CHAPTER 1

INTRODUCTION

1.1 Background of Study

Most of the global primary energy production derives from fossil energy. Fossil-fuel resources are decreasing daily and due to environmental concern, biodiesel comes as a renewable energy to overcome this issue. Biodiesel as a biofuel is getting attention around the world as the suitable solution due to shortage of petroleum resources and earth pollution. Several biofuel were proposed to displace fossil fuels in order to eliminate the vulnerability of the energy sector (Singh et al., 2011). Biodiesel fuel is a mixture of mono-alkyl esters of long chain fatty acids (FAMEs) derived from plants oil or animal fats (Abdullah et al., 2009). Biodiesel has received high attention since the fossil-fuel resources are depleting due to development of various kinds of petrochemical industries. Biodiesel was used as an alternative fuel to compete with rising price of crude oil. Biodiesel or fatty acid methyl ester (FAME) is a renewable, biodegradable and alternative fuel for diesel engines obtained from transesterification of vegetable oils or animal fats with alcohols. As a renewable energy from plant, biodiesel can contribute to a reduction of greenhouse-gas emissions if it sustainable managed.

Direct blending, micro-emulsification, pyrolysis and transesterification have been used to produce biodiesel from vegetable oils. The most favoured process for biodiesel production is transesterification which involves alcohol and oil in the presence of catalyst to produce FAME and glycerol. Many research has been done to produce biodiesel from various vegetable oils such as palm oil, corn oil, peanut oil, soybean oil, sunflower oil and, etc. However, this edible type oil has been plunged by controversy because it competes with food demands. Besides, all these crops also require land for the production of biodiesel. Comparing to other source such as inedible oils, waste cooking oil (WCO) is the most attractive option to overcome this issue. Utilisation of lower cost vegetable oil such as waste cooking oil (WCO) may be able to reduce the
overall cost of biodiesel production (Noshadi et al., 2012). Furthermore, utilization of waste cooking oil circumvents the oil vs. food issue, which has become a hotly debated issue during past few years. The consumption of cooking oil is increasing and its consistent supply makes waste cooking oils as commercial viable feedstock. Approximately, there are about 3 billion litres of cooking oil consumed in Malaysia annually, for which about 30% of WCO available for biodiesel production translating to about 10% of diesel demand in Malaysia (Kumaran et al., 2011). This project attempt is to utilize waste cooking oil as viable feedstock for biodiesel production.

Catalysts play a significant role in improving production of biodiesel fuel. The choice of catalyst is mostly controlled by the nature of raw material to be used. The performance of acid and alkaline catalysts is usually affected by free fatty acids (FFAs) and water contents of the raw materials. In the case of heterogeneous (solid and enzymes) catalysts, the effects of water and FFAs contents are less noticed during transesterification process (Atadashi et al., 2012). The type of catalysts, oil to methanol ratio, reaction temperature and impurity contents in crude oil give effects to biodiesel synthesis in laboratory scale. Among that, the selection of catalyst is main important for designing a transesterification system (Lee et al., 2009). Catalyst has significant effect on improving the biodiesel production. At this time, industrial production of biodiesel employs homogeneous catalysts such as sodium hydroxide (NaOH) or potassium hydroxide (KOH) which cannot be recovered and tolerate to soap formation if the FFA value in oil greater than 1 wt.% which lead to lower production yield (Wan Omar & Saidina Amin, 2011; Azcan & Yilmaz, 2012).

Transesterification of WCO to biodiesel present a greater challenges due to its high FFA value and water content which may cause soap formation instead of biodiesel thus an efficient catalyst is needed to solve this problem. Heterogeneous catalysts have advantages of being reusable, noncorrosive, show greater tolerance to water and FFAs in feedstock, improve biodiesel yield and purity, have a simpler purification process for glycerol and are easy to separate from the biodiesel product (Ilgen & Akin, 2009; Jairam et al., 2012; Xie et al., 2006). Therefore, this work aims to prepare a heterogeneous catalyst from cement clinker that is easy to recover apart from providing an efficient conversion of vegetable oil to biodiesel.
As mentioned earlier, several factors give effect to biodiesel production such as the choice of alcohol, alcohol to oil ratio, catalysts type and its loading etc. The reaction temperature is a crucial factor as the reaction can reach its optimum condition to generate high yield. There are many research on development of catalyst for biodiesel production such as from alumina based (Ilgen & Akin, 2009), waste oyster shell (Jairam et al., 2012) and calcined Mg-Al hydrotalcites (Xie et al., 2006). However, the implement of heterogeneous catalyst in industry are still deliberate due the costs of catalyst synthesis and the possible way to reduce the costs of catalyst is to utilize agriculture waste as catalytic materials (Jairam et al., 2012). Apart from that, heterogeneous catalyst offer several advantages as easy to separate by-products, catalyst reusability and low energy as low water consumption (Atadashi et al., 2012; Kaur & Ali, 2011). Moreover, the catalyst selection of heterogeneous catalytic process is most crucial as appropriate catalyst preparation will affect transesterification efficiently.

1.2 Objectives
a) To develop and characterize the catalyst derived from cement clinker.

b) To study effect of various conditions i.e. different activated catalyst using KOH, temperature, WCO to methanol ratio, catalyst loading, reaction time and recyclability on biodiesel production by using the cement clinker-based catalyst.

1.3 Scope of this research
a) To study the surface morphology, pore size and surface area, basic strength, and chemical composition of the cement clinker-based catalyst.

b) To study effect of different activation (calcination at 500 and 700 °C for 2, 5 and 7 hours), temperature at 45 to 70 °C, WCO to methanol ratio from 2:1 to 6:1, catalyst loading from 2 to 6 wt.%, reaction time from 30 min to 5 hours and recyclability up to 3 times in batch mode.

c) To study the recyclability of catalysts on producing biodiesel.

d) To achieve high quality biodiesel that comply with ASTM D 6751 Standards.

1.4 Main contribution of this work

This research aims to develop low cost and effective catalyst and to convert waste cooking oils to biodiesel. The idea on developing catalyst from cement clinker