One-pot integrated process for the production of ethanol from lignocellulosic biomass

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Abstract

There is a clear and unmet need for a robust biomass conversion technology that can process a wide-range of sustainable feedstocks and produce high yields of fermentable sugars and biofuels with minimal intervention between unit operations. The integration of ionic liquid (IL) pretreatment with enzymatic saccharification and microbial fermentation is challenging due to the toxicity of the ILs currently used for pretreatment, requiring extensive water washes or the development of engineered IL tolerant enzymes and microbes. We demonstrate a one-pot, integrated process for the production of ethanol directly from lignocellulose without removal of IL or any other separation or post-treatment operations prior to saccharification and fermentation. This is achieved through the screening, identification and use of a biocompatible IL, cholinium lysinate, and using carbon dioxide to reversibly control the pH mismatch that historically prevented integration of IL pretreatment with downstream saccharification and fermentation operations into a single unit operation. Also high gravity biomass processing, including IL pretreatment, enzymatic saccharification, and yeast fermentation, was developed and optimized for high-titer cellulosic ethanol production (over 40 g L^{-1}) using a one-pot approach.

These technologies represent a significant development in IL biomass conversion into biofuels by 1) reducing the usage of ionic liquid and water; 2) using CO_2 to reversibly control the pH mismatch that historically prevented integration of IL pretreatment with downstream saccharification and fermentation operations into a single unit operation; and 3) providing

economic benefits for ethanol production at using high biomass loading (25 wt%). Next steps are to work with the Fuels Synthesis Division to incorporate advanced biofuel hosts.

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