Efficient deoxygenation of waste cooking oil over Co3O4–La2O3-doped activated carbon for the production of diesel-like fuel

ABSTRACT

Untreated waste cooking oil (WCO) with significant levels of water and fatty acids (FFAs) was deoxygenated over Co3O4–La2O3/ACnano catalysts under an inert flow of N2 in a micro-batch closed system for the production of green diesel. The primary reaction mechanism was found to be the decarbonylation/decarboxylation (deCOx) pathway in the Co3O4–La2O3/ACnano-catalyzed reaction. The effect of cobalt doping, catalyst loading, different deoxygenation (DO) systems, temperature and time were investigated. The results indicated that among the various cobalt doping levels (between 5 and 25 wt%), the maximum catalytic activity was exhibited with the Co : La ratio of 20 : 20 wt/wt% DO under N2 flow, which yielded 58% hydrocarbons with majority diesel-range (n-(C15 + C17)) selectivity (~63%), using 3 wt% catalyst loading at a temperature of 350 °C within 180 min. Interestingly, 1 wt% of catalyst in the micro-batch closed system yielded 96% hydrocarbons with 93% n-(C15 + C17) selectivity within 60 min at 330 °C, 38.4 wt% FFA and 5% water content. An examination of the WCO under a series of FFA (0–20%) and water contents (0.5–20 wt%) indicated an enhanced yield of green diesel, and increased involvement of the deCOx mechanism. A high water content was found to increase the decomposition of triglycerides into FFAs and promote the DO reaction. The present work demonstrates that WCO with significant levels of water and FFAs generated by the food industry can provide an economical and naturally replenished raw material for the production of diesel.