

## Setting up the base for the first lignin biorefinery : from lignin to biofuels and chemicals

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## Setting up the base for the first lignin biorefinery: From lignin to biofuels and chemicals

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The concept of a biorefinery that integrates processes and technologies for lignocellulosic biomass conversion demands efficient utilization of all three components (lignin, cellulose, hemi-). The lignocellulosic- to-ethanol process (2G ethanolic plants) makes use of the cellulose and hemicellulose, leaving lignin as waste. For this reason and also because of its richness in functional groups, lignin is a potential resource for the production of renewable fuels and chemicals.

We have developed an approach that can convert technical lignins into mainly aromatic compounds. A one-step lignin upgrading process in supercritical ethanol using a Cu-Mg-Al mixed oxide catalyst has been already reported [1, 2]. Currently, efforts are made to optimize the promising routes of catalytic conversion of lignin into lignin crude oil (LCO) [1], by studying kinetics and properties on 4 L scale. This LCO has already been found to be a suitable renewable marine fuel “as is”, creating thus a quick route to market. Functional and conceptual process design based on experimental data, together with techno-economical risk assessment are already planned, in order to process second generation biomass and bioethanol into fuels and chemicals. This work is focusing on the definition of the optimized process operating window for converting lignin into a crude oil which meets the marine fuel viscosity specifications (<1000cST at 40 °C), preserving high the yield of oxygenated aromatics. Ethanol not only prevents repolymerization of lignin, but also ethanol conversion products such as butanol, acetaldehyde, and ethyl-acetate are also contributed to lowering the LCO viscosity, to very low levels (typically ~3-40 cST at 40 °C). Significant monomer yields (~ 25 wt% for soda lignin) can be obtained after reaction of lignin at 340 °C for 4 hours, using the Cu-Mg-Al mixed oxide catalyst. The lignin monomer yield distribution changed from mostly hydrogenated oxygen-free cyclics to phenolics, while varying the lignin loading. 95% of pure ethanol could be recovered, while the partially depolymerized lignin oligomer fractions absorbed on the catalyst surface could be used as feedstock for resins application. Elemental analysis of the potential sulphur-free marine fuel showed a low oxygen content and high GHV (~ 15 wt% O and 40 GJ/tn respectively), in contrast with the pyrolysis oil properties (~ 46 wt% O and 16 GJ/tn).

[1] Xiaoming Huang, Tamas I. Koranyi, Michael D. Boot, and Emiel J. M. Hensen, ChemSusChem 2014, 7, 2276 – 2288.

[2] Xiaoming Huang, Tamas I. Koranyi, Michael D. Boot, and Emiel J. M. Hensen Green Chem., 2015, 17, 4941–4950

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