Catalytic Hydrodeoxygenation of Sawdust Pyrolysis Oil using the Fixed-Bed Continuous Reactor

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Among renewable energy sourecs, the lignocellulose-derived bio-oil is promising, which can be converted to petroleum-like transportation fuels. Abundance of lignocellulose including woods and grass motivated the research on the production of hydrocarbons from inexpensive inedible biomass feedstocks; particularly, the thermolysis of biomass has been suggested as a simple process to utilize carbons in the biomass. Although the thermal decomposition of biomass produce valuable products of solid, liquid, and gas, which can be used as solid fuels, petroleum-alternates, and syn-gas feed stocks, respectively, the use of thermally produced liquid product, or bio-oil, cannot be directly replace current petroleum feed because of its high acidity, high viscosity, and low energy density which were caused by its high oxygen content.

The high oxygen content of bio-oil can be reduced by catalytic hydrodeoxygenation (HDO) which upgrades the bio-oil to petroleum-like oxygen-free hydrocarbons. Although the production of high quality hydrocarbon fuels can be produced, it is difficult to develop the mass-production because of significant coke formation and catalyst deactivation [1]. The purpose of this study is to develop the highly active catalysts with the less formation of cokes for the continuous HDO process. Two-step HDO reaction system was optimized in an excess high pressure H_2 flow at 115 – 350 °C. The first step of hydrotreating stabilized the bio-oil and suppressed the coke formation [2].

Several catalysts were studied to find an optimum set to efficiently deoxygenate the bio-oil and suppress the formation of cokes. Reactants and products were characterized using GC/MS, elemental analysis, FT-IR, and Karl-Fischer titration revealing the change of chemical properties by the HDO to understand the roles of catalysts. The catalysts were also characterized by N_2-physisorption, XRD, CO-chemisorption. Based on these observations, tungstate-zirconia-supported catalyst was the most active HDO catalyst in our study. The combination of catalysts for two-step reactions was observed and the most efficient set of catalysts was discussed.

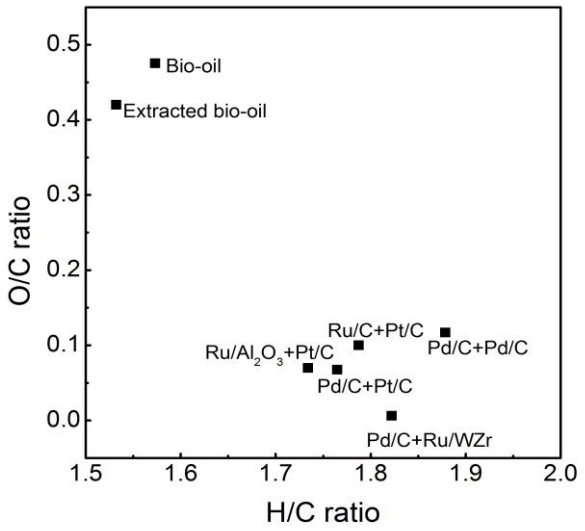

Fig.1. Van Krevelen diagram of two step upgrading results using sawdust pyrolysis oil.

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