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PRODUCTION OF BIODIESEL FROM WASTE VEGETABLE OIL (WVO) USING NANO CAO-NCC CATALYST: MODELLING AND OPTIMIZATION USING CENTRAL COMPOSITE DESIGN (CCD) IN RESPONSE SURFACE METHODOLOGY (RSM)

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Abstract – Biodiesel production as a fuel in diesel engines has expanded dramatically in recent years and is likely to increase more in the near future. Increasing biodiesel consumption requires optimized production techniques that allow for significant production capacities, simplified operations, high yields, and the usage of more cost-effective feedstocks such as waste oils and fats. In this study, biodiesel was produced from waste vegetable oil (WVO) and Methanol (CH_3OH) in the presence of a nanoCaONCC catalyst that was derived from industrial waste that mainly consists of Calcium Carbonate ($CaCO_3$). The produced nanoparticle catalyst was characterized by using FTIR, SEM, and XRD. Response surface methodology (RSM) was used to determine the optimum operating conditions for the highest biodiesel yield. After applying the RSM methods using the CCD experimental design, the optimum biodiesel production was found to be at a temperature of 55 °C, catalyst loading of 1.25 % w/v, Methanol to oil ratio of 1:5 w/w, and reaction time of 75 min with an average yield of 94.01 %. The FTIR showed the presence of the CaO and NCC functional groups. SEM image revealed that the produced catalyst is more porous, with a small particle size. The XRD pattern presented the presence of cellulose (NCC) and Calcium Oxide (CaO) nanoparticles in the synthesized catalyst. The R^2 of 0.963 was found to be for the mathematical models to predict biodiesel production

Keywords – Biodiesel; composites; nano-catalyst; nanocrystalline cellulose; nanoparticles