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NARA will host a wood-based biofuels conference

In the past decade, funding agencies (USDA-NIFA and DOE), stakeholder coalitions (SAFN), state agencies, and industry have invested millions of dollars and substantial time to envision a Pacific Northwest industry that uses wood-based biomass to produce liquid biofuels and other co-products. USDA-NIFA funded programs like the Northwest Advanced Renewables Alliance (NARA) and Advanced Hardwood Biofuels Northwest (AHB) will end in 2016. These programs, in collaboration with stakeholders, produced tools and information that will assist all parties engaged in developing a sustainable wood-to-biofuels industry in the Northwest.

With this backdrop, the USDA-NIFA and WSU Extension will sponsor the **2nd Northwest Wood-Based Biofuels and Co-Products Conference** (NWBCC) to be held in Seattle May 3-4th, 2016.

View conference website for agenda and registration.

The overarching goal of the **2nd Northwest Wood-Based Biofuels + Co-Products Conference** is to communicate research findings and promote collaboration so that attendees can approach commercialization using underutilized wood resources or dedicated wood feedstocks in a strategic and sustainable manner. Specific conference tracks will focus on feedstock logistics, conversion technologies, sustainability, bioenergy literacy and commercialization. Although the focus will be on regional efforts, a national and global perspective will also be included.

A list of confirmed speakers is available on the conference website. Confirmed speakers include representatives from Red Rock Biofuels, Alaska Airlines, Boeing, the Port of Seattle, Anellotech, Oakridge National Laboratory, FPInnovations, Cool Planet and Cosmo Specialty Fibers.

K-12 education track

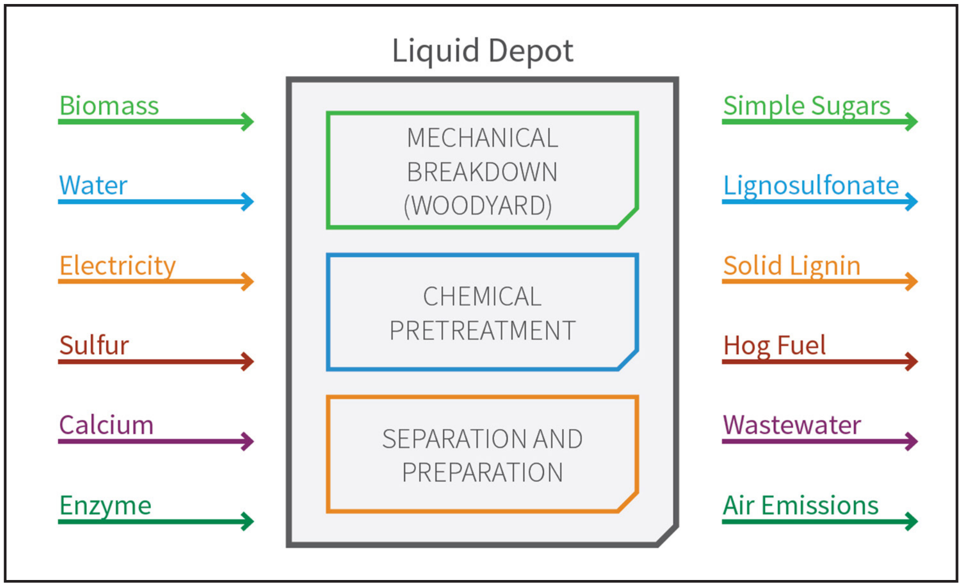
This conference offers a unique track designed to help formal and informal K-12 educators learn about bioenergy and wood-based biofuels and of the lesson plans and strategies developed to connect bioenergy to STEM education. The intent is to increase bioenergy awareness in the classroom so that students become citizens who are better informed and can contribute to a bio-energy workforce. Western Washington University (contact Danica.Hendrickson@wwu.edu) and the University of Idaho (contact jschon@uidaho.edu) will offer professional development credits for educators attending the conference.

Registration

Early registration is $250 for the general audience, and a subsidized rate is available for K-12 educators. High school and university students who present a poster at the conference receive complimentary registration.

The first NWBCC was held in 2014 and drew over 200 participants. A majority were affiliated with either industry or academia with government and environmental organization representatives also present.

Review the 2014 conference agenda and proceedings



Liquids depot inputs and outputs. Reprinted from Pacific Northwest Wood Based Biofuels, Volume 2: Site Selection and Design (page 6), 2015, NARA.

Environmental impact of a slash to sugar supply chain

There are multiple ways to construct a supply chain to convert post-harvest forest residuals (slash) into chemical products like biojet fuel. A supply chain, for instance, could consist of a large centralized biorefinery that would handle all of the processing steps, or could contain smaller depots specializing in a portion of the process. One type of depot considered is a liquids depot. A liquids depot would accept woody biomass like slash to generate a sugar syrup as the primary product. The syrup could then be sold to a fermentation facility for conversion into alcohols, as envisioned in the NARA supply chain to produce biojet fuel, or could be sold for other uses.

Efficiency and yield, translated into cost savings, are often driving forces that determine how the supply chain is structured. Environmental impact is also considered. In a peer-reviewed paper funded by the USDA-NIFA, through NARA, researchers evaluate the environmental impact of a liquids depot located in the Pacific Northwest.

Read Environmental assessments of mild bisulfite pretreatment of forest residues into fermentable sugars for biofuel production.

Model assumptions

To perform the assessment, the authors modeled a liquids depot supply chain using data generated from NARA research and from a techno-economic assessment plus plant designs developed by the National Renewable Energy Laboratory (NREL). The assessment considers seven steps associated with a simulated liquids depot: 1) biomass pre-processing, 2) pretreatment, 3) enzyme production, 4) enzymatic hydrolysis, 5) separation, 6) wastewater treatment, and 7) boiler energy production.

The model assumes that 845,000 green tons of post harvest forest residuals (slash) are used annually with 770,000 tons processed in the liquids depot after loss from grinding rejects. The rejects are used in this scenario for heat and energy production. The slash (35% moisture content, ponderosa pine and Douglas-fir mix) is transported from a primary landing site to a secondary site where the material is chipped, loaded into chip vans, and transported an average of 75 miles to a liquids depot.

The Mild Bisulfite (MBS) pretreatment protocol is used in the model. MBS was developed by NARA researchers and is considered efficient and highly adaptable to pulp mill infrastructure. The model assumes that the MBS pretreatment and enzymatic hydrolysis will provide an 80% yield of fermentable sugars.

The model also assumes that most of the wastewater is reused by the liquids depot and that the biogas, sludge, fines and lignin cake, produced as byproducts, are burned to generate electricity.

Model results

This study reports on greenhouse gas emissions (carbon dioxide, CO2), eutrophication (nitrogen), smog, acidification, ozone depletion, and ecotoxicity. The assessment shows that the pre-processing and MBS pretreatment steps contribute the highest carbon dioxide emissions. The use of diesel fuels to grind and process the slash during pre-processing contributes to the high carbon dioxide levels emitted. The energy used to produce high-pressure steam used in the MBS pretreatment also contributes relatively large CO2 amounts.

A global warming potential (GWP) value (measured in CO2 discharge) was calculated for the sugar product produced by the liquid depot supply chain. The GWP value was less for the MBS-based conversion process than for other pretreatment options evaluated in previous studies and was similar to values assigned to the super critical water pretreatment process.

When measuring eutrophication (a process by which a body of water acquires a high concentration of nutrients), the pre-processing and the MBS pretreatment steps were also high contributors. During pre-processing, the associated burdens of using diesel fuels contributed to water pollution. The water used to wash the biomass and to cool the heat exchanges contributed greatly to the MBS impact. The overall eutrophication impacts were less than those recorded for sugar beet and sugarcane processing.

Measurements for smog, acidification, ozone depletion, and ecotoxicity are also presented in the publication.

Conclusions

This study provides a framework and data that can be used to compare the environmental impact of an MBS-based approach to other pretreatment alternatives. It also quantifies the relative environmental impact of varied stages in a supply chain that uses slash to make a sugar syrup. Identifying key hot spots within that supply chain that most affect global warming and water purity will allow industry to prioritize efforts to reduce the overall environmental impact of the supply chain.

Much of the analysis in this report relied on data generated through NARA on feedstock logistics, supply chain analyses, and pretreatment optimization. The intent is to use this primary data to address economic and environmental questions covering multiple proposed supply chains including a complete life cycle assessment (LCA) of a supply chain that runs from slash removal to the use of the biojet fuel.

Pretreated FS-10 postharvest forest residuals. NARA image.

Sugar yields from two feedstock sources

Pretreatment is the process that breaks up major wood components (lignin and polysaccharides like hemicelluloses and cellulose) so that enzymes can degrade (hydrolyze) the polysaccharides into simple sugars. Effective pretreatment and hydrolysis are necessary to achieve high sugar quality and yield. The sugars derived from the pretreatment/hydrolysis process can serve as a feedstock to produce chemicals including bio-fuels.

NARA has evaluated multiple pretreatment technologies to develop a pretreatment strategy that is effective on post-harvest forest residuals (slash), adaptable to existing pulp mill infrastructure, and produces a sugar slurry with few inhibiting chemicals that could interfere with downstream fermentation. This effort has produced a sulfite–based pretreatment protocol that is being used at large scale to produce 1000 gallons of bio-jet fuel made from slash. It is anticipated that Alaska Airlines will use this bio-jet fuel in a commercial flight once the jet fuel receives ASTM International (ASTM) approval for commercial use.

The wood material used to produce the 1000 gallons of bio-jet came from post-harvest forest residuals sourced from multiple private forests in the Pacific Northwest and from reject fibers provided by Cosmo Specialty Fibers, Inc. (Cosmo). In a peer-reviewed paper, partially funded by the USDA-NIFA through NARA, NARA researchers evaluate how much sugar can be obtained from representative post-harvest forest residuals and from the Cosmo reject fibers.

Read Case studies on sugar production from underutilized woody biomass using sulfite chemistry.

Experiment

The authors evaluated two feedstock samples for sugar production through enzymatic hydrolysis: sulfite mill rejects from Cosmo and post-harvest forest residuals. Cosmo produces high-grade dissolving pulp used to make a wide variety of products including textiles, food ingredients and chemicals. Cosmo joined NARA as an affiliate member in order to explore markets for the rejected fibers produced from their production processes. The mill rejects contain a high amount of moisture (up to 70%) which makes burning them for energy and heat a challenge. Weyerhaeuser, another NARA affiliate member, provided the post-harvest forest residuals obtained from a regeneration harvest in Lane County, Oregon. These residuals, labeled FS-10, have served as a representative feedstock sample used by NARA to optimize the pretreatment, hydrolysis and fermentation steps in the supply chain to make bio-jet fuel from slash.

Prior to enzymatic hydrolysis, the Cosmo fiber rejects were milled for effective hydrolysis. The FS-10 samples were pretreated using the sulfite-based pretreatment protocol for large-scale processing. Commercial enzymes (Cellic CTec3 and HTec2) were obtained from Novozymes and used to perform the hydrolysis step that converts polysaccharides into simple sugars.

Results

Sixty-five percent of the Cosmos reject fiber sample consisted of carbohydrates (cellulose and hemicelluloses). Hydrolyzing enzymes were able to convert 80% and 85% of the cellulose and hemicelluloses respectively into simple sugars, which is considered a high rate of enzymatic saccharification. Previous hydrolysis experiments had been conducted on reject fibers; however, those fibers were obtained by ammonia sulfite pumping without ammonia recovery. The Cosmo reject fibers were processed using magnesium sulfite with a magnesium recovery step. The results presented in this study indicate that the magnesium ion did not adversely affect hydrolysis efficiency.

Approximately 80% of the carbohydrates contained in the pretreated FS-10 sample were hydrolyzed into simple sugars. The sulfite-based pretreatment process creates a liquid and solid fraction, and both fractions were evaluated for hydrolysis efficiency. The results not only show that hydrolysis efficiency is high when slash is pretreated with the optimized sulfite-based pretreatment protocol, but also that the solid and liquid fractions can be combined and that the solids fraction does not need washed for efficient hydrolysis. The ability to efficiently hydrolyze unwashed solids with the liquid fraction presents a simple one-step process for hydrolysis. The authors also evaluated the lignosulfonate generated as a byproduct of the sulfite-based pretreatment/hydrolysis process and determined that the lignosulfonate is a valuable and directly marketable co-product.

The data suggests that milled reject fibers from Cosmo and the sulfite-based pretreated FS-10 samples both provide high sugar yields after hydrolysis. In addition, both processes can be scaled and adapted to a pulp mill infrastructure.

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