UNIVERSITI TEKNOLOGI MARA

SUGARCANE BAGASSE ASH SUPPORTED CALCIUM OXIDE AS THE HETEROGENEOUS BASIC CATALYST FOR BIODIESEL PRODUCTION

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Calcium oxide (CaO) is a high potential heterogeneous catalyst for biodiesel production. However, it is often reported with leaching problem requiring the usage of catalyst support which can further increase the catalyst production cost. Hence, in this study, the feasibility of the waste derived support which is the sugarcane bagasse ash (SCBA) impregnated with CaO as a heterogeneous basic catalyst in biodiesel production was explored. The SCBA was successfully prepared via calcination process for 2 hours under various temperatures at 500 °C, 600 °C, 700 °C and 800 °C, and were impregnated with varied CaO loading ranging from 10 wt.% to 40 wt.%. The prepared CaO/SCBA catalysts were furthered qualitatively and quantitatively characterized using Fourier Transform-Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM), X-Ray Diffraction (XRD), Temperature Programmed Desorption of Carbon Dioxide (TPD-CO_2), Thermal Gravimetric Analysis (TGA), X-Ray Fluorescence (XRF) and Brunuaeur-Emmett-Teller (BET) surface techniques. The BET and TPD-CO_2 characterizations revealed that varied calcination temperature and CaO loading have significant impacts on the surface area and basicity of the catalyst. It was found that the increment of calcination temperature and CaO loading had decrease the surface area of the catalyst. Besides that, among the catalysts prepared, $CaO_{(40\%)}SCBA_{600°C}$ catalyst possessed the highest basic densities (3889.75 μmol g^{-1}) which further contributed to the highest biodiesel yield in the preliminary transesterification test. The $CaO_{(40\%)}SCBA_{600°C}$ catalyst was then further implemented into the optimization reaction condition steps which include various parameters (methanol-to-oil molar ratio, catalyst loading, reaction time and reaction temperature). It was found that, the catalyst has a high catalytic activity by producing 93.8% FAME yield at methanol-to-oil molar ratio of 20:1, reaction temperature of 65 °C, 6 wt.% of catalyst in 3 hours of reaction time. Furthermore, the reusability analysis found that the catalyst can be re-used up to 5 reaction cycles with biodiesel yield of from 93% at first cycle and drop to 70.3% on the fifth cycle. This may be contributed by the interaction between the impregnated CaO and silica in the SCBA forming $CaSiO_4$ as recorded by the previous XRD and FTIR analysis. This proved the significant role of the natural SiO_2 in the SCBA which helps to enhance the catalytic performance and also reduced the catalyst's deactivation problem by minimizing the leaching of active sites, CaO.

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