Recyclability of Ionic Liquid in the Pretreatment of Eucalyptus Globulus

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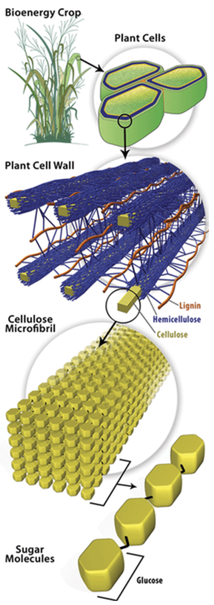
Abstract

One of the most successful methods for the pretreatment of biomass is the use of Ionic Liquids (IL). However, the cost associated with IL prohibits it from being plausible for mass production of bioethanol. In order to decrease the cost of this pretreatment method, the recyclability ILs was tested by performing a series of pretreatments on Eucalyptus globulus.

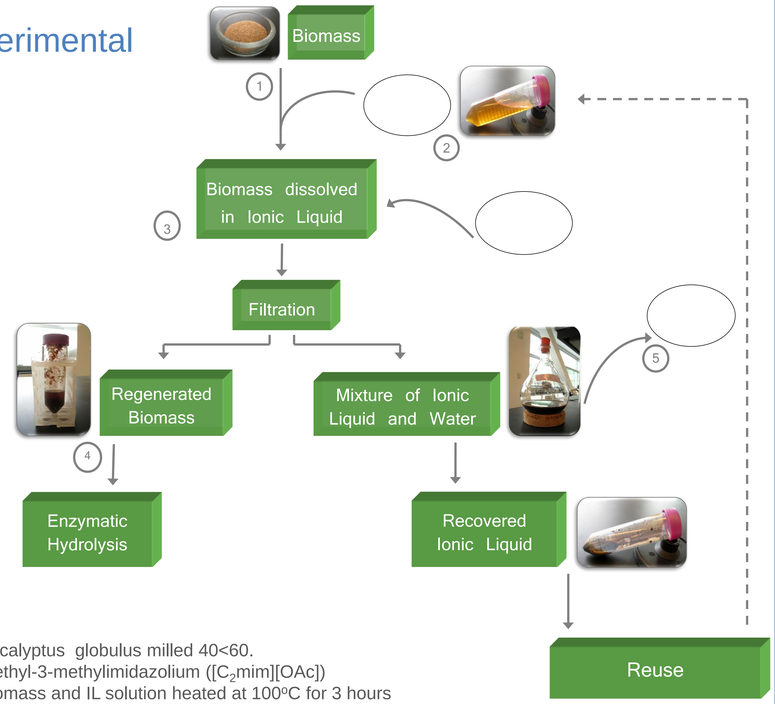
The IL used was 1-ethyl-3-methylimidazolium acetate ([C_2mim][OAc]). The IL from each series was recovered, dried and reused for the following series. It was determined that there was a significant reduction in the enzymatic hydrolysis yields after the first and subsequent recycling steps, and a significant amount of IL was lost in each round of recycling.

Background



Increasing greenhouse gas emissions, rising fuel costs and accumulated environmental damage drive the need for developing inexpensive, low carbon fuels. Cellulose available in the cell walls of inedible agricultural residues, forest debris and grasses, is one of the most abundant natural resources available. The key to utilizing this resource for biofuel production is in separating the lignin from the cellulosic fractions so that these fractions can be hydrolyzed then fermented into ethanol. (Hu, 2008)

Experimental



1. Eucalyptus globulus milled 40<60.
2. 1-ethyl-3-methylimidazolium ([C_2mim][OAc])
3. Biomass and IL solution heated at 100°C for 3 hours
4. Regenerated biomass was dried in lyophilizer.
5. IL was dried using a rotary evaporator. (RotoVap)

Results

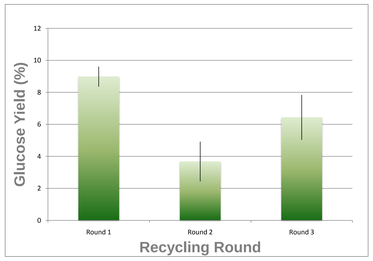


Figure 1: Enzymatic Hydrolysis of Biomass Pretreated with Recycled IL

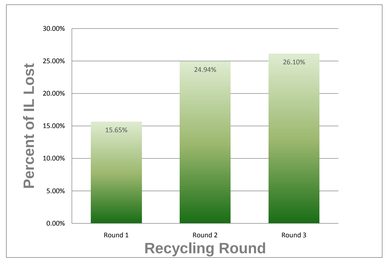


Figure 2: Percent of IL Lost per Recycling Round

- The second and third rounds of IL recycling were equivalent given the experimental error (Figure 1)
- There was a significant reduction in the enzymatic hydrolysis yields with the second and third rounds of IL (Figure 1)
- The average decrease in enzymatic hydrolysis yields was 43.73%
- There is less than 0.5% IL in the recovered biomass as determined by pyrolysis GC-MS
- A significant amount of IL was lost in each cycle of the biomass washing (Figure 2)

Conclusions

The glucan loading data showed a consistent average of 71.60%, and the amount of IL remaining in the biomass was insignificant; therefore, the recycled IL is a less effective pretreatment solvent. A decreased enzymatic activity of 43.73% is too high for recycling to be an economically viable method.

In order to make ILs a feasible option for biomass pretreatment:

- Other organic solvents could be used to clean the IL
- Other methods for decreasing the amount of IL lost in each round of recycling

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