Aerobic oxidation of benzyl alcohol using Ru nanoparticles supported on zeolites

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Oxidation reaction of primary alcohols to aldehydes is important in the synthesis of chemical intermediates and fine chemicals [1-2]. There are many catalysts reported so far, such as organometallic compound-type catalysts and nanomaterials-based catalysts. These are usually used as homogeneous and heterogeneous catalysts, respectively. The oxidation reactions are tested in the presence of oxidant such as oxygen and hydrogen peroxide (H_2O_2) [3-4]. In view of green chemistry, the nanostructured catalysts are more promising due to their advantages such as stability, easy to handle, and recyclability, etc. In addition, using oxygen as the oxidant is much better than using hydrogen peroxide in views of oxidant cost and environment.

The most representative form of heterogeneous catalyst is metal nanoparticles supported on nanostructured materials having high surface areas [5-6]. Zeolites are the powerful candidates for supporting metal nanoparticles within the micropore void spaces. According to the type of metal nanoparticles and the methods for supporting on the zeolites, the resultant catalysts show different catalytic behavior. In this presentation, Ruthenium metal nanoparticles were supported on zeolites via different pathways involving (i) ion-exchange, (ii) direct synthesis during zeolite crystallization, and (iii) post support on zeolite, in order to study the aerobic oxidation of benzyl alcohol to benzaldehyde. In addition, effect of zeolite type was also investigated. The catalytic materials were characterized with X-ray powder diffraction (XRD), scanning electron micrograph (SEM) and transmission electron micrograph (TEM). The oxidation reaction was carried out using round bottomed flask equipped with reflux condenser in the presence of oxygen gas as the oxidant at 35 ~ 70°C under atmospheric pressure. The results in Figure 1 show significant difference in catalytic behavior according to reaction temperature, time and catalysts. In most cases, the catalysts prepared by ion-exchange of Ruthenium metal to the zeolite framework show much better catalytic activity and lower activation energy.

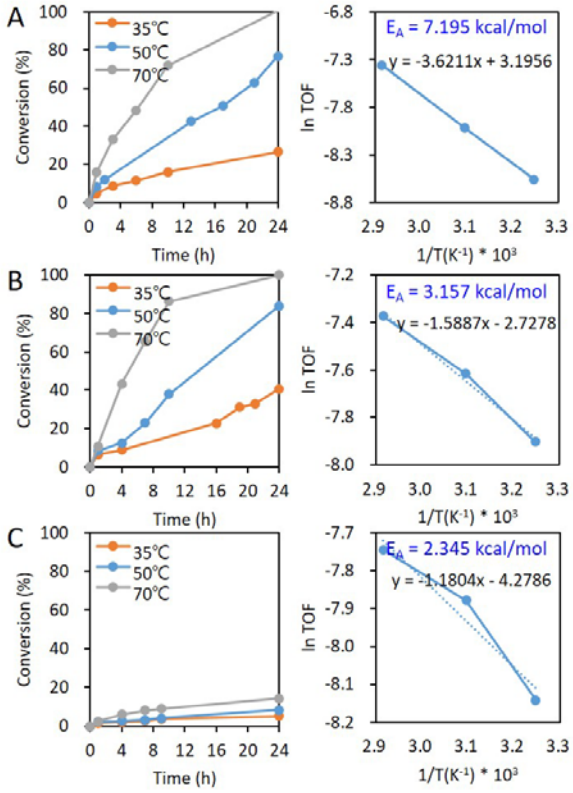

Fig.1 Benzyl alcohol conversion with reaction temperature and Arrhenius plots of (A) Ru NPs/Y, (B) Ru/Y, and (C) Ru/BEA zeolites

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