

# Conversion of Lignin into Functionalised Alkylphenols over Heterogeneous Catalysts

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Lignin is the most recalcitrant part of woody biomass yet is one of the few natural aromatic resources available in abundance. There is huge potential for this material to be used as a key feedstock in future applications however a conversion route to fine chemicals must be first be established. In this lecture we report on a methodology to convert the high purity lignin, extracted from raw wood sawdust, into value added products by hydrogenolysis.

It was found that lignin isolated using an ammonia pre-treatment from Poplar wood gave an uncondensed structure that was more reactive to catalytic depolymerisation compared to the condensed lignin produced using an organosolv or dilute sulphuric acid pre-treatment [1].

The lignin was converted to aromatic monomers over a series of supported metal catalysts in a batch reactor at 250 – 300C with 20 barg hydrogen in a water/methanol solvent [2]. The monomers produced were based on a simple substituted alkyl phenol motif shown in Fig. 1,

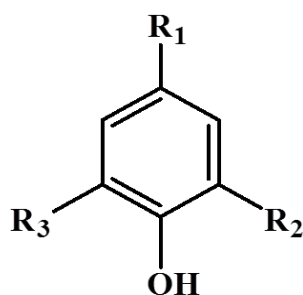


Fig. 1. Alkylphenol motif.

where  $R_1 = \text{H}, \text{C}_1 - \text{C}_3$ ,  $R_2 = \text{H}, \text{OMe}$  and  $R_3 = \text{H}, \text{OMe}$ . By changing the water to methanol ratio in the solvent it was possible to direct the selectivity, with methanol favouring  $R_1$  as a  $\text{C}_3$  unit and water favouring  $R_1$  as H.

The mechanism of the reaction was probed using deuterium and deuterated water and methanol. Interestingly an inverse kinetic isotope effect was observed when a deuterated reaction was performed instead of a protiated reaction. Hence by using mixtures of deuterated and protiated solvents and gas a picture of the surface chemistry has been developed and will be presented.

## References.

- [1] Florent P. Bouxin, Michael C. Jarvis, S David Jackson, *Bioresource Technology*, **162**, 236-242 (2014)
- [2] Florent P. Bouxin, Ashley McVeigh, Fanny Tran, Nicholas J. Westwood, Michael C. Jarvis and S. David Jackson, *Green Chemistry, Green Chemistry*, **17**, 1235-1242 (2015), DOI: 10.1039/C4GC01678E

# **Steam Reforming for Hydrogen Production: From Hydrocarbons to Alcohols.**

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The conversion of hydrocarbons by steam reforming to give hydrogen and syn-gas has been an industrial process for over 60 years. Over that time the feedstock has changed from naphtha to methane. In the future it is likely that the feed will change again, this time to biomass derived compounds. In the first part of this lecture we will look at the differences between hydrocarbon steam reforming and alcohol steam reforming in terms of selectivity and carbon deposition. In the second part we will examine the effect, on the steam reforming reaction, of typical impurities in an alcoholic feedstream and how they alter the catalyst and the product distribution.