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Development of castor oil-based paints with anti-radiation and antimicrobial properties

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2021

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Abstract

Agricultural commodities are increasingly being utilized in the chemical industry as alternative raw materials to petrochemicals. In the polymer industry, vegetable oils are used to produce oleo-based polymers which find application in the paint and coatings industry as chief ingredients. Among the vegetable oils, castor oil has gained much interest because it is non-edible and constitute of ~90% ricinoleic acid which offers flexible modifications.

In this research, castor oil was used to synthesize a drying oil, polyurethanes and epoxy resins, and to achieve this objective, castor oil had to undergo certain chemical modifications, which include: epoxidation, ring opening, dehydration and polymerization. The synthesized paints were then blended with Ag and TiO_2 NPs to impart anti-radiation and antimicrobial properties. The synthesized paints were characterized by FTIR and ^{1}HNMR to confirm the occurrence of the reactions and also to evaluate the reaction conversion. Rheology studies were done to determine the usability of the synthesized materials as coatings. A study was performed on the drying time of the drying oil, polyurethanes and epoxy resins paint formulations under atmospheric conditions. Further tests were done to test for the anti-radiation and antimicrobial properties. A 100% conversion was obtained for epoxidation reaction for the following reaction conditions: 35 ℃ temperature, 4wt% catalyst amount , 1:2 (castor oil: H_2O_2) ratio and 32 hrs reaction time. For the ring opening reaction a conversion of ~ 70% was obtained when the reaction was done with H_2O as the nucleophile and $HClO_4$ as catalyst. The temperature was 100℃ with a mass ratio of 1:18:0.2 (ECO:H_2O: $HClO_4$) for 48 hrs. A conversion of 43% for DCO and 53% for RCO was attained at the following reaction conditions: 240 ℃, 0.1 g NaHSO_4 and 120 min reaction time. The synthesized CO-based polyurethanes had a 6 hrs drying time when a 2k catalyst was added, while the drying time for epoxy resins was 6 days. The lowest drying time for the drying oil

was 2 days. It was found that *Streptococcus sp* growth inhibition can be obtained at a low concentration of Ag/AgTiO_2 NPs within the paints. For the anti-radiation properties, it was found that paint sample with NPs TiO_2++ showed no changes at all after UV irradiation for 90 minutes. With the chemical modifications and incorporation of the right additives, paints were obtained that can be used practically.