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ORIGINAL RESEARCH

Sustainable Energy

Pongamia pinnata biodiesel production using cobalt doped ZnO nanoparticles—An analytical study

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Abstract

Karanja is second most popular non-edible oil, in Indian sub-continent, for Biodiesel production; with current plantation, almost 55,000 ton/year of oil can be extracted. Also, studies in past two decades have elucidated that use of heterogeneous solid catalyst has been commercially most viable, economical, produces almost pure biodiesel, easy to use, recycle and environment friendly. In this paper, we have used cobalt doped zinc oxide (CZO) nanoparticles for dual step esterification—transesterification processes, which has not been studied for Karanja oil, additionally, the detailed analytical study such as X-ray diffraction, field emission scanning electron microscope, Brunauer–Emmett–Teller and energy-dispersive analysis of X-rays on catalyst unavailable in literature, has also been incorporated here. The CZO particles are synthesized using co-precipitation method and yields particles of size ~75 nm, the reusability of catalyst is also included. The optimum process parameters where experimentally determined and compositional analysis of oil and biodiesel is done using Fourier transformed infrared. The economic and technical aspects of CZO synthesis, the benefits of easy separation of glycerol and reduced impurities in final product, make this process commercially more suitable for Karanja oil biodiesel synthesis, and study will promote use of CZO nanoparticles for other oil biodiesel production too. Result shows that under optimized condition of transesterification, 1:25 M ratio of oil: methanol, 0.3 wt% catalytic concentration, 70°C reaction temperature, 180 min time of reaction and 500 rpm of stirring speed fatty acid methyl ester (biodiesel) conversion was 98.5 ± 0.5%.

KEYWORDS

biodiesel, heterogeneous catalyst, Karanja oil, nanoparticles, optimization, transesterification process

STATEMENT OF INDUSTRIAL RELEVANCE

The findings that belong to this paper is broadly in the domain of novel production of clean fuel such as biodiesel made from Karanja oil, popularly grown in Indian sub-continent; the cultivation of Karanja tree does not require very fertile land and hence this can be grown on barren lands and less fertile grounds. In this paper, we have focused on manufacturing of Karanja oil using modified heterogeneous dual acid–base catalyst esterification—transesterification process while equipping a modified and environment and energy efficient set-up, to enhance the currently available processes, waste minimization, maximum catalyst recyclability and negligible incorporation of water and pollution generation. The process mentioned herewith, is easily scalable and open doors for commercial production without creating much hindrance to ecosystem.

