NEWSLETTER

Advanced Biorefinery Concepts Integrated to Chemical Pulping

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Sustainable economic growth requires a more efficient utilization of renewable resources for industrial production; this trend is mainly due to the depleting resources of fossil fuels, concern of global warming, and increased demand for energy and materials. Chemicals, biofuels, and biocomposites manufactured from bioresources, such as forest and agricultural biomasses, have been considered the most promising alternatives for replacing traditional raw materials. While the direct energy production can be based on various alternative production systems (wind, solar, etc.), the production of chemical products and liquid fuels depends on biomass. For these reasons, different biorefinery processes integrated into modern pulp and paper mills have gained a great interest especially during the last few decades. This approach includes the modification of a conventional pulp mill to an integrated forest biorefinery (IFBR).

The objectives of my PhD thesis "Advanced Biorefinery Concepts Integrated to Chemical Pulping" were to determine the effects of various aqueous acidic and alkaline pre-treatments on the main Nordic pulp woods and to study the behaviour of the pre-treated feedstocks during the subsequent alkaline sulphur-free pulping (soda-AQ and oxygen-alkali pulping). This approach included pre-treatments performed with different wood materials under various conditions as well as chemical characterization and fractionation of the pre-treatment hydrolysates, sulphur-free pulping of the pre-treated feedstocks, and analysis of the black liquors and produced pulps.

The results obtained clearly revealed the effects of applied pre-treatments on the chemical composition of the hydrolysates. Whereas the acidic pre-treatments could be utilized for producing mainly carbohydrate-containing hydrolysates, the alkaline treatments produced mainly aliphatic organic acids. Other main soluble components were dissolved lignin, furanoic compounds, and small-size phenolics. It could be concluded that pre-treatment liquors rich in various organics could serve as potential raw material sources for the production of green chemicals in numerous applications.

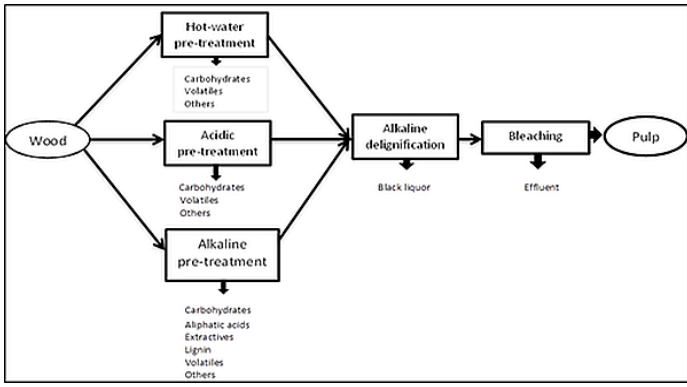

Figure 1. Alternative IFBR concepts including pre-treatment, delignification, and bleaching stages.
(Lehto & Alén, TAPPI Journal, 14(2015)237-244)

In addition to the production of organics-containing hydrolysates suitable for further refining, the effects of acidic pre-treatments on the subsequent sulphur-free pulping operations were determined. Applying this stage prior to alkaline pulping, the content of residual lignin in pulps could be significantly decreased. In addition, the chemical composition of black liquors was clearly different to those prepared without pre-treatments.

The research project was conducted in the Laboratory of Applied Chemistry (LAC) at the Department of Chemistry, University of Jyväskylä. Most of the LAC research has been suggested and financed by the pulp and paper industry as well as other chemical industry. The research areas have dealt either with more fundamental topics or with actual full-scale industrial problems, mainly serving the versatile area of wood processing chemistry.