LICENSING OPPORTUNITY

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Triplicating sugar yields by a novel steam pretreatment process for the production of biofuels

Keywords

Second-generation biofuels, Cellulosic ethanol, Biochemicals, Biorefinery, Steam pretreatment, Enzymatic hydrolysis, Lignocellulose, Cellulose, Lignin

Summary

A state-of-the-art steam explosion pretreatment process for lignocellulosic biomass was modified to prevent lignin repolymerisation reactions. This allows for remarkable higher sugar yields in the enzymatic hydrolysis of cellulose, which can be fermented to biofuels or chemicals.

Background

Second generation biofuels (e.g. bioethanol) produced from lignocellulosic biomass like wood or agricultural residues, show economic and environmental advantages in comparison to biofuels from starch or sugar. However, physical and chemical barriers caused by the entanglement of the main components (cellulose, hemicellulose, lignin) of lignocellulosic biomass hinder the enzymatic hydrolysis of cellulose and hemicellulose to fermentable sugars. Therefore, pretreatment steps aim at breaking down the biomass structure to enhance cellulose accessibility.

Invention

Steam explosion pretreatments are of high commercial relevance, as they allow for high biomass loadings and do not need acid, base or solvent chemicals that have to be removed or neutralised in a later stage of a biorefinery process. The difficulty in steam pretreatments, however, are repolymerisation reactions of lignin fragments which hinder the desintegration of the biomass structure. In the presented invention, carbocation scavengers in the steam pretreatment suppress those repolymerisation reactions. The digestibility of softwood, which is typically very recalcitrant to enzymatic hydrolysis, could be improved by more than 150 % (Ref. 1).
Besides, the less repolymerised lignin fraction which is obtained is expected to have a higher commercial value.

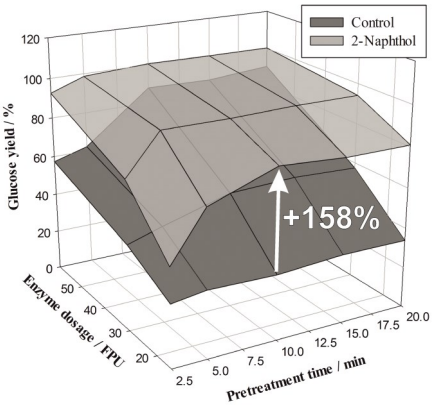

Fig. 1: Enhancement of glucose yields in enzymatic hydrolysis. Steam explosion pretreatment: 1.5 kg spruce wood, 35 g 2-naphtol (scavenger) or no additive (control), T=235°C; Hydrolysis: 1% w/w cellulose, 15/30/60 FPU/g cellulose

Patent Status

- Patent pending

Features & Benefits

- Remarkable increase of sugar yields (3x higher) in enzymatic hydrolysis
- Very recalcitrant biomass like e.g. softwood becomes digestible
- Economic and environmentally friendly process: No acid/base/solvent chemicals needed
- Valuable lignin fraction obtained, which is less repolymerised, uniform and has low molecular weight

Field of Application

2nd generation biorefineries:

- Production of biofuels or chemicals from (hemi) cellulosic sugars
- Production of aromatic chemicals from the obtained lignin fraction

Polymer industries:

- Use of obtained lignin as a blend in phenolic resins
- Introduction of specific functionalities (e.g. aryl groups) into the lignin

References & Institute

T. Pielhop et al., “Lignin repolymerisation in spruce autohydrolysis pretreatment increases cellulase deactivation”, *Green Chemistry* **17**, 3521-3532, 2015

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