LICENSING OPPORTUNITY

Biomass pretreatment for enhanced chemicals production from cellulose and lignin

Keywords

Lignocellulose, Cellulose, Lignin, Pretreatment, Biorefinery, Biochemicals, Biofuels

Summary

A state-of-the-art pretreatment for lignocellulosic biomass has been modified to prevent lignin repolymerisation reactions. This enables significantly higher sugar yields in the enzymatic saccharification of cellulose, which can be fermented to chemicals. At the same time, a high quality lignin fraction is obtained.

Background

Lignocellulosic biomass is a sustainable source for the production of chemicals and fuels. However, physical and chemical barriers caused by the entanglement of its main components (cellulose, hemicellulose and lignin) hinder the enzymatic saccharification of the carbohydrates to fermentable sugars. Therefore, a biomass pretreatment is required to breakdown its structure and enhance the accessibility to cellulose.

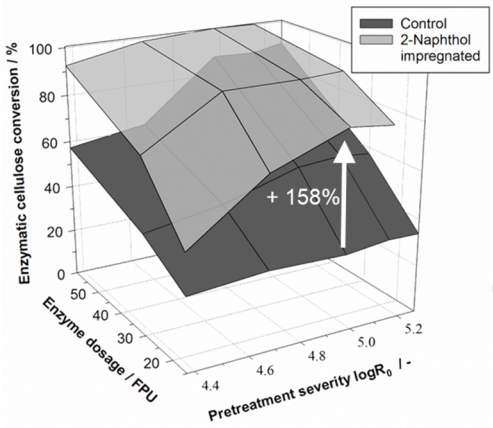

Fig. 1. Glucose yields in the enzymatic saccharifcation of steam explosion pretreated wood chips. Pretreatment: 1.5 kg spruce, 35 g 2-naphthol (scavenger) or no additive (control).

Invention

The dominating pretreatment technology in commercial-scale lignocellulosic biorefineries is steam explosion. We disclosed that a major challenge of this kind of pretreatment are lignin repolymerisation reactions, which hinder the desintegration of the biomass structure.

The invention makes use of a carbocation scavenger to suppresses lignin repolymerisation. This allows enhancing the enzymatic conversion of softwood cellulose by more than 150%, compared to a state-of-the art steam pretreatment (Fig. 1). The approach has proven efficient for enhancing the bioconversion of more than 20 different lignocellulose species (woody biomass, agricultural restudies, grass).

The lignin obtained in the processing is of low and defined molecular weight. It can be selectively functionalised by the scavenger for its dedicated use (Fig. 2), such as depolymerisation to aromatic building blocks or use in polymers.

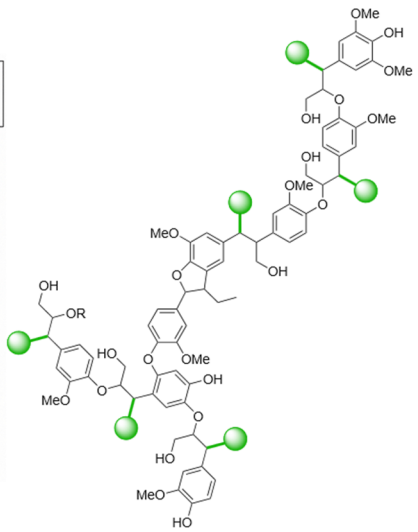

Fig. 2. Lignin polymer which has been chemically functionalised by the scavenger (green).

Features & Benefits

- Increase of sugar yield in enzymatic cellulose saccharification
- Very recalcitrant biomass like softwood becomes digestible
- High-quality lignin fraction obtained
- Simple and environmentally friendly process: No acid/base/solvent chemicals needed in pretreatment

Field of Application

Cellulose-derived sugars:

- Production of biochemicals
- Production of biofuels

Functionalised lignin:

- Depolymerization to aromatic chemicals (building blocks)
- Use as polymer in resins, dispersants, coatings, carbon fibres etc.
- Use as polymer in battery materials (anode, cathode, electrolyte)

Patent status, TRL

- 2 patents granted (US9611494B2, US10370501B2)
- Tested in steam-explosion pilot plant
- TRL: 5-6

Key publications

T. Pielhop et al., Green Chemistry (2015), doi.org/10.1039/C4GC02381A

B. Nikqi et al, Industrial Crops and Products (2025), doi.org/10.1016/j.indcrop.2025.122230

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