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ABSTRACT

The production of biofuels has witnessed a renewed interest in light of finding alternatives to fossil fuels. One such important biofuel is biodiesel. Biodiesel made from waste vegetable oil (WVO) is particularly favorable due to the availability of waste as fuel source as opposed to oil derived from food plants. Biodiesel production can therefore loom as a large economic opportunity for South Africa, whose fuel is largely imported from crude-oil rich regions in the world. Despite the environmental benefit compared to the fossil fuel, bio-fuels production at industrial level is not currently financially attractive in comparison to the conventional diesel fuel prices. The market price of the produced biofuel depends on its feedstocks, which fluctuate significantly and affect the production cost.

The purpose and aim of this research project is to combine and investigate the optimum conditions and the elementary reaction kinetics for the production of biodiesel from waste vegetable oil using a calcium silicate catalyst. The optimum conditions of interest are the methanol to oil ratio and the catalyst concentration.

There are various methods available for the production of biodiesel. For this project, transesterification was discovered to be the most suitable, and was then used throughout during the experiment. Prior to the production of biodiesel the catalyst was prepared from a reaction containing calcium hydroxide and silica gel as the reactants. The catalyst was characterized using FTIR, BET, XRD and SEM determinations. The waste vegetable oil was also characterized in order to determine its free fatty acid (FFA) content, its density and its moisture content; which are all essential to the quality of biodiesel that could be produced. The biodiesel produced was confirmed using GCMS and its quality in terms of concentration was derived from its absorbance using an absorbance vs. concentration calibration curve.

The results show that the optimum methanol to oil ratio at a constant temperature of 60 ℃, with a reaction time of 180 minutes is 3:1. The optimum catalyst concentration at the same reaction temperature and time was found to be 5%. The transesterification reaction in this project correlated to an irreversible first order kinetic model. The reaction kinetics depicted this catalyst as ineffective for transesterification since low reaction rates were observed.