



Esterification of Free Fatty Acid in Crude Palm Oil Off Grade

Muhammad Dani Supardan^{1*}, Satriana²

¹Department of Chemical Engineering, Engineering Faculty, University of Syiah Kuala
Jl. Syech Abdussauif No. 7, Darussalam, Banda Aceh, 23111

²Department of Agriculture Product Technology, University of Syiah Kuala
Jl. Tgk. Hasan Krueng Kalie 7, Darussalam, Banda Aceh 23111

*E-mail: m.dani.supardan@unsyiah.ac.id

Abstract

The esterification of free fatty acids (FFA) found in crude palm oil (CPO) off grade with methanol is a promising technique to convert FFA into valuable fatty acid methyl ester (FAME, biodiesel) and obtain a FFA-free oil that can be further transesterified using alkali bases. In this work, the effects of the main variables involved in the esterification process i.e. alcohol to oil molar ratio, reaction temperature, agitation speed and the initial amount of FFA of oil, were studied in the presence of sulphuric acid as catalyst at concentration of 1%-w. The experimental results show that the esterification process could lead to a practical and cost effective FFA removal unit in front of typical oil transesterification for biodiesel production.

Keywords: CPO off grade, esterification, free fatty acid

1. Introduction

Development of an alternative energy resource to replace traditional fossil fuels has recently become more and more attractive due to the high energy demand, the limited resource of fossil fuel and environmental concerns. Biodiesel fuel derived from vegetable oils or animal fats is one of the promising possible sources to be substituted for conventional diesel fuel and produces favourable effects on the environment. It can be used directly or mixed with conventional fuel for diesel engines or as a heating fuel. However, in spite of the favourable impact, the economic aspect of biodiesel production is still a barrier for its development, mainly due to the lower price of fossil fuel. The costs of biodiesel production are highly dependent on the costs of feedstock which affect the cost of the finished product up to 60-75% (Cetinkaya and Karaozmanoğlu, 2004). Currently, partially or fully refined and edible-grade vegetable oils, such as soybean, rapeseed and palm are the predominant feedstock for biodiesel production (Haas, 2005), which obviously results in the high price of biodiesel. Therefore, exploring ways to reduce the cost of raw material is of much interest in recent biodiesel research.

Currently, Indonesia is the world's largest producer of palm oil where palm plantation covered about 5.3 million hectares of the country. It is expected that in the near future, Indonesia has the largest palm plantation in the world. Most of palm fruit produced is further processed to produce crude palm oil (CPO) as raw material of palm oil industry. However, in some provinces such as NAD, Banten and Lampung, there was a large number of unprocessing palm fruit due to limitation the number of palm oil industry. Therefore, the excess of unprocessing palm fruit can be converted to CPO off grade by simple processing as feedstock for biodiesel production by the farmers to increase its economic value. CPO off grade is one of potential low-cost feedstock for biodiesel production which contained 5-20% of free fatty acids (FFA).

According to several researchers (Freedman *et al.*, 1984; Liu, 1994), the oil or fat used in alkaline transesterification reactions (as typically catalyzed in industrial-scale for biodiesel production) should contain no more than 1% FFA, which is equivalent to 2 mg KOH/g triglycerides. If the FFA level exceeds this threshold, saponification hinders separation of the ester from glycerine and reduces the yield and formation rate of FAME. The acid-catalyzed of high FFA feedstock is an

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