Hydrodeoxygenation of isoeugenol catalyzed by Co/biochar catalyst

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Significance and Relevance

The hydrodeoxygenation (HDO) of pyrolysis oil is considered a valuable strategy to obtain biofuels. Isoeugenol (IE) is a phenolic compound that is found in bio-oil. The HDO of IE leads to propylcyclohexane (PCH), that has the right features to be used as sustainable jet fuel. For the first time, cobalt based on biochars deriving from the pyrolysis of waste were used as catalysts on isoeugenol hydrodeoxygenation. The best catalytic activity was obtained with Co on biochar derived from rice husk (Co/ARH), which gave total conversion and 55% yield of PCH after 4 hours at 300 °C and 30 bar H_2.

Preferred and 2nd choice for the topic: Green chemistry and biomass transformation, renewable resources conversion, Sustainable and clean energy production and transport

Preferred presentation: Oral preferred

Introduction and Motivations

Lignocellulosic biomass (LB) is one of the most important renewable sources for the production of chemicals and fuels. LB utilization requires however some physical or thermochemical transformations, such as fractionation, distillation, pyrolysis, liquefaction, hydrolysis etc[1]. Through catalytic upgrading, such as hydrodeoxygenation (HDO), the liquid fraction of pyrolysis, bio-oil can be exploited as a renewable fuel, for example for the aviation industry[2]. The solid fraction of pyrolysis, biochar, is a renewable carbon based porous material, with a high thermal and chemical resistance that can be used as support for catalysts preparation[3].

Materials and Methods

10 wt. % Co on different biochars were synthesized via wet impregnation, calcined in Ar at 350°C, and reduced in H_2 at 450°C. The materials underwent comprehensive characterization, (N_2 physisorption, CHNS analysis, TPR, NH3-TPD, XRD, SEM, TEM, and XPS). The HDO of IE was explored by varying parameters such as temperature (200–300°C), H2 pressure (10–40 bar), and the catalyst-to-IE ratio in a semi-batch autoclave system (Parr reactor).

Results and Discussion

The characteristics of the carbon support influenced the final catalytic activity, as depicted in Figure 1, with the best results obtained by Co supported on rice husk biochar (ARH). ARH exhibited a hybrid composition of carbon and silica, featuring a hierarchical micro- and mesoporous structure. Co/ARH demonstrated good metal dispersion, the presence of acid sites, and the coexistence of two cobalt phases (Co^0 and CoO). Under optimal conditions, 55% yield of propylcyclohexane was achieved. The kinetic experiments allowed to propose a reaction network, outlined in Figure 1. Recycling tests revealed a slight decline in activity, attributed to organic deposits on the catalyst surface, although the conversion was maintained complete after three cycles (Figure 2).

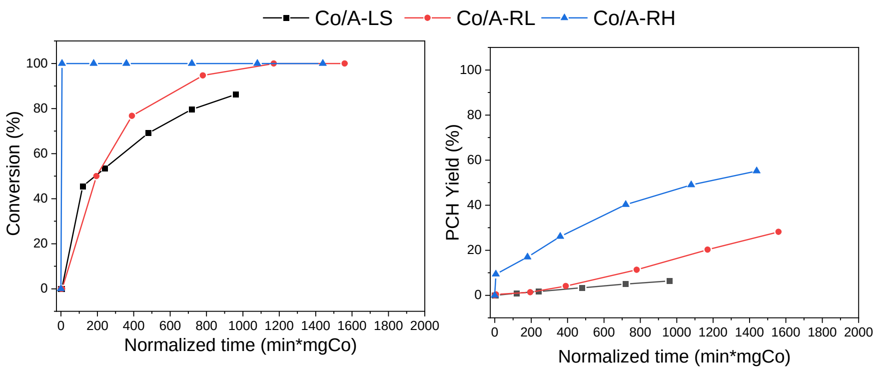

Figure 1 Reaction profiles of Isoeugenol HDO over different catalysts. Reaction conditions: IE 2 mg/mL, dodecane 50 mL, 50 mg cat., 300 °C, 30 bar H_2, 900 rpm, 240 min.

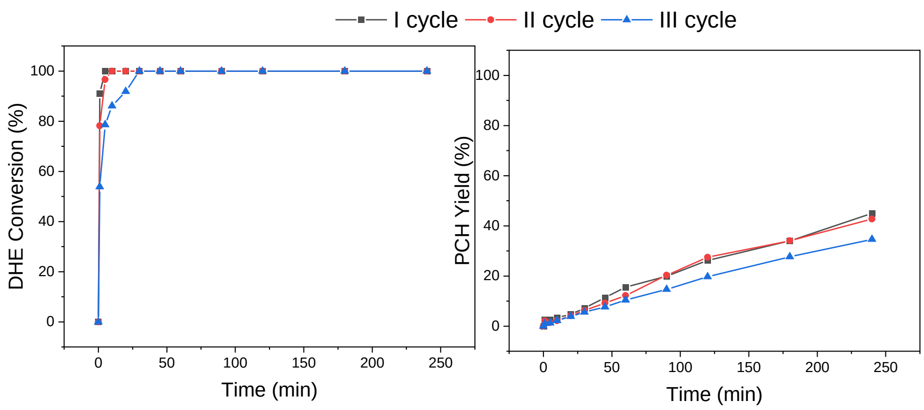

Figure 2 Catalyst recyclability. Reaction conditions: 50 mg Co/A-RH (< 63 µm), dodecane 50 mL, IE 2 mg/mL, 275 °C, 30 bar H_2 900 rpm, 240 min.

References

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