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

July-September 2007, #16

The Biochemical 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 "biochemical 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 the content of this update or for further information on the Biochemical Processing Integration Task, contact Daniel Schell at NREL, phone (303) 384-6869, email dan_schell@nrel.gov

30th Symposium on Biotechnology for Fuels and Chemicals.

Mark your calendars as the 30th Symposium is rapidly approaching with abstracts due in early December. The Symposium will be held at the Astor Crowne Plaza Hotel in New Orleans, LA from May 4-7, 2008. Meeting and abstract submittal information (deadline is December 14, 2007) can be found at the following web site: http://www.simhq.org/meetings/30symp/index.html. Session titles are listed below.

Sunday, May 4
Session 1 - Advances in Bioenergy Feedstocks and Plant Science
Session 2 - Advances in Microbial Science and Technology I

Monday, May 5
Session 3 - Pretreatment and Biomass Recalcitrance: Fundamentals and Progress I
Session 4 - New Biofuels and Biomass Chemicals
Session 5 - Advances in Enzyme Science and Technology 1
Session 6 - The New Biofuels Industry: Biomass Availability and Supply Chain

Tuesday, May 6
Session 7 - Advances in Microbial Science and Technology II
Session 8 - Pretreatment and Biomass Recalcitrance: Fundamentals and Progress II
Evening Special Topic: International Bioenergy Centers: Plans for the Future

Wednesday, May 7
Session 9 - Advances in Bioprocessing and Related Separations Technology
Session 10 - The New Biofuels Industry: Biomass Environmental Feasibility and Sustainability
Session 11 - Bioefining Technology Deployment and Demonstration
Session 12 - Advances in Enzyme Science and Technology II

Please note: Due to limited poster space, the symposium organizers are requesting that at least one author on each abstract be registered to attend the Symposium before the end of pre-registration. Also, if a paper is to be submitted for the Proceedings, at least one author must be registered and attend the Symposium.

R&D Progress Biomass

Developing Techniques to Rapidly Measure Biomass Composition on Different Near-Infrared (NIR) Spectrometers.

NREL researchers have been using near-infrared (NIR) spectroscopy coupled with multivariate calibration algorithms for many years to rapidly measure the composition of biomass feedstocks. However, all NIR spectrometers are different, so the reflectance spectra of a given biomass sample collected on two different NIR spectrometers typically are different. This makes the use of a multivariate calibration equation developed on one NIR spectrometer inaccurate when used on another instrument. The solution to this "calibration transfer problem" is to perform mathematical transformations of the NIR spectra prior to applying the multivariate calibration equation. We have demonstrated the use of two public-domain mathematical transformation algorithms to transfer multivariate calibrations for the glucan and xylan content of corn stover feedstock samples with relative uncertainties of less than 10% from one spectrometer to another. The ability to use these

non-proprietary algorithms to perform NIR spectra transformations significantly increases our ability to compare results from different NIR spectrometers and to address the current and future needs of NREL and the biorefining industry.

Evaluating Several Biochemical Conversion Process Configurations. NREL uses state-of-technology economic models for co-current dilute acid pretreatment and enzymatic saccharification of corn stover to ethanol to guide research and evaluate progress toward cost goals. The data for these models has been based primarily on performance of individual unit operations rather than on performance achieved during integrated processing. Because process performance depends on interactions between the various unit operations, work in the Biochemical Processing Integration task is focused on understanding the interplay of the various unit operations particularly with respect to performance and cost. As part of this effort, we recently conducted work to understand performance differences between several biochemical conversion process configurations. We generated preliminary performance data on these two process configurations using dilute acid pretreated corn stover as the starting material. In the first configuration, cellulose in a whole slurry was enzymatically hydrolyzed to glucose in the presence of pretreatment liquors containing hemicellulosic sugars and then all of the sugars were fermented to ethanol by a recombinant glucose-xylose co-fermenting *Z. mobilis*. In the second configuration, pretreated solids and liquor were separated and the hemicellulosic sugars in the liquor were fermented using the glucose-xylose fermenting *Z. mobilis,* and independently, the cellulosic solids were enzymatically hydrolyzed to glucose and then glucose was fermented by *S. cerevisiae* using a simultaneous saccharification and fermentation process. Ethanol yields for each of these configurations are shown in Figure 1. Better conversion of sugars to ethanol was achieved with the separated process configuration because the fermentation conditions could be adjusted to the best conditions for each microorganism. Additionally, this configuration relieves inhibition of enzymatic cellulose hydrolysis by hemicellulosic sugars. However, because this configuration requires solid-liquid separation it has higher capital costs due to the need for additional separation equipment.

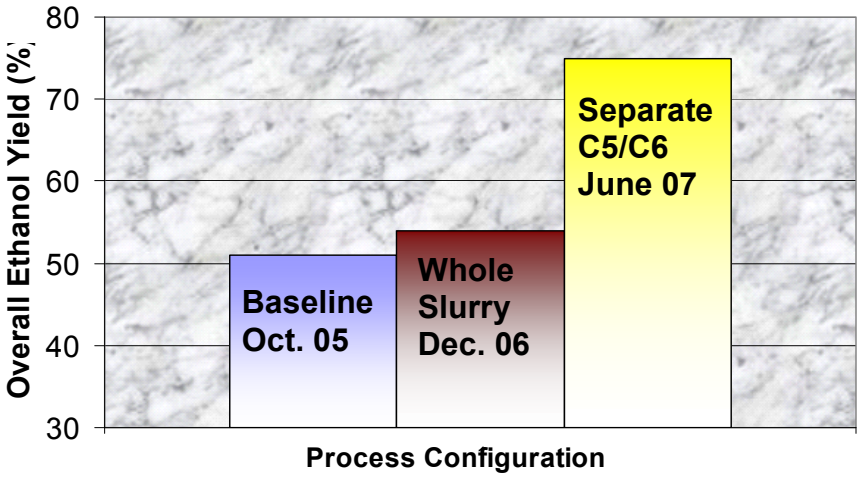

Figure 1. Ethanol yields from glucose and xylose achieved upon integrated processing using the baseline process configuration described in Aden et al. (2002)† and those described in the text. Results for the separate process configuration are preliminary (completely integrated processing results for separate C5/C6 fermentation configuration are pending).

†Aden, A, M. Ruth, K. Ibsen, J. Jechura, K. Neeves, J. Sheehan, B. Wallace. 2002. "Lignocellulosic Biomass to Ethanol Process Design and Economics Utilizing Co-Current Dilute Acid Prehydrolysis and Enzymatic Hydrolysis for Corn Stover." National Renewable Energy Laboratory. NREL/TP-510-32438. http://www.nrel.gov/docs/fy02osti/32438.pdf.

Related Activities

Paper Published in ACS Journal of Agricultural and Food Chemistry. Baylor University and NREL researchers recently published a paper in the American Chemical Society (ACS) Journal of Agricultural and Food Chemistry. The paper, "Compositional Analysis of Water-Soluble Materials in Corn Stover," was co-authored by the Baylor University team of Shou-Feng Chen, Richard Mowery, and Professor Kevin Chambliss in collaboration with Christopher Scarlata of NREL. In a first-of-its-kind study, this paper describes the analysis of over 30 previously unknown compounds in the water soluble fraction of corn stover. Glucose and fructose were the main constituents found, composing 30%-46% of the dry weight of the aqueous extracts, which itself accounts for 4%-12% of the dry weight of stover. Additional constituents contributing to the mass balance for extractives included various alditols (3%-7%), aliphatic acids (7%-21%), inorganic ions (10%-18%), oligomeric sugars (4%-12%), and a distribution of oligomers tentatively identified as being derived from phenolic glycosides (10%-18%). Full reference: J Agric. Food Chem., Compositional Analysis of Water-Soluble Materials in Corn Stover, **55** (15), pp. 5912-5918, 2007, DOI: 10.1021/jf062150k.

DOE Biochemical Platform Peer Review Meeting. A peer review meeting for the Office of the Biomass Program's Biochemical Platform was held on August 7-9 in Denver, CO. Links to the various presentations made at this meeting as well as other information can be found at the following link (http://obpreview07.govtools.us/biochem/).

Biochemical Processing Integration Task Information. Web-based information on the process integration project, including presentations made at 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).

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