Industrial production of green chemicals from biomass

(LignoWaste Mill for Green Solvents)

Background

In today's scenario, chemicals are produced mainly from non-renewable feedstock such as coal, natural gas and petroleum. The diminishing trend in the availability of these fossil fuels coupled with their harmful impact on the environment has led to more research to find alternative sources which are not only renewable but also sustainable. Biomass is one such resource which is renewable and abundantly available. Biomass mainly consists of lignocellulose which can be utilized for the production of value added chemical products such as green solvents and biofuels. The main goal of this research is to find feasible ways for the industrial production of value added green chemicals using biomass.

Objectives

Green solvents project

Organic solvents are capable of dissolving solutes, enhancing system stability, kinetics and yield are indispensable in chemical industry. In terms of applications, paints and coatings, pharmaceuticals, and adhesives dominate the global consumption of solvents. However, the majority of today's organic solvents have hazardous and toxic properties and forming large waste by-products of the chemical industry causing environmental problems and occupational diseases when exposed for prolonged duration. Therefore, there is a strong motivation to replace these inconvenient solvents with greener sustainable alternatives using replacement and synthetic techniques.

One possibility towards greener solutions in the production of solvents is to search for bio-based lignocellulosic or raw materials (Byrne et al., 2016). The interesting greens solvents are especially those replacing common fossil-based chemicals such as dimethylsulfoxide, (DMSO), dimethyl formamide (DMF), xylenes and n-methyl pyrrolidone (NMP). Instead of these, the following green solvents could be used: methyl tetrahydrofurane (MTHF), gamma valero-lactone (GVL), levulinic acid derivatives, dihydrolevoglucosenone (Cyrene). Green solvents are characterized by their low toxicity, low water solubility, ease of biodegradability, high boiling points (less volatile, less odor and low health risk for workers) and ease of recycling after use (Mohammad and Inamuddin, 2012). Often the obstacle is the cost of production and investments.

Under the green solvents project, our aim is to create new technology solutions for the production of green solvents from lignocellulose-containing side streams and subsequently develop a model pilot plant for testing purpose. The research study will include exploring for alternatives to petrochemical derived solvents, evaluating the use of biomass in the production of green solvents, carrying out techno-economic assessment of selected alternative synthesis routes, use of simulation and modeling tools for the comparative study between biomass to model simulation and finally verifying the models with experimental testing. (Oinas, 2016).

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Project-related publications:

Hyötyläinen, L. (2017) Production of dihydrolevoglucosenone, M.Sc. thesis, Aalto University, 54 p.