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Development of a modern biorefinery

Title of the doctoral thesis	A new generation of organosolv biorefinery: Birch fractionation in gamma-valerolactone, full valorization of pulping streams, and solvent recovery
Content of the doctoral thesis	The thesis focuses on the development of a current pulp mill into a biorefinery. The main difference between traditional pulp mills and upgraded biorefineries is their product portfolio. While cellulose (pulp) remains the main and practically the only product in pulp mills, biorefineries utilize the complete biomass, producing fractions of cellulose, hemicellulose, and lignin. The purpose of this study was to propose a concept of biorefinery that uses an organic solvent called gamma-valerolactone (GVL). GVL is a completely biomass-derived, degradable, and non-toxic solvent that effectively decomposes the lignocellulosic biomass. GVL yielded pure cellulose with qualities that can be easily tailored to paper or dissolving pulp. In addition, the lignin was completely solubilized and consequently easily precipitated from spent liquor. Dissolved hemicelluloses were hydrolyzed into monomeric xylose. The produced dissolving pulp was converted into regenerated fibers of high toughness through IONCELL® technology and the fibers were knitted into fabric. Precipitated lignin was converted into a polyhydroxyurethane sample, and the hydrolyzed xylose was crystallized from the spent liquor. Not only appealing products are important for the successful implementation of biorefinery but also economic sustainability of the whole process. The solvent, GVL, must be fully recyclable and chemically stable. Therefore, part of the study was dedicated to the research of stability and recovery of GVL. GVL proved to be highly stable during the pulping reaction without decomposition to unwanted side-products. Additionally, it was demonstrated that GVL can be recovered from the spent liquor and re-used in pulping. This dissertation built the ground for a novel pulping process that could significantly improve biomass utilization.
Field of the doctoral thesis	Chemical engineering
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Opponent(s)	Prof. Emeritus Adriaan Van Heiningen, The University of Maine, USA
Custos	Prof. Ville Alopaeus, Aalto University, Finland
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