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 information in 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

29th Symposium on Biotechnology for Fuels and Chemicals.

The 29th Symposium is rapidly approaching. The Symposium will be held in downtown Denver, CO at the Adam's Mark Hotel from April 29 – May 2, 2007. Meeting, registration and hotel information can be found at the following web site: http://www.simhq.org/meetings/29symp/index.html. NREL will also be offering tours of its biomass conversion laboratories, including its Biochemical and Thermochemical Pilot Plants. Please sign up during registration if you would like to attend.

This year's sessions are listed below:

Session 1A: Feedstock Genomics and Development
This session will highlight advances in plant breeding and development to improve plant architectural, compositional or physiological characteristics to enhance the quality and value of the renewable feedstocks base.

Session 1B: Microbial Catalysis and Engineering
Presentations will focus on progress in discovery and/or development of microorganisms for improved production of fuels and chemicals.

Session 2: Enzyme Catalysis and Engineering
This session will highlight advances in enzyme discovery, characterization and/or modification to improve performance, as well as on improvements in cost effectively producing and applying enzymes to fuels and chemicals production processes.

Session 3: Bioprocess and Separations R&D
Presentations will focus on improvements in the efficient integration of reactor and process design and engineering with microbiology, biochemistry and chemistry to develop more economical bioprocesses and unit operations to produce and/or recover fuels and chemicals

Session 4: Biorefineries and Advanced System Concepts
This session will highlight lessons learned and progress being made in today's biorefining operations as well as describe concepts for increasing the efficiency and economic viability of future biorefineries.

Session 5A: Feedstock Preprocessing and Supply Logistics
Presentations will focus on innovations in agronomic cultivation, harvesting, storage and transportation methods, including environmental and economic impacts.

Session 5B: Feedstock Fractionation & Hydrolysis
This session will highlight progress in the development and demonstration of novel reactor configurations and more economical processing approaches for pretreating and saccharifying biomass.

Session 6: Industrial Biofuels and Biobased Products
Presentations will focus on improvements in the development, demonstration and commercialization of biologically-based processes for the economical production of fuels, chemicals and other value-added bioproducts.

Special Session A: Policy Drivers and International Development of Biofuels
A panel of speakers will address the policy drivers necessary to further the international development of 2nd-generation biofuels. Participants may consider advances in 1st-generation fuels, technological challenges and solutions, and innovative policy tools to support lignocellulosic biofuels development.

Special Session B: Compositional and Structural Analysis of Biomass
Invited presentations will highlight advances in the accuracy, precision, comprehensiveness, and cost of characterizing the structure and composition of lignocellulosic feedstocks, processing intermediates and residues.

R&D Progress Biomass

Developing On-line Feedstock Compositional Measurements. Industry needs rapid, accurate, and inexpensive methods for compositional analysis of biomass and biomass-derived materials. These methods, when applicable for on-line analysis, can be used to assess feedstock quality at the plant gate and ultimately provide real time process control and optimization capability. We recently used a FOSS Direct-Light 5000 on-line NIR spectrometer to measure the composition of corn stover moving on a pilot-scale weigh belt conveyor. A 3-factor, 2-level factorial experiment was undertaken to study the effect of sensor height (3 in and 9 in), particle size (0.25 in and 1.25 in), and number of sub-scans (16 and 64) on component concentration measurements (e.g., glucan, xylan, etc.). We also performed a study to determine the effect of temperatures ranging from 75°F to 88°F on instrument performance. The results demonstrate that it is possible to reliably measure corn stover composition with such a system. However, careful sensor placement and monitoring is required to ensure accurate results are obtained, as sensor height, and to a lesser extent, temperature, affect measurement of component concentrations. The technique also requires rigorous in-place calibration for each site-specific installation. Access to a broad range of calibration samples with compositional diversity will also be a challenge. On a positive note, feedstock particle sizes within the range tested, 0.25-1.25 in, do not affect compositional measurements. With appropriate attention to calibration, it should be possible to implement reliable and accurate on-line measurements of feedstock composition in a plant environment.

An Improved Method for Measuring Organics Acids, Furans and Ethanol in Liquid Process Samples. Accurate measurements of component concentrations are required to calculate important process performance parameters such as ethanol yield. Currently, an HPLC-based method is recommended for measuring concentrations of organics acids, furan and ethanol in liquid process streams (http://devafdc.nrel.gov/pdfs/9462.pdf). Although the method is accurate, it requires over 55 min of instrument run time per sample, which is problematic because a large number of samples can be generated by a single shake flask experiment. For example, a single 12 shake flask experiment that is sampled daily produces 94 (12 flask x 1 sample/d x 7 d) samples for analysis, which requires over 4 d of instrument run time to analyze (when calibration and verification standards are included). To decrease run times, we are developing a new HPLC method that matches the accuracy and precision of the existing procedure, but with analysis time reduced to less than 10 min per sample. This would reduce overall instrument run time for the above experimental scenario from over 4 days to less than 17 h (e.g., overnight). We are currently fine tuning and validating the method before releasing it as a new Laboratory Analytical Procedure.

Related Activities

The Whole Genome Sequence of Populus (Poplar Tree) Featured in Two Magazines. The publication of the whole genome sequence of Populus (Poplar tree) was a cover article in the September issue of *Science.* This work was also featured in the November issue of *Ethanol Producer Magazine.* This work was led by Dr. G. A. Tuskan (ORNL) with the DOE Joint Genome Institute (JGI). A quote from the JGI said, "This research lays the groundwork that may lead to the development of trees as an ideal feedstock for a new generation of biofuels." The article in *Ethanol Producer Magazine* entitled "Tracking the Cell Wall Breakthrough," concluded that according to the leading researchers in the field, "Native grasses and fast-growing trees are the best candidates for energy crops in the United States. After initializing and then expanding the use of marginal or idle lands for switchgrass, poplar trees and other species, technological and scientific research is developing rapidly and aggressively to transform the biomass energy crops into ethanol."

References:

G.A. Tuskan et al. 2006, The Genome of Black Cottonwood, Populus trichocarpa. *Science,* 15 September: Vol. 313. No. 5793, pp. 1596 – 1604.
N. Zeman, 2006, Tracking the Cell Wall Breakthrough, *Ethanol Producer Magazine,* November.

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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A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

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