Principles of ethanol organosolv lignin precipitation: process simulation and energy demand

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For quite some time now, a lot of research is aimed to substitute fossile raw materials with renewable sources. Biorefinery concepts are investigated to produce transportation fuels which could increasingly replace their fossile counterparts. In addition to fuels, newer biorefinery concepts also offer the possibility to produce chemicals on a sustainable basis. Besides sugars, bioethanol and fibers, lignin is a promising product of biorefineries. To fractionate lignocellulosic biomass, which is the feedstock of choice to produce this spectrum of chemicals, several processes are investigated in literature. One of them that appears to yield high quality lignin is the ethanol organosolv (EOS) process, that utilizes ethanol in the pulping liquid. As a result of ethanol organosolv treatment, a cellulose rich solid fraction, and a liquor containing the cleaved lignin as well as some hemicellulose derived sugars and sugar degradation products are generated. In order to obtain the lignin, it has to be precipitated from this matrix of several compounds selectively. In some cases, this was achieved by selective precipitation through acidification by sulphuric acid or addition of water. Fractionation of different molecular weight lignins by ultrafiltration with subsequent precipitation was also investigated.

Previous studies, including our own, have also shown that lignin solubility depends on the ethanol content of the solution (Figure 1), therefore lignin precipitation can also be performed by reducing the ethanol content and/or removing liquid to bring the lignin concentration to its solubility limit. After precipitation, the lignin can then be recovered by filtration and/or centrifugation.

This study focuses on the ways to precipitate lignin, their energy and chemicals demand, and how the choice of precipitation technique affects the efficiency of a EOS process. Experiments are performed in order to precipitate from an EOS pretreatment liquor by a) direct precipitation with sulphuric acid (Figure 2), b) vacuum-assisted evaporation, c) concentration by cross-flow nanofiltration and acid precipitation, and d) nanofiltration and evaporation.

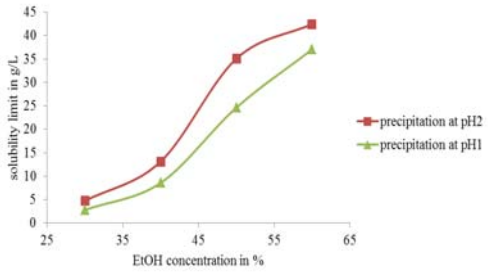

Figure 1: Lignin solubility limit

Figure 2: Lignin samples precipitated by acidification

The experimental results are used in simulation with ASPEN Plus®. The simulation of an organosolv process shows how valuable preconcentration of the liquor can be in order to reduce energy and chemicals demand.