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Sustaining biodiesel synthesis via coal fly ash based zeolite catalysts

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The application of heterogeneous catalysts in biodiesel production alleviates problems associated with homogeneous catalysis. Heterogeneous catalysts can be recycled and re-used several times and being solids, they give a better separation of the final product. This reduces material and reducing processing costs. The use of heterogeneous catalyst is environmentally benign and can be applied in either batch or continuous mode without the need for further purification steps. According to Yan et al. (2010), heterogeneous catalysis in biodiesel production, unlike homogeneous catalysis, removes costly and time-consuming water washing and neutralization steps required to separate and recover the spent catalyst. Contaminated effluent after the heterogeneous catalysis process is also greatly reduced and the need for waste water treatment minimized. This route has also influenced purity of methyl esters produced and boosted an increase in FAME yields. In addition, the heterogeneous process produces glycerol as by-product with a purity of greater than 98 % compared to about 80 % from homogeneous processes. It also has the ability to reduce the water content in the reaction medium to values lower than the specified limit. Heterogeneous catalysts can easily be tuned to include desired catalyst properties so that the presence of FFAs or water does not adversely affect the reaction steps during transesterification. Other advantages of the heterogeneous catalysts include their prolonged lifetime for fatty acid methyl ester (FAME) production and the fact that they are relatively cheap in comparison to homogeneous catalysts. It has been shown that the mechanism of heterogeneous catalysis follows homogeneous mechanism of catalysis of either acid or base systems. Evidently, solid catalysts derived from waste resources are effective for transesterification reactions since they are recyclable, eco-friendly and are highly suited for the production of biodiesel from different types of oils. South Africa's coal is high in ash content and as such, the use and development of environmentally safe utilization of the waste coal fly ash is considered an environmentally important issue. The disposal and management of the huge quantities of fly ash generated by thermal and power stations in the country has been a growing concern. Coal fly ash is a widely available feedstock with a rich content of silica (SiO₂) and alumina (Al₂O₃); compounds fundamental to the formation of zeolites. The zeolitic forming property is one of the attractive alternatives to reduce the cost of fly ash disposal as well as to minimise environmental impacts of waste disposal. Different types of zeolites can be obtained using fly ash as feed stock to synthesize zeolites, depending on the composition of the synthesis mixture. A nearly pure phase of hydroxy-sodalite was produced and these zeolites hold potential for widespread industrial application. Fly ash-based catalysis in the conversion of vegetable oils to fatty acid methyl ester (FAME) has been previously reported. Zeolites have also been used in biodiesel catalysis due to their unique properties. This presentation paper reports the catalytic application of various synthesised coal ash based zeolites via a novel routes for zeolite synthesis, and thereafter for biodiesel production. The application of renewable sunflower oil as feedstock and heterogeneous catalysts made from waste for biodiesel production allows the development of cost-effective processes that are environmentally friendly and eco-sustainable.

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