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Biotechnical modification of lignocellulose

Summary

Conversion of lignocellulosic raw materials into chemicals and fuel ethanol in Biorefinery context is the main target of studies. The research concentrates on fractionation and modification of lignocellulose by different pretreatments and development of enzymatic hydrolysis.

Background

In recent years, growing attention has been devoted to the conversion of renewable raw materials (biomass) into fuel ethanol. Lignocellulosic materials are a heterogeneous complex of carbohydrate polymers and lignin. Cellulose and hemicellulose can be hydrolysed chemically or enzymatically to monosaccharides. The physical structure of cellulose in native lignocellulose is, however, resistant to enzymatic attack and cellulose is further protected by the surrounding matrix of lignin, hemicellulose and pectin. Therefore, the lignocellulosic biomass must be pre-treated to make the cellulose fraction more accessible to hydrolysis.

Work description

The aim in the thesis work studies is to develop technologies for fractionation and modification of renewable raw materials in Biorefinery, especially via sugar route into fuels and chemicals and to evaluate the feasibility of raw materials and processes for production of second generation bioethanol. Domestic forest and agro-based materials or industrial lignocellulosic side streams are studied as raw materials. Raw material composition and structure, pretreatment techniques, enzymatic hydrolysis as well as ethanol fermentation are studied. State-of-art pretreatment technologies (e.g. steam explosion) are applied to raw materials and compared with novel oxidative pretreatment methods which will be developed further in the work. Composition, other characteristics, quantities and utilization of non-carbohydrate fractions in context of Biorefinery concepts are studied in collaboration with other research groups. Enzymatic hydrolysability of the carbohydrate-containing materials is evaluated and the effects of different pretreatments and pretreatment parameters are compared. Factors determining the performance and optimal enzyme mixtures for total hydrolysis with mesophilic and thermophilic enzymes are investigated in more detail. The performance of the developed processing options will also be evaluated in connection of yeast fermentation and factors affecting the economics and technical efficiency of the scaled-up process are studied further to evaluate the feasibility of the technology developed.

Research with agro-based materials was carried out at VTT in Tekes funded project “Development of pre-processing and hydrolysis technologies of domestic agrobiomass in production of bioethanol” (AGROETA). Work has been continued in Tekes BioRefine programme project “Hydrolysis technology for producing sugars from biomass as raw material for the chemical industry” (SugarTech), and EU 7th framework programme project “High efficiency consolidated bioprocess technology for lignocellulose ethanol” (HYPE).