Experimental Investigation on Catalytic Transesterification of Natural Feedstocks towards Biodiesel Production

A Thesis

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ABSTRACT

The dwindling reserves and increasing consumption trends of conventional fuels pose a serious threat to the goal of energy security as well as a clean and healthy environment. This situation has urged researchers all over the world to search for alternative energy resources, which can be cost effective apart from being abundant in nature and are more environmentally friendly when compared to conventional fuels. Biodiesel has emerged to be more sustainable than conventional diesel as it is produced from vegetable oils and animal fats. The process of biodiesel production using transesterification represents one of the most promising ways when compared to pyrolysis and microemulsion approaches. However, a major concern associated with this is the high production costs which limit its appreciability on a commercial scale. It was investigated that production costs can be reduced by using waste oils as feedstock and catalysts derived from waste materials. Heterogeneous catalysts have emerged as one of the more potent alternatives to their homogeneous counterparts, as they have the potential to successfully overcome these shortcomings. Thus in recent years many potential heterogeneous catalysts have been developed and tested in the biodiesel industry. Catalysts used herewith could facilitate in achieving optimal performance, as they can be developed to be more selective towards desired products which could be easily handled and can be quickly separated for reuse.

In the present study, waste chicken eggshells have been utilized to derive CaO by wet-impregnation method which was then incorporated with transition metals. The catalysts prepared have been characterized by XRD, FTIR, TGA, SEM and BET techniques. The conversion of tri, di and mono glycerides to fatty acid methyl esters has been confirmed by TLC and GC. The catalytic property of these mixed metal oxides (M-Cao, M-Zn, Cu) has been studied in transesterification of non-edible oil (eucalyptus oil and *Hevea brasiliensis* oil) and waste edible oil (soybean oil and palm oil). Zn-CaO was found to be the most efficient catalyst, giving highest yield of biodiesel (FAME) among all the three catalysts for the different oils reported. For each raw material, the corresponding biodiesel synthesis was optimized by multivariate analysis in a design of experiments (DOE) approach. At the end, excellent yields were achieved, specifically 93.2% for eucalyptus, 93.27% for waste frying oil, and more than 94% for HBO and palm waste oils. In all cases, catalyst

loading between 4% and 5% were enough to guarantee a near-total conversion of the raw material in less than 2.5 h at a temperature between 55°C and 65°C. Finally, the quality of the produced biodiesel was assessed and resulted suitable for EN, ASTM and IS standards.