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Impact of hardwood species on production cost of second generation ethanol

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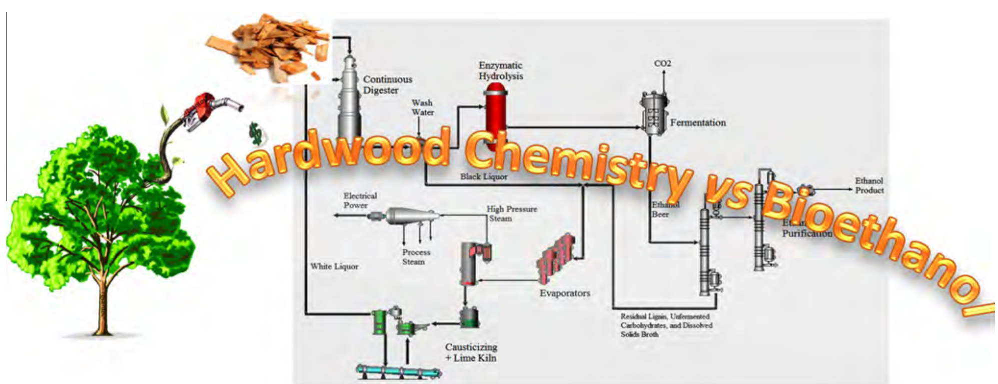
HIGHLIGHTS

- ▶ Study targeted the influence of different hardwood species on ethanol production yield and costs.
- ▶ Minimum ethanol revenue was lower for extended kraft-pretreated samples.
- ▶ The influence of species characteristics remained restricted to high residual lignin content.
- ▶ Species such as maple, globulus and sweet gum presented the lowest variation in relative MER.
- ▶ Sensitivity analysis showed that ethanol yield has the largest influence in MER followed by CAPEX.

GRAPHICAL ABSTRACT



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ABSTRACT

The present work targeted the understanding of the influence of nine different hardwood species as feedstock on ethanol production yield and costs. It was found that the minimum ethanol revenue (MER) ($ per gallon to the producer) to achieve a 12% internal rate of return (IRR) on invested capital was smaller for low lignin content samples and the influence of species characteristics remained restricted to high residual lignin content. We show that if the pretreatment being applied to the feedstock targets or is limited to low lignin removal, one can expect the species to have a significant impact on overall economics, playing important role to project success. This study also showed a variation of up to 40% in relative MER among hardwood species, where maple, globulus and sweet gum varied the least. Sensitivity analysis showed ethanol yield per ton of feedstock had the largest influence in MER, followed by CAPEX.

1. Introduction

The availability of cellulosic polymers (cellulose and heteropolysaccharides) on the planet in the form of biomass gives them the prominent position of one of the most promising feedstocks for conversion into liquid and solid fuels (Aden et al. 2002; Gonzalez et al., 2011a–c; Wu et al., 2010). However, the conversion of lignocellulosic biomass is challenged by its recalcitrant structure which is demonstrated by its virtual immutability to almost any chemical and enzymatic hydrolysis attempts (Mosier et al., 2003, 2005; Gonzalez et al., 2011c).

Because carbohydrates in natural wood are not amenable to enzymatic hydrolysis, the use of some type of pretreatment is essential for the ultimate production of liquid biofuels. Pretreatments target wood structure by opening up pathways in the microstructure to facilitate enzyme hydrolysis of the carbohydrates. A variety of pretreatments have been tested over the past years including ozonolysis, organosolv, AFEX, auto hydrolysis, alkaline hydrolysis as well as integrated process with hemicellulose extraction prior to pulping and power generation (Treasure et al., in

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