discussion of how Stage Gate management is used in the Biomass Program is also available at this site (Stage Gate Management).

Produced for the

U.S. Department of Energy
Energy Efficiency and Renewable Energy

Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable.

1000 Independence Avenue, SW, Washington, DC 20585
by the National Renewable Energy Laboratory, a DOE national laboratory

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DOE/GO-102005-2088 • July 2005

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