



One- and Two-Phase Conversion of Biomass to Furfural

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The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing two industrial-scale methods of rendering furfural from biomass-derived xylose and hemicellulose by utilizing recycled gamma-valerolactone as a solvent.

Overview

Exploiting the energy potential of biomass high in cellulose and lignin—including grasses, shrubs, husks, bark, yard and mill offal not readily digestible by humans—offers a vast and renewable alternative to fossil carbons. In addition to producing gamma-valerolactone (GVL), an organic compound viable in gasoline mixtures, other valuable chemicals can be derived. These include furfuryl acid, used in the manufacture of resins, adhesives, wood treatments, herbicide agents and nonhazardous agricultural solvents.

Producing furfural from dehydration of the xylose and hemicellulose sugars found in biomass traditionally has been complicated by the need to separate and purify the compound at high yields when using a mineral acid catalyst. Solid acid catalysts have been implemented but reactions in aqueous solutions result in low yields and challenging separations. A new conversion strategy is needed to address these limitations.

The Invention

UW–Madison researchers have developed monophasic and biphasic systems to produce furfural from the C₅ sugar fraction of biomass utilizing GVL, itself a product of the reaction, as a solvent. Both methods result in furfural that can be directly distilled out of, or converted into, GVL.

In the monophasic method, a single reaction medium comprises GVL and an acid such as nitric, sulfuric, or solid acid zeolite to minimize the use of water and eliminate the separation step required of mineral acids. Into this solution is introduced pretreated biomass xylose or hemicellulose. The GVL acts as a reaction solvent. By reducing or removing water from the process, less leaching of acid sites occurs and a significantly higher yield of furfural is produced.

The biphasic, or two-layered, method also utilizes GVL, but as an extraction solvent in the form of a suspended organic layer. The lower phase contains an aqueous, acidic solution with a solute such as sodium chloride or fructose. The saturated biomass material dehydrates into furfural, which spontaneously partitions into the upper GVL layer, thereby preventing further degradation via mineral acid catalysis in the aqueous phase.

Applications

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Key Benefits

- Eliminates purification step
- Produces GVL that can be recycled for use
- Biphasic system makes distillation easier.
- Monophasic system increases yield by decoupling catalyst from solution.

Stage of Development

The researchers have demonstrated the viability of both methods. Yields of 81 percent and 71 percent furfural in 20 minutes for the biphasic and monophasic systems, respectively, were observed.

The development of this technology was supported by WARF Accelerator. WARF Accelerator selects WARF's most commercially promising technologies and provides expert assistance and funding to enable achievement of commercially significant milestones. WARF believes that these technologies are especially attractive opportunities for licensing.

Additional Information

Related Technologies

- [For more information about the conversion of biomass into value-added fuels and chemicals using alkylphenols as solvents, see WARF reference number P110124US01.](#)

Publications

- Dumesic J., Sen S.M., Henao C.A., Braden D.J. and Maravelias C.T. 2012. Catalytic Conversion of Lignocellulosic Biomass to Fuels: Process Development and Technoeconomic Evaluation. Chem. Eng. Sci. 67, 57.
- [Read a news story about this technology.](#)

Tech Fields

- [Clean Technology.: Biobased & renewable chemicals & fuels](#)

For current licensing status, please contact Mark Staudt at mstaudt@warf.org or 608-960-9845

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