Abstract

The development of polymer-based products in various industries has decreased as a result of depleting fossil fuels and increasing environmental concerns such of greenhouse gases, global warming and population. However, vegetable oils have emerged as a worthy replacement for fossil fuels. The need to use non-edible oils is recommended for industrial processes to reduce the dependency on edible oils and hence increasing food security. The main objective of this investigation is to use an affordable process to develop bio-binders for composite materials by using non-edible oil produced from castor seed.

The extraction of oil from the castor seeds was done using the Soxhlet extraction set-up. After purification, the processed to yield castor oil-based bio-binders was done through Polycondensation, Epoxidation and Ozonolysis methods. Polycondensation is a three step process. The first step is the synthesis of the N, N-Bis (2-hydroxyethyl) Castor Oil Fatty Amide (HECA), followed by the synthesis of the Castor Oil Polyesteramide (CPEA) and lastly, the synthesis of Castor Oil Polyurethane - esteramide (UCPEA). The polycondensation process was monitored by Thin Layer Chromatography (TLC) until the production of the polyurethane, and temperatures range was 120 – 250 °C at various stages of the process. The polyurethane peak was observed at 1618 cm^{-1} and 1459 cm^{-1} using Fourier-transform infrared spectroscopy (FTIR).

Ozonolysis was a two-step process whereby firstly it was the synthesis of the polyols by converting the vinyl group to an ozo-group by using ozone at very low temperatures (-30 to -40 °C). This was followed by the second step which is the synthesis of the polyurethanes from the polyols (70 – 110 °C). The ozo (c-o) peak was observed using FTIR at 1269 and 875 cm^{-1}.

The Epoxidation catalyst was synthesized from of tungstic acid and hydrogen peroxide between 50 - 60 °C. The Epoxidation process temperature varied between 60 and 100 °C while

varying the catalyst loading and the reaction time. The epoxy peak was also observed using FTIR at 830 cm^{-1}.

Additional characterizations that were done for the three processes include thermal stability using and rheology properties. The effect of castor oil content on the epoxidation and ozonolysis process showed that 5 % oil excess is sufficient to prepare a castor oil based binder.

From the results obtained, ozonolysis was a better process as compared to polycondensation and epoxidation. Based on the yield processed and it is also recommended from those investigation of ozonolysis as this process uses the least amount of temperature, reagents and processing steps making the process more energy. However, it is recommended that more investigations be done in order to confirm the findings.