Renewable diesel via solventless and hydrogen-free catalytic deoxygenation of palm fatty acid distillate

ABSTRACT

This work involved the utilization of a byproduct from the palm oil refining process as reaction feedstock in a solventless and hydrogen-free catalytic deoxygenation (DO) over NiO–ZnO catalyst in producing diesel-like hydrocarbons as advanced biofuels. The catalyst supporter was synthesized using coprecipitation methods to form highly crystalline meso-macrostructured ZnO particles. The catalyst support was wet-impregnated with different loadings (wt %) of NiO to prepare the NiO–ZnO catalyst. X-ray diffraction patterns verified the persistence of good crystallinity and phase purity of the support, with fine NiO crystallites of size 14–22 nm. Synthesized NiO–ZnO catalysts demonstrated Type IV isotherm with H3 hysteresis loop with mesoporous-macroporous properties. The Brønsted and Lewis acidic sites of NiO–ZnO offer a synergy effect between the active site and catalyst supporter. Both N_2 adsorption isotherm and electron microscopy analysis revealed the increase of the crystallite size of the catalyst by increase the NiO loadings. The catalytic activity of the NiO–ZnO catalyst was tested in a semi-batch reactor at 350 °C for 2 h in N_2 atmospheric. The oxygenated compounds of palm fatty acid distillate (PFAD) have been successfully removed to form linear hydrocarbons as green diesel compounds. The synergistic effect between NiO and ZnO significantly enhanced the catalytic activity for substrate DO. The hydrocarbons product yield reached 83.4%, with a diesel range (C_{11}–C_{17}) selectivity of 86.0%. The green diesel, which contains diesel-range hydrocarbons, is suitable as an alternative fuel product for vehicle engine usage. It is possible to be upscaled and compatible with the existed petrochemical refinery facilities. Hence, this is a promising work could be an economic potential and give value added to the palm oil byproduct sectors.