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A new biorefinery process to produce biofuels and chemicals from forest biomass

Title of the dissertation	Conditioning of SO_2-ethanol-water (SEW) spent liquor from lignocellulosics for ABE fermentation to biofuels and chemicals
Contents of the dissertation	Rising crude oil prices, diminishing conventional oil reserves and global warming attributed to the use of fossil fuels are the sustained driving forces supporting efforts to convert forest biomass into transportation fuels and chemicals. A promising conversion technology for economic industrial production of biofuels and chemicals from biomass is the SO_2-ethanol-water (SEW) process. Butanol is a good replacement for motor fuels and a superior alternative to currently produced cellulosic ethanol. Butanol may be produced by fermentation via the acetone-butanol-ethanol (ABE) process. This technology has been discontinued since the middle of the last century due to high sugar feedstock costs and availability of cheap oil. However, the current rise in crude oil prices and the potential availability of cheaper sugars derived from woody biomass such as residues from the forest industry has renewed interest in this process. In the current PhD thesis a new biorefinery process is presented to produce ABE solvents. The process combines: i) SEW fractionation and ii) a conditioning protocol to produce detoxified SEW hydrolysates of suitable monosugars content for use as feed in subsequent ABE fermentation by *Clostridia* bacteria. The conditioning scheme in its basic form comprises the consecutive steps of vacuum evaporation, steam stripping, liming and catalytic oxidation. The most preferable fractionation conditions for industrial SEW fractionation of the tested lignocellulosic feedstocks (spruce chips, mixed softwood biomass and oil palm empty fruit bunch fibers) are: 12% SO_2 in 55 v/v% ethanol-water, 30 min, 150^0C, liquor-to-feedstock ratio of 3 L kg^{-1}. The conditioning process fully removes ABE fermentation inhibitors (furans and formic acid, ethanol, SO_2) from SEW hydrolysates and also raises their monosugars content. Dissolved lignin is almost fully removed by introducing additional steps to the basic conditioning scheme (addition of chitosan after liming, nanofiltration after the step of catalytic oxidation). In this case ABE solvents (mostly butanol) are produced at maximum total concentration of 11 g L^{-1} (yield of 0.30 g g^{-1} sugars).
Field of the dissertation	Biorefineries
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A doctoral dissertation is a public document and shall be available at Aalto University School of Chemical Technology noticeboard (Kemistintie 1, Espoo, PL 16100, 00076 Aalto) and at the Department of Forest Products Technology.