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Abstract

Deoxygenation of *Jatropha curcas* Oil to Hydrocarbons Using NiO/Al-PILC as a Catalyst †

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The energy crisis associated with fossil fuels has necessitated the development of catalytic methods for the deoxygenation of triglycerides into fuel-like hydrocarbons [1]. Much of the prior research on deCOx has concentrated on supported Pd or Pt catalysts, which display strong conversion and selectivity to diesel-like hydrocarbons [2]. The exorbitant cost of these precious metals, however, may preclude their usage in large industrial applications. Clays, in their natural and ion-exchanged forms, can act as both Bronsted and Lewis acids. Among them, the one proven to be most beneficial as a catalyst for synthetic organic chemists is montmorillonite, a subgroup of smectite clay that is a major component of bentonites [3]. The catalytic properties of these clays can be improved by a process called pillaring. Generally, metal oxides enhance deoxygenation reactions to produce hydrocarbons. In this research, inexpensive metal oxide, such as NiO doped on aluminium pillared bentonite will be prepared, characterized, and tested as potential catalysts for the conversion of Jatropha oil to hydrocarbons.

The aluminium pillared clay (Al-PILC) was prepared according to the procedure reported by Suhas et al. [4]. NiO was doped into the pillared clay using the impregnation method to provide 20 w% loading (coded NiO/Al-PILC). The resultant materials were characterized using XRF, XRD, and BET. The deoxygenation reaction was carried out using a semi-batch reactor under a continuous flow of nitrogen (5 wt%, 380 °C, 1 h). The product was taken to GC-MS to determine its molecular profile.

The XRF result revealed the presence of SiO_2, Al_2O_3, CaO, K_2O, and Fe_2O_3 in all the samples and NiO in the case of NiO/Al-PILC. In the XRD result, the 2θ value reduced from 7.10 to 5.32 after the pillaring process and translated to an increase in d-spacing from 12.45 to 17.07 Å. The surface area was increased from 173.955 m^2/g in bentonite to 385.869 m^2/g in the pillared clay and was subsequently reduced after the impregnation with NiO. The same trend was observed in pore volume, while the pore diameter was in the range of 2.101 to 2.144 nm. The GC-MS showed that the Al-PILC and NiO/Al-PILC had a better hydrocarbon yield than the blank reaction, indicating the importance of a catalyst in the deoxygenation of triglycerides. NiO/Al-PILC displayed a hydrocarbon yield of 51%, with alkenes being the most predominant group. The catalyst also gave gasoline and diesel-range hydrocarbons at 45.2% and 47.5%, respectively.

The pillared clay and metal oxide-doped pillared clay were successfully prepared and characterized. Due to its deoxygenation activity, NiO/Al-PILC produced up to 51% hydrocarbons. The nearly equal percentages of biogasoline and green diesel in the product are an indication of the occurrence of both the cracking and deoxygenation of long fatty acids.

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