Recovery of Byproducts from Steam Explosion of Wood Biomass in a Biorefinery

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Introduction

The purpose of my Ph.D. research is to examine ways to recover different value-added chemicals from steam explosion pretreatment of wood biomass from forestry residues in a large scale biorefinery. The recovery of these value-added chemicals from lignocellulosic biomass sources, will contribute to a reduced dependence on fossil sources for chemicals. Together with Arbacore energy pellet technology that will help offset the use of coal and thereby reduce climate gas emissions of energy production, this biorefinery approach can add significant value to resource recovery from forestry

Picture 1: Picture from the ArbaOne biorefinery

Energy Pellets

Arbaflame AS is a Norwegian biotech company that produces energy pellets with properties similar to that of coal, with the goal of substituting/replacing the use of coal in coal fired powerplants. To make these pellets biomass, usually in the form of small wood chips, are subjected to steam explosion pretreatment, a process where high pressure saturated stem is injected into a reactor with the biomass. During cooking the steam will penetrate deep into the fibers of the biomass and with a dramatic, but controlled pressure-drop the explosive decompression will cause the wood fibers to start decomposing. The steam explosion pretreatment hydrolyzes the hemicellulose and promotes the formation of furanic compounds from the hydrolyzed hemicellulose [1].

By-Product stream

During the pressure release step of steam explosion high pressure steam will exit the reactor. This steam also brings with it a large number of the organic compounds that are generated during hydrolysis of hemicellulose and decomposition of the biomass. Within this by-product stream the most abundant compounds are methanol, acetic acid and furfural, but significant amounts of 2-Acetylfuran, 5-Methylfuran and 5-Hydroxymethylfurfural have also been discovered.

The steam explosion conditions are observed to significantly influence the yields of these products, so the optimization of the steam explosion severity for production of the furanic compounds and recovery pathways for the value-added chemicals will be the focus of my work.

NMR Analysis

Analysis of the by-product streams are performed with qNMR on a 600 MHz Bruker NMR spectrometer, following the method outlined by Løhre C. et al. [2], which enables accurate identification and quantification of the desired by-products from the aqueous by-product stream.

Ongoing and future research

This project is currently in the earlier stages of research, with a focus on optimizing the production of furfural and also investigating the extraction and utilization of other furanic compounds.

In the future the aim is to expand research into utilization of other possible feedstocks and expand the recovery of other value-added chemicals from the product streams.

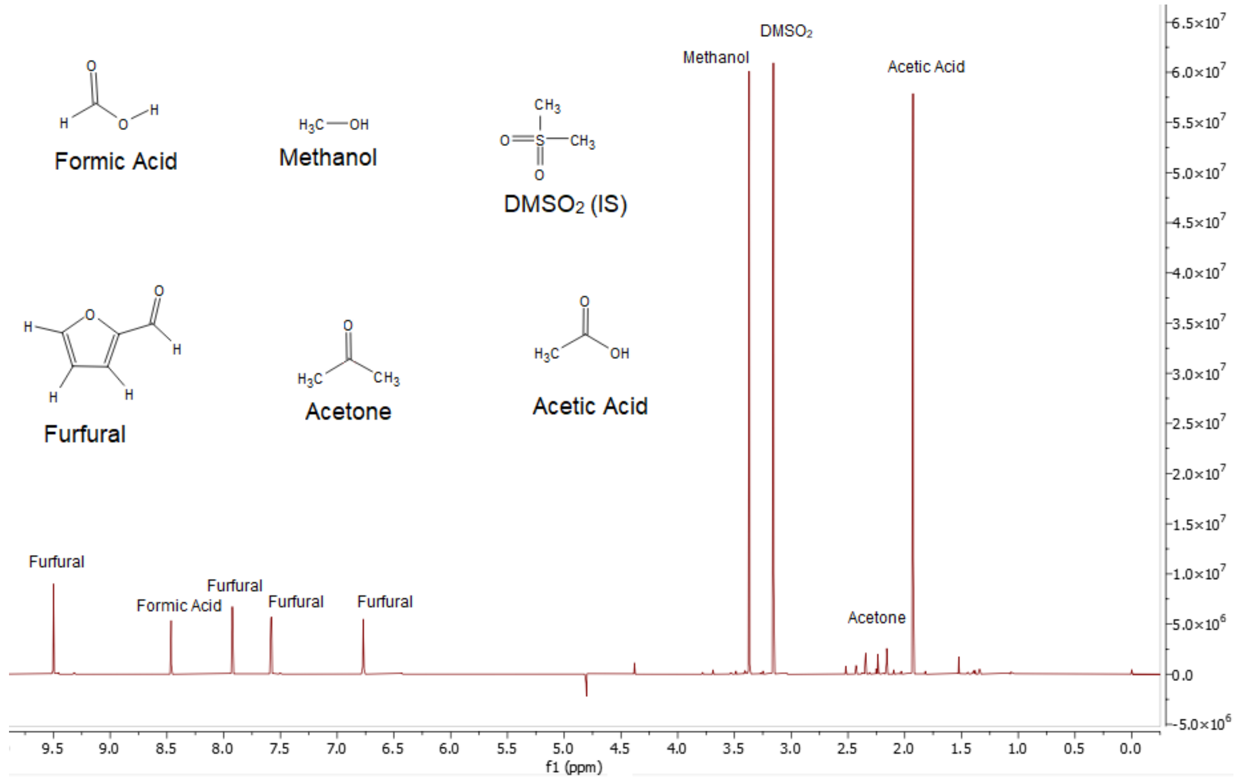

Figure 1: ^{1}H NMR of condensate stream acquired with a 600MHz NMR spectrometer. Some products including Furfural are identified and can be quantified.

References:

[1] - WERTZ, J. *LIGNOCELLULOSIC BIOREFINERIES*; EPFL Press: LAUSANNE, 2013; pp 323-328.

[2] Løhre, C. et al. A Workup Protocol Combined With Direct Application Of Quantitative Nuclear Magnetic Resonance Spectroscopy Of Aqueous Samples From Large-Scale Steam Explosion Of Biomass. *ACS Omega* 2021, *6* (10), 6714-6721.

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