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## CATALYTIC HYDROTREATING OF LIGNIN TO PRODUCE BIOFUEL COMPONENTS

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Due to the rapid consumption of available oil reserves, one of the main priorities of the 21<sup>st</sup> century is to find new resources to obtain fuel and chemicals. In this context the most appropriate choice is biomass - an abundant and renewable resource. Lignin is the second most abundant natural polymer after cellulose. Approximately 70 million tons of kraft lignin (KL) is formed annually as a byproduct of the paper industry as black liquor. Lignin is considered as a low energy fuel, as it has high oxygen content. KL comprising sulfur from cellulose pulping process is more unsuitable as a fuel. One purpose of hydrotreating is to reduce the content of oxygen and sulfur in lignin and further to process it into the fuel. The catalysts used in the process for the depolymerization of lignin in order to obtain high conversion and to suppress side condensation reactions. In many cases, catalysts are involved in the selective cleavage of bonds, thereby increasing the yield of the specific compounds or types of compounds. Application of the hydrotreating catalysts of lignin increases product yield and promotes hydrodeoxygenation. Typically studied hydrogenation catalysts are usually composed of transition metals (e.g., cobalt, nickel and molybdenum) or noble metals (eg palladium). This paper presents the results of the study of kraft lignin hydrotreating process, (alkali lignin, Sigma-Aldrich, USA) using 5%Pd/C. The process was conducted in a six-cell reactor Parr Series 5000 Multiple Reactor System for 4 hours in a hydrogen atmosphere under the following conditions: substrate weight - 1.0 g catalyst weight - 0.1 g, the temperature range of 200 - 300, a hydrogen partial pressure - 1 MPa, the volume of solvent - 30 ml. Also polar solvents were used: 2-propanol, water and ethanol. Substrate conversion was calculated at the end of the reaction, based on the difference between the initial mass and the mass of the substrate dryness. Sampling in all experiments was performed every 30 minutes. Analysis of samples was carried out using GC-2010 chromatograph and mass spectrometer GCMS-QP2010S (Shimadzu, Japan). The catalyst was investigated using the following physico-chemical methods: X-ray photoelectron spectroscopy, infrared spectroscopy, infrared spectroscopy of diffuse reflection of the adsorption of CO (DRIEFT), transmission electron microscopy, thermal gravimetric analysis, differential scanning calorimetry, and the low-temperature nitrogen adsorption. Among the products obtained during hydrotreating of lignin the most promising for fuels are aromatic hydrocarbons (benzene, toluene, cyclohexane), and also phenolic

compounds which can be used as additives to conventional fuels and fuels derived from biomass. Furthermore, a number of cyclic and aromatic hydrocarbons, can also be used in various fields of fine chemicals as solvents and reagents. Maximum feedstock conversion was achieved at 300°C (98%). Maximum selectivity to phenol was achieved at 250°C (68% selectivity at 90% conversion). The optimal solvent is 2-propanol.

### Recent Publications

1. Tejado A, Pena C, Labidi J, Echeverria J M and Mondragon I (2007) Physico-chemical characterization of lignins from different sources for use in phenol-formaldehyde resin synthesis, *Bioresource Technology* 98:1655-1663.
2. Zakzeski J, Bruijninx P C, Jongerius A L and Weckhuysen B M (2010) The catalytic valorization of lignin for the production of renewable chemicals. *Chemical Reviews* 110:3552-3599.
3. Oasmaa A and Czernik S (1999) Fuel oil quality of biomass pyrolysis oils-state of the art for the end users. *Energy Fuels* 13:914-921.
4. Thring R W and Breau J (1996) Hydrocracking of solvolysis lignin in a batch reactor. *Fuel* 75:795-800.
5. Kleinert M and Barth T (2008) Towards a lignocellulosic biorefinery: Direct one-step conversion of lignin to hydrogen-enriched bio-fuel. *Energy Fuels* 22:1371-1379.

### Biography

Mikhail G Sulman has graduated from Kalinin Polytechnic Institute in 1990. He obtained his PhD in the field of Chemistry in 1994. In 2000 he obtained Full Professor (Doctor) degree in the field of Chemistry. He works in Tver Technical University, Tver, Russia till 1990 and now he is the Head of the Department of Standardization, Certification and Quality Management. His fields of research include span fine chemistry, fuel processing, waste processing, and heterogeneous catalysis. He is author or co-author of about 200 peer-reviewed publications and more than 500 conference papers with regard to catalysis, 30 patents. He received the awards Honored Worker of Higher Professional Education of Russian Federation in 2013.

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