Quarterly Update

National Bioenergy Center Biochemical Platform Integration Project

Biomass

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

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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

2007 Joint ACS/AIChE Rocky Mountain Regional Meeting. This Meeting will be held August 29 – September 1, 2007 in downtown Denver, CO at the Adam's Mark Hotel. Meeting and registration information and a link for submitting abstracts are available at the following web site: http://www.uwyo.edu/rmr2007acs-aiche. Meeting topics are listed below.

- **Advances in Conventional Energy Technologies (Coal, Oil, Natural Gas)**
- **Advances in Alternative Energy Technologies (Fuel Cells, Photovoltaics, Hydrogen, Biofuels)**
- **Advances in Pollution Control and Environmental Remediation Technologies**
- **Green Chemistry and Engineering**
- **Bioprocesses for Diagnostic and Therapeutic Agents**
- **Biomaterials**
- **Electronic Materials**
- **Advances in Nanotechnology**
- **Teacher workshop**

R&D Progress Biomass

Predicting Biomass Chemical Composition from Existing Detergent Fiber-Based Analytical Data. The available carbohydrates in a biomass feedstock determines its theoretical ethanol yield, so being able to quickly assess the carbohydrate content of many different feedstocks for which detailed compositional data is not available would be extremely valuable. Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) are two analytical methods that are widely used as measures of the nutritive qualities of feeds and forages. Because these methods have been used for many years, there are large amounts of NDF and ADF data available for many different cellulosic feedstocks. NREL researchers recently investigated the possibility of using existing NDF and ADF data to predict component composition by examining a dataset for corn stover containing both NDF/ADF and glucan/xylan compositional data. The results of this study indicate that xylan and glucan are highly correlated to both NDF and ADF values. However, the correlation between the values is largely driven by the total extractives content of the stover. We conclude that the glucan and xylan content for stover can be estimated from either NDF or ADF values. However, the accuracy of these predictions is lower than for compositional measurements obtained using traditional wet chemical analysis methods. If these correlations could be established for other feedstocks for which NDF and ADF data are available, it would be possible to quickly estimate the glucan and xylan content of many lignocellulosic materials. This would provide a new rapid method for estimating the composition of new feedstocks, although with slightly reduced accuracy. We will continue to assess the state of available NDF/ADF data to determine the potential value of mining this information.

Improving Analytical Methods for Measuring Hydrolysate Liquor Composition. NREL uses a defined set of analytical methods based on High Performance Liquid Chromatography (HPLC) to measure sugars and other compounds produced during acid hydrolysis of lignocellulosic biomass and during biochemical conversion processing. Because these methods are time intensive, we are exploring new methods to improve both throughput and accuracy to increase research productivity. We recently completed work to assess alternative methods for measuring the concentrations of organic acids, furans and ethanol, and biomass-derived sugars in dilute acid hydrolysates. Whereas current HPLC methods require 46 min/sample and exhibit poor peak resolution that affects measurement quality, a Capillary Electrophoresis (CE) method was investigated that can measure sugars and organic acid concentrations in less than 8 min. Results showed that the CE method could measure glucose and xylose concentrations in less than 3 min. However, we were not able to develop a method that could achieve good measurements on all of the biomass-derived sugars and other compounds in the hydrolysate. Although the CE method is not ready for routine use, its ability to rapidly measure component concentrations may provide the basis for a better technique for real time measurement of these compounds in biomass hydrolysates. We have also developed a new HPLC method that reduces analysis time for organic acids and ethanol from 55 min to less than 10 min/sample that has the same level of accuracy and precision as the previous method. We will validate this new method and post it as a new Laboratory Analytical Procedure in the near future (see site for postings: http://www1.eere.energy.gov/biomass/analytical_procedures.html).

Related Activities

NREL Research Group Publishes Paper in ACS Journal of Agricultural and Food Chemistry. NREL researchers recently published a paper in the American Chemical Society Journal of Agricultural and Food Chemistry (Volume 55, Issue 7, 2575-2581). The paper, "Porosity and Its Effect on the Digestibility of Dilute Sulfuric Acid Pretreated Corn Stover," is co-authored by Claudia I. Ishizawa, Mark F. Davis, Daniel J. Schell, and David K. Johnson. This work assessed the importance of porosity as one of the factors governing overall enzymatic cellulose digestibility in dilute acid pretreated corn stover prepared in a pilot scale continuous reactor. The porosity of wet pretreated corn stover was determined using two different methods, solute exclusion and ^{1}H nuclear magnetic resonance (NMR) thermoporometry. Both methods identified differences in the accessible pore volume of the pretreated samples compared to untreated corn stover; however, only small differences in porosity were observed among samples pretreated with a range of severities exhibited digestibilities ranging from 70% to 96%. No correlation was found between the volume accessible to an enzyme-sized molecule (diameter estimated to be 51 Å) and the cellulose digestibility in these samples. It is likely that mechanical stresses experienced by the corn stover during pretreatment in pilot scale reactor prevented creation of a porous structure. The particle size of the pretreated material decreased substantially as pretreatment severity was increased. Both increased porosity and decreased particle size will result in a larger surface area and should increase cellulase hydrolysis rates; however, it is unclear at this time which of these effects is better at increasing the surface area accessible to a cellulase-sized molecule.

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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