WiSys TECHNOLOGY FOUNDATION ™

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Recyclable, Magnetic Catalyst for Lower Cost Production of Fermentable Sugars and High Value Chemicals from Biomass

Market and Background

The global lignin market was valued at almost USD 795 million in 2018 and is projected to grow to more than USD 900 million by the end of 2025. About 40% of this is estimated to apply to aromatic compounds and their derivatives, which have historically come from petroleum-based sources. Growth in lignin-based alternatives is being driven by fluctuations in crude oil prices and increased pressure to reduce greenhouse gas emissions.

Lignocellulose is plant biomass that is the most abundantly available raw material on Earth for producing end products such as biofuels and certain high value chemicals. Processes currently exist to separate this biomass into cellulose and lignin fractions, convert them to fermentable sugars and cyclic compound intermediates, and ultimately generate the desired end products. However, the cost is still greater than that of petroleum-based production. This is because complex, time-consuming and expensive pretreatment steps using acids and enzymes are required to make lignocellulosic biomass accessible for further processing.

Research and Development Status:

An assistant professor in chemical engineering at the University of Wisconsin-Stevens Point and former senior research scientist at the Montana State University Bio-Energy Center have developed a technology that reduces the processing cost and time to fractionate lignocellulose into fermentable sugars. The technology is centered on the use of a catalyst linked to a magnetic bead, which replaces the need for acids and enzymes in the pretreatment step of the production process. Because of its magnetic properties, the catalyst can easily be recovered from the reaction mixture and reused multiple times. It is also capable of functioning under cellulose loads as high as 50%, whereas loads for competing solid acid catalysts have been typically limited to less than 15%. The end result is a process that makes better use of carbon-neutral biomass by lowering production costs and increasing yield of desirable monomer sugars and high value chemical compounds such as vanillin, phenol, acetophenone.

The catalyst has been produced and tested at laboratory scale. Operational parameters, including temperature, pressure and reaction solvent have been optimized. The catalyst has demonstrated success in simultaneously fractionating lignin and cellulose directly from softwood and other biomass materials. In addition, four rounds of enzyme recycling have shown no effects on conversion rate and yield of desired end products.

Applications:

- Production of high value chemicals – vanillin, phenol, acetophenone, phenolic based compounds.
- Cellulosic ethanol production

Key Benefits:

- Two revenue streams – high value chemicals and biofuels
- Magnetic catalyst:
    - Works with both lignin and cellulosic wood
    - Can be reused for multiple fractionations

    - Reduces or eliminates the need for acids and enzymes in fractionation reactions
    - Works with higher cellulose loads than other methods currently in use
    - High specificity for production of desirable monomer sugars
- Produces high concentration of sugars
- Process cost reduction makes lignocellulosic materials more competitive with petroleum-based materials
- Promotes use of carbon-neutral biomass
- Commercial use of agricultural waste

Intellectual Property:

A U.S. Patent Application has been filed for this technology. The final product is anticipated to be a metal catalyst and process that can be adapted to existing manufacturing facilities. For more information, please contact Jennifer Souter at jennifer@wisys.org or by phone at 608-316-4131.

Development and Commercialization Needs:

WiSys is currently seeking strategic partners in the lignocellulose processing, aromatic chemical, and cellulosic biofuel industries that are interested in further developing and scaling up this novel fractionating process, ultimately providing a route to market for its commercialization.