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Biodiesel production from non-edible crops using waste tyre heterogeneous acid catalyst

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ABSTRACT

The present study aims at the ways and means of decreasing environmental pollution using spent tyre waste as an acid-based catalyst intended for the synthesis of biodiesel from Pongamia pinnata, a year-round crop that costs roughly 1300 $/tonne, whereas coal costs around 50 $/tonne. Heterogeneous catalysts were developed as a successful replacement for homogeneous catalysts because they have unique benefits over homogeneous catalysts, especially the ability to separate and reuse the solid catalyst used. The characteristics of the produced waste tyre acid-catalyst were studied using instrumental analysis such as EDX, scanning electron microscope and Fourier-transform infrared spectroscopy. Operating parameters studied for the catalyst were methanol-to-oil molar ratio (12:1 to 24:1), catalyst loading (1–5 weight %), reaction temperature (30–70°C), and reaction duration (1–4 h) were tuned upon the steady stirring rate of 400 rpm. At optimal conditions, the spent tyre waste activated by pyrolysis gives maximum conversion of biodiesel (82.1%). The pseudo-first-order model with a rate constant of 0.0269 min^{-1} (at 60°C) and activation energy of 21.53 kJ/mol was found to be the best match for demonstrating the methanolysis kinetics of Pongamia pinnata oil. When compared to other solid base catalysts reported in the literature, the catalytic activity of the waste tyre acid-catalyst provided a high yield of biodiesel under relatively mild reaction conditions.

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Introduction

The global demand for crude oil is around 1.6×10^7 m^3/day. This dwindling crude oil resource will put a damper on our way of life while the automobile sector will suffer a severe setback, and many other industries that rely on fossil fuels for energy will meet a great loss. Biodiesel is a sustainable energy reserve utilized to supplant traditional fossil-based fuel, thus lowering greenhouse gas emissions and considering other environmental issues. Aside from the advantages of utilizing biodiesel as a fuel, having renewable and sustainable sources is a strong factor for ensuring sustainable production. Edible oils, non-edible oils, and microalgae are the three most frequent biodiesel feedstocks, representing the first, second, and third generations (Chong et al. 2021).

Second-generation biofuels notably Cotton, Pongamia, Jatropha, Neem, Macassar, and others are used to extract oils (Fadhil, Al-Tikrity, and Albadree 2017). Numerous popular analysts have pushed for the utilization of Karanja oil in fitting diesel mix as a substitute for the ordinary petrol diesel used

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