NABC National Advanced Biofuels Consortium
Biofuels for Advancing America
Developing cost-competitive, sustainable biofuels for today's transportation infrastructure.

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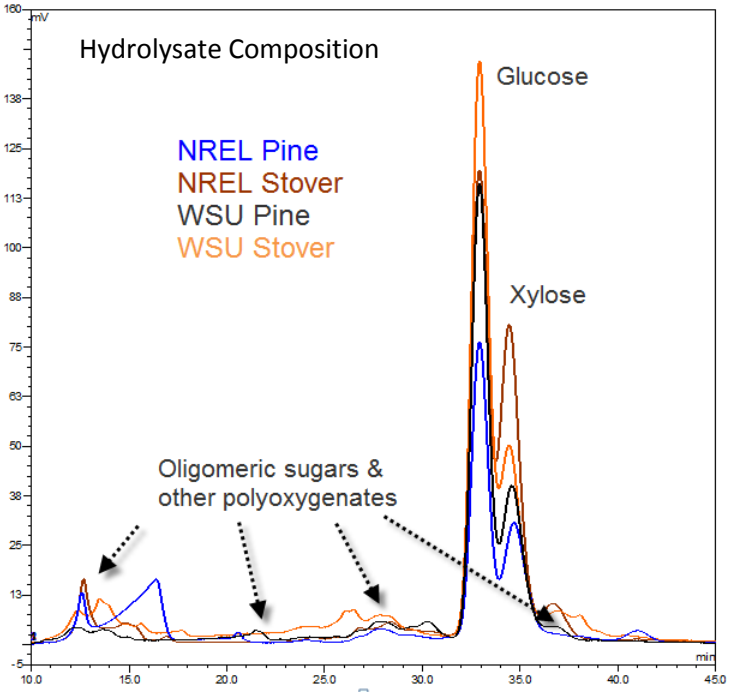
Virent and Fellow NABC CLS Collaborators Make BioFormate Gasoline from Biomass

Virent Energy Systems and its feedstock supply and upstream conditioning partners in the National Advanced Biofuels Consortium (NABC) convert corn stover and loblolly pine materials into a renewable substitute for petroleum-derived gasoline reformate.

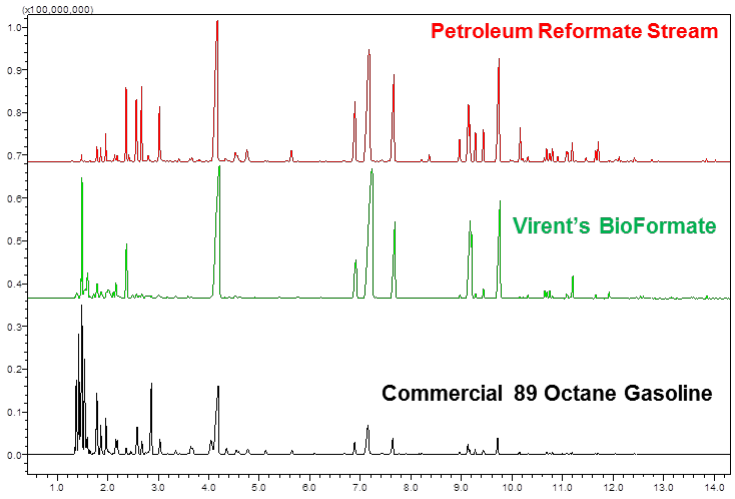
In a significant milestone accomplishment for the catalytic conversion of lignocellulosic sugars (CLS) process strategy, Virent has successfully demonstrated the production of BioFormate gasoline from corn stover and loblolly pine forest harvest residuals. This work was completed with key collaborators in the CLS process strategy. Catchlight Energy supplied the pine material and Iowa State University (ISU) supplied the corn stover. ISU dried, formatted, and supplied both materials to the consortium partners. In Stage I for the CLS process strategy, Washington State University (WSU) chose a wet oxidation pretreatment and enzymatic hydrolysis process to digest the hemicellulose and cellulose to create several hydrolysates from both feedstocks. The National Renewable Energy Laboratory (NREL) has also supplied several hydrolysates using a dilute sulfuric acid pretreatment and enzymatic hydrolysis process. More details on hydrolysate production within NABC can be found in the March 10, 2011, highlight. Virent processed these hydrolysates using its BioForming process.

The relative composition of four representative hydrolysates via HPLC analysis is shown in the figure below. The chromatograms show some differences relative to each other; however, the following important points can be made: 1) In addition to generating significant amounts of glucose, the hydrolysates contain significant amounts of pentoses (e.g., "Xylose") and other carbon-containing species including organic acids and furanic materials (e.g., "Oligomeric sugars and other polyoxygenates" peaks); 2) Virent's catalytic BioForming process converts all of these materials to desirable products, significantly increasing the overall process and liquid fuel yield; and 3) Virent has converted these and other biomass hydrolysate samples to BioFormate gasoline. This shows that a range of feedstocks and process techniques can be employed. This flexibility means that technical, economic, and sustainability factors can be optimized to select the most attractive deconstruction process and feedstock.



HPLC chromatograms of four representative hydrolysates

In this work, Virent has used two key steps in the BioForming process. The hydrolysate is first fed to the aqueous phase reforming (APR) catalyst reactor system. This process step removes a significant amount of oxygen from the biomass sugar mixture to produce primarily monoxygenates (alcohols, aldehydes, ketones, etc.) and the reforming products of hydrogen and carbon dioxide. The APR liquid product is then fed to a tailored ZSM-5 catalyst system to produce a renewable reformate product (BioFormate) in high yield.



Gas chromatography comparison of Virent's BioFormate gasoline, a typical petroleum reformate, and a sample of commercial 89 octane gasoline

Gas chromatography analysis performed by Virent, seen in the figure to the left, shows the strong similarity between Virent's BioFormate gasoline made with NABC biomass hydrolysates, a typical petroleum reformate, and an 89 octane commercial gasoline sample. Virent's high octane BioFormate material can be blended at high concentrations analogous to how petroleum reformate is used in commercial gasoline today. In addition, Virent's renewable aromatic hydrocarbons will serve as several key platform chemicals historically sourced from petroleum reformate.

Moving forward in Stage I, the CLS team will produce larger volumes of BioFormate material to enable evaluation by BP and Tesoro, the refinery integration team that will be giving recommendations back to the NABC regarding the quality of fuel blendstocks or intermediate products from all of the process pathways. Pall Corporation has been studying methods for improved hydrolysate purification and will be contributing to the commercial scale economics. Pacific Northwest National Laboratory (PNNL) is characterizing fresh and used catalyst samples. NREL and Argonne National Laboratory (ANL) will be completing techno-economic and life cycle analysis work for the CLS process strategy as well as for the other process strategies within NABC.