Clean Technology

Cheaper Process Converts Biomass into Furan Derivatives like Furfural & HMF

View U.S. Patent No. 8,389,749 in PDF format.

WARF: P110124US01

Inventors: James Dumesic, Jesse Bond, David Martin Alonso, Thatcher Root, Mei Chia

The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a streamlined method for the recovery and purification of furan derivatives like HMF and levulinic acid, which could significantly improve the feasibility of these reactive intermediates as platform chemicals for further processing into fuels, commodity chemicals and other valuable products.

Overview

New, renewable sources of transportation fuel and commodity chemicals are needed to meet continuing demand. Biomass has tremendous potential as a renewable resource for the production of fuels and chemicals because it is inexpensive and readily available from crop residues and forests.

Furan derivatives such as hydroxymethylfurfural (HMF) or furfural derived from biomass may substitute for petroleum-based building blocks used to produce transportation fuels, plastics and fine chemicals. For example, levulinic acid, which has been identified as a top biomass-derived chemical due to its ease of production for both five and six carbon sugars and its useful functional groups, a ketone and a carboxylic acid, can be produced from HMF or furfural. Levulinic acid is a platform chemical for forming other, more valuable reactive chemicals including methyl vinyl ketone, olefins and n-butenes. However, currently it is more expensive to create commercially desirable products from biomass than petroleum feedstocks.

The Invention

UW–Madison researchers have developed a novel, cost-effective method for producing furan derivatives such as HMF, furfural, levulinic acid or gamma-valerolactone from biomass using alkylphenols as solvents. The overall strategy involves converting lignocellulosic biomass into value-added fuels and chemicals by partially removing oxygen to yield reactive intermediates such as HMF, furfural and levulinic acid. These platform molecules are valuable commercial products and can be converted into desirable final products, including liquid transportation fuels.

The acid-catalyzed process for converting biomass into furan derivatives uses a biphasic reactor containing a reactive aqueous phase and an organic extracting phase, which includes an alkylphenol. Alkylphenols are chemically distinct from previously reported extracting solvents. They offer efficient extraction of furan derivatives like levulinic acid and unique options for recovery and processing. For example, the researchers found that no butylphenol is transferred into the aqueous phase, minimizing solvent loss and contamination of the aqueous stream. Additionally, alkylphenols are inert under conditions relevant to levulinic acid processing, including distillation and selective hydrogenation in the presence of butylphenol to yield gamma-valerolactone.

Applications

- Recovery and purification of [illegible]

Key Benefits

- Provides a cost-effective route for making valuable chemical intermediates from biomass
- Furan derivatives do not need to be purified, reducing costs.
- All or a portion of the final products may be recycled for further use as an extracting phase.
- Alkylphenols allow catalytic conversion of intermediates without purification.
- Alkylphenol solvents do not extract water or acids, enabling sustainable recovery of water and the acid catalyst for further biomass deconstruction.
- Water does not need to be separated from the reaction products by evaporation at any stage, reducing energy demands.

Stage of Development

The researchers successfully used alkylphenols to separate levulinic acid from sulfuric acid solutions with high selectivity.

Additional Information

For More Information About the Inventors

- Thatcher Root

Related Technologies

- For information about producing liquid fuels from levulinic acid, see WARF reference number P09298US.
- For information about producing methyl vinyl ketone from levulinic acid, see WARF reference number P09350US01.
- For information about producing gamma-valerolactone and olefins from levulinic acid, see WARF reference number P100099US01.

Publications

- Gürbüz E.I., Alonso D.M., Bond J.Q. and Dumesic J.A. 2011. Reactive Extraction of Levulinate Esters and Conversion to γ-valerolactone for Production of Liquid Fuels. ChemSusChem. 4, 357-361.

Tech Fields

- Clean Technology : Biobased & renewable chemicals & fuels

For current licensing status, please contact Jennifer Gottwald at jennifer@warf.org or 608-960-9854