# Catalytic Depolymerization of Lignin Extracted from Kraft Black Liquor and Lignin Model Compound 4-phenoxyphenol

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Lignin is the only renewable source of aromatic species, consisting of a network of guaiacyl, syringyl, and p-hydroxyphenyl units connected through various types of ether linkages forming an alkyl aryl ether backbone functionalized with methoxyl, benzyl alcohol, and phenolic hydroxyl species. Lignin conversion into lower molecular weight, monomeric type species with valuable functionality, such as phenols and aromatic acids, would shift dependence away from fossil fuels to a renewable source of aromatics.

Lignin was extracted from Kraft black liquor via the continuous Sequential Liquid Lignin Recovery and Purification (SLRP) process whereby the pH of the incoming black liquor (pH ~ 13.5) was lowered to a pH ~ 9.5 by acidification with $CO_2$ resulting in lignin precipitation. The precipitated, liquid lignin phase is then acidified with sulfuric acid until a final pH ~ 2.5 is achieved, whereby the lignin is fully acidified.

Catalytic conversion of SLRP lignin and lignin model compound 4-phenoxyphenol was investigated using a Pd/SBA-15 heterogeneous solid catalyst. The high surface area, large pore diameter, and hydrogenation sites enable the cleavage of ether linkages in lignin and lignin model compounds as well as stabilization of the resulting product thus preventing repolymerization which would result in low conversion. The nanometer length scale of the catalyst particles also contributes to these advantages. The heterogeneous nature of the catalyst allows for separation and reuse of the catalyst.

Lignin model compound depolymerization experiments were carried out in small batch reactor in the presence of the catalyst and under hydrogen pressure. Characterization of depolymerized lignin fractions was done using gas chromatography-mass spectrometry to analyze lighter molecular weight fractions. Catalyst reusability experiments were also performed to assess potential industrial application.