NREL NATIONAL RENEWABLE ENERGY LABORATORY

Quarterly Update

National Bioenergy Center | Biochemical Platform Integration Project

Winter 2011

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.

33rd Symposium on Biotechnology for Fuels and Chemicals

This symposium will be held at the Sheraton Seattle in Seattle, Washington, on May 2–5, 2011. Meeting information can be found at the following website: http://www.simhq.org/meetings/sbfc2011/index.asp. Program topic areas are listed below.

Topic Area 1 – Biomass Resource Supply, Development and Characterization

- Biomass Supply and Logistics
- Plant Science and Technology
- Biomass Physicochemical Analysis
- Biomass Recalcitrance

Topic Area 2 – Conversion Technologies

- Biomass Pretreatment and Fractionation
- Microbial Science and Technology
- Enzyme Science and Technology
- Bioprocessing and Separations Technology

Topic Area 3 – Fuels and Chemicals Products (Production, Supply and Use)

- Biofuels and Biorefinery Economics and Sustainability
- Emerging Biofuels and Chemicals
- Biorefinery Commercialization and Deployment

R&D Progress

Reactive Membrane Extraction of Inhibitors from Dilute-Acid Pretreated Corn Stover

Acid-pretreated biomass contains biomass-derived sugars and other compounds (e.g., acetic acid, furfural) that are inhibitory to fermentative microorganisms. Removing or deactivating these compounds using detoxification methods such as overliming or ammonium hydroxide conditioning (AHC) improves sugar-to-ethanol yields. In this study, researchers at Colorado State University tested reactive membrane extraction as an alternative detoxification method. The liquor fraction of dilute-acid pretreated corn stover was treated using AHC and membrane extraction, both separately and in combination, and then the sugars in the treated liquor were fermented with the glucose-xylose fermenting bacterium, *Zymomonas mobilis* 8b.

Reactive extraction was performed using a cross-flow filtration module with liquor on one side of the membrane and mixtures of octanol/Alamine 336 or oleyl alcohol/Alamine 336 on the other side. Alamine 336 is a commercially available tertiary amine that readily forms an acid-amine complex, which effectively extracts acetic acid and other compounds from the hydrolysate liquor. The best ethanol yields and rates were achieved on oleyl alcohol-extracted hydrolysates followed by AHC, while octanol-extracted hydrolysates were unfermentable because highly toxic octanol was found in the hydrolysate (see Figure 1). Eliminating the ammonium hydroxide produces significant cost savings, but membrane systems have high capital and operating costs. Additional work is underway to determine if this technology is a cost-effective alternative to traditional hydrolysate conditioning processes.

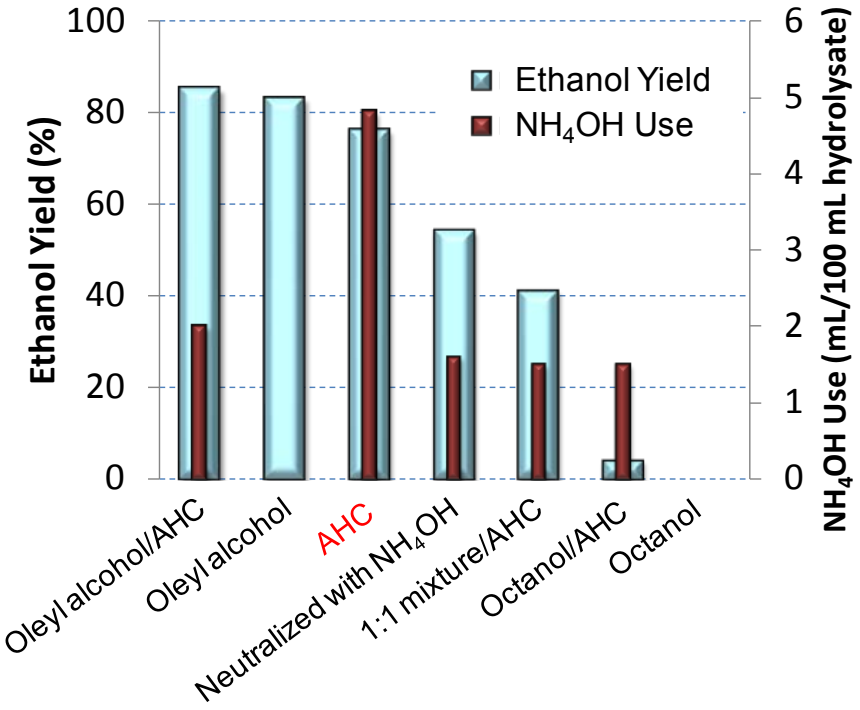

Figure 1. Ethanol yield from glucose and xylose for AHC and extracted hydrolysates using various organic phases (octanol and oleyl alcohol), followed in some cases by AHC. Also shown is ammonium hydroxide use for the various options.

2010 Task Publications

Grzenia, D.L.; Schell, D.J.; Wickramsinghe, S.R. (2010). "Detoxification of biomass hydrolysates by reactive membrane extraction." *Journal of Membrane Science*, 348, 6-12.

Humbird, D.; Mohagheghi, A.; Dowe, N.; Schell, D.J. (2010). "Economic impact of total solids loading on enzymatic hydrolysis of dilute-acid pretreated corn stover." *Biotechnology Progress*, 26, 1245-1251.

Mohagheghi, A.; Schell, D. (2010). "Impact of recycling stillage on conversion of dilute sulfuric acid pretreated corn stover to ethanol." *Biotechnology & Bioengineering*, 105, 992-996.

Scarlata, C.J.; Hyman, D.A. (2010). "Development and validation of a fast high pressure liquid chromatography method for the analysis of lignocellulosic biomass hydrolysis and fermentation products." *Journal of Chromatography A*, 1217, 2082-2087.

Sluiter, J.B.; Ruiz, R.O.; Scarlata, C.J.; Sluiter, A.D.; Templeton, D.W. (2010). "Compositional analysis of lignocellulosic feedstocks. 1. Review and description of methods." *Journal of Agricultural and Food Chemistry*, 58, 9043-9053.

Templeton, D.W.; Scarlata, C.J.; Sluiter, J.B.; Wolfrum, E.J. (2010). "Compositional analysis of lignocellulosic feedstocks. 2. Method uncertainties." *Journal of Agricultural and Food Chemistry*, 58, 9054-9062.

Weiss, N.D.; Farmer, D.J.; Schell, D.J. (2010). "Impact of corn stover composition on hemicellulose conversion during dilute acid pretreatment and enzymatic cellulose digestibility of the pretreated solids." *Bioresource Technology*, 101, 674-678.

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.obpreview07.govtools.us/biochem/ and http://www.obpreview2009.govtools.us/biochem. A project review meeting is scheduled for the week of February 14, 2011, in Denver, Colorado. Information is available at the following website: http://obpreview2011.govtools.us/.

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