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Pre-Treatment of Crude Palm Oil Using Super Acid for Biodiesel Production

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Abstract

Malaysia, as one of the biggest palm oil producers and exporters in the world, produces large amount of crude palm oil (CPO) from its mills. Due to the high free fatty acids content (FFA) in CPO, the alkali catalyzed transesterification to produce biodiesel gives low biodiesel yield because FFA reacts with alkali to produce soap. To resolve this problem, esterification reaction was used to convert FFA to fatty acid methyl ester (FAME). In this study, trifluoromethanesulfonic acid (TfOH) was used in the pre-treatment of CPO by esterification process. The purpose of pre-treatment process was to reduce the FFA content in CPO to a minimum level for biodiesel production. Esterification process of CPO was carried out to evaluate TfOH as a super acid catalyst. The optimum conditions showed that the FFA of CPO was reduced from 8.3% to less than 0.5% FFA and the yield of treated CPO and conversion of FFA to FAME were 95% and 97% respectively.

Keywords: *Biodiesel; Esterification; Free fatty acids; Trifluoromethanesulfonic acid*

1. Introduction

Biodiesel has many merits as an alternative, renewable, non-toxic, biodegradable and environment friendly fuel [1, 2]. It is receiving an increased attention because of the increase in crude oil prices, limited resources of fossil oil and the environmental concerns [3]. In Malaysia, there has been an interest in the utilization of palm oil as raw material for biodiesel production [4]. The high value of palm oil as a food product makes production of biodiesel very expensive. Exploring new methods to produce biodiesel from low cost raw materials is a major interest [5]. Many studies have proposed waste and non edible oils for biodiesel production e.g. palm oil fatty distillate [6], tobacco (*nicotiana tabacum L.*) seed oil [7], mahua (*madhuca indica*) [8]. Low grade oils such as waste cooking oil and sludge palm oil (SPO) have been proposed [5,9].

However, there are other types of low-grade oils in large amounts such as crude palm oil (CPO) from palm oil mills that could be converted into biodiesel. CPO is a by-product of the palm oil milling process and considered as low-grade oil with high free fatty acid (FFA) [5]. However, low grade CPO usually contains high FFA and too far beyond the level that could be converted into biodiesel by transesterification reaction. Pre-treatment by esterification process has been proposed in order to reduce the level of FFA in oils and fats [1,5,6].Thus, an acid catalyzed pre-treatment step by esterification reaction to convert the FFA to fatty acid methyl ester (FAME) followed by transesterification reaction using alkali–catalyzed offers an effective and efficient method to convert high FFA feedstock to biodiesel [1]. The most commonly preferred acid catalysts are sulfuric acid, hydrochloric acid, and organic sulfonic acid such as *p*-toluene sulfonic acid (PTSA) [3,5,10]. Investigating the catalytic activity and the effect of other types of acids is important in the development of pre-treatment and biodiesel production. Hence, in this study, trifluoromethanesulfonic acid (TfOH) was examined and used in the pre-treatment of CPO by esterification process. TfOH, also known as triflic acid, is a sulfonic acid with the chemical formula CF_3SO_3H. Its acid dissociation constant (pKa) is -15 mol/kg which qualifies TfOH as one of the strongest acids. TfOH is mainly used in research as a catalyst for esterification [11]. The objectives of this study were to investigate the potential of CPO as a low-cost feedstock in biodiesel production and the influence of operating conditions when using TfOH acid as a catalyst.

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