Green Gasoline from Aqueous Phase Hydrodeoxygenation of Carbohydrate

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Aqueous-phase hydrodeoxygenation (APHDO) is a promising technology to convert biomass-derived oxygenates into alkanes and oxygenates. Selectively breaking the C-O bond without C-C bond cleavage is the biggest challenge and key for this project. In the previous work of Dumesic's group, it was shown that sorbitol can be converted to gasoline by APHDO over bifunctional catalysts (Pt/SiO_2-Al_2O_3) that contain both metal and acid sites. However, the low octane number, high Reid vapor pressure and low yield of gasoline range compounds produced in such a process limited the real application of this technology. As the first part of this work, we investigated the reaction chemistry for the APHDO of sorbitol over Pt/SiO_2-Al_2O_3 catalyst. From the analysis of gas phase and liquid phase products, more than 40 different compounds were identified. These compounds include dehydrated sorbitol (1,4-sorbitan, isosorbide), polyols, cyclic-ether alcohols, ketones, alkanes and CO_2. From the APHDO of sorbitol and a series of model intermediates, it was found that the APHDO is mainly composed of three unit reaction: 1) C-C breaking reactions by decarbonyldration or retro-aldol reactions. 2) C-O bond cleavage (dehydration followed by hydrogenation). 3) Hydrogenation reactions. Then we investigated the effect of reaction conditions (temperature, pressure, and sorbitol concentration) and different acidic support. Base on the experience we got in above work, we achieved up to 70 % gasoline product by APHDO of sorbitol over Pt/Zirconium phosphate catalyst which was proved to be the best among the catalysts we investigated. The octane number and Reid vapor pressure were also improved by the new catalytic process.