Development and characterisation of novel heterogeneous palm oil mill boiler ash-based catalysts for biodiesel production

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1. Introduction

Increasing worldwide energy demands in addition to depleting fossil fuel reserves have necessitated the search for alternative renewable fuels (Basha et al., 2009; Demirbas, 2007). Amongst the promising alternatives fuels is biodiesel, a suitable replacement for petroleum diesel because of its relatively lower cost, compatibility with existing diesel infrastructure and availability of production technology (Ng et al., 2010a, 2010b). Moreover, biodiesel has been demonstrated to have potential to reduce pollutant emissions in both engines and oil burners (Ng and Gan, 2010; Ng et al., 2011, 2012).

Biodiesel is produced through transesterification in which triacylglycerides of an oil or fat are converted into lower molecular weight fatty acid monoalkyl esters using methanol in the presence of a basic or acidic catalyst (Boro et al., 2012). The main hurdle in the commercialisation of biodiesel is the cost of raw feedstocks. One way to reduce the cost of biodiesel production is to employ cheaper feedstocks such as waste cooking oils (Enweremadu and Mbarawa, 2009; Lam et al., 2010; Math et al., 2010) or crude palm oil (CPO) instead of neat or refined vegetable oils (Lou et al., 2008). However, such a process is challenging due to the presence of considerable undesirable components especially free fatty acids (FFAs) and water (Aijaz and Flora, 2010; Gan et al., 2010). The use of homogenous base catalysts for the transesterification of such feedstocks suffers from saponification whereby the catalyst reacts with FFAs to form large amounts of unwanted soap as by-product which inhibits the separation of biodiesel, glycerin and wash water (Helwani et al., 2009). This ultimately reduces the yield of biodiesel substantially (Lou et al., 2008). On the other hand, homogenous acid catalysts are not sensitive to FFAs but they are difficult to recycle and result in slower reaction rates as well as environmental and corrosion problems. Both these homogeneous catalysts are not reused hence they must be neutralised and discarded as aqueous salt waste streams (Helwani et al., 2009). Due to the problems associated with the use of homogenous catalysts, there has been an