CHAPTER I

INTRODUCTION

Currently, supply of fossil fuels is limited while energy demands and environmental problem continuous rising. Transportation and agricultural sector is one of the major consumers of fossil fuel and using of various fossil fuels such as petroleum product and coal lead to several environmental problems such as increasing of CO_2 level in atmosphere which lead to greenhouse effect, acid rain etc (Hill *et al.*, 2007). Nowadays, a number of alternative fuels for transportation such as alcohol, vegetable oil, biodiesel are potentially available in the country and presently studied at different stages.

Biodiesel, a one choice, is an alternative fuel which made from renewable sources. It is nontoxic and biodegradable fuel comprised of mono-alkyl esters of long chain fatty acids, which derive from vegetable oils or animal fats. Biodiesel can be used in compression-ignition (diesel) engines with little or no modification. Furthermore, it also shows a decrease in the emissions of CO, SO_x, unburned hydrocarbons, and particulate matter during the combustion process (Agarwal *et al.*, 2006; Ban-Weiss *et al.*, 2007). There are many processes for biodiesel production such as Micro-emulsion (Wellert *et al.*, 2008), Pyrolysis (Demirbas *et al.*, 2003), and transesterification. In case of transesterification, biodiesel is consisted of a triglyceride, come from vegetable oils or animal oils, with an alcohol to form glycerol and ester. The esters or alkyl esters are known as name of biodiesel. The most important variables affect the yield of biodiesel such as reaction temperature, molar ratio, reaction time, moisture and FFA, and type of alcohol which affect to the properties of biodiesel (Dorado *et al.*, 2004; Ebiura *et al.*, 2005).

Biodiesel is usually prepared by transesterification, which can be catalyzed by both acid and base catalysts. The acid catalysts that are generally used include sulfuric acid and hydrochloric acid (Lotero *et al.*, 2005). Base catalyst includes NaOH, KOH, and their carbonated or sodium or potassium alkoxides such as $NaOCH_3$ (Meneghetti *et al.*, 2006). However, the catalytic activity of a base is higher than that of an acid. In the case of homogeneous catalysis, side reactions would occur. The presence of water in oil leads to hydrolysis and results in soap formation which reduce yield of biodiesel, and difficult to separate the homogeneous catalyst from the reaction solution (Xie *et al.*, 2005). Therefore, the heterogeneous catalyst would have many advantages, easy catalyst separation from the reaction mixture, reduction of environmental pollution, and easy to work up procedures.

Generally, biodiesel is produced by a batch-type process, which usually used in small scale due to high labor cost. Then, the continuous processes using a catalyst and a packed-bed reactor can increase production efficiency and quality of biodiesel fuel. The catalyst, such as anion resin (Shibasaki-Kitakawa *et al.,* 2007) or $Ca(C_3H_7O_3)_2/CaCO_3$(Hsieh *et al.,* 2010), was employed in a continuous flow packed-bed system, in which the products and the catalyst could be separated easily.

Therefore, in this thesis work, the interpretations of the performance of a heterogeneous catalyst for the transesterification process are discussed. In the first part of study, the comparative study of KOH loaded on the Al_2O_3 and NaY was discussed to evaluate the most efficiency condition for biodiesel production in a batch reactor with several parameters such as amount of potassium loading, methanol-to-oil molar ratio, reaction time, and amount of catalyst. Moreover, reusability was investigated by XRF to determine the amount of active species on the prepared and spent catalysts. In the second part of study, a number of techniques were used to provide some insight into the interpretation of the performance of K loaded on NaY zeolite for the transesterification process in a packed-bed reactor. In the third part of study, the catalytic performances of KOH/mordenite in transesterification under mild condition were determined in order to evaluate the performance of this catalyst in both the batch and packed-bed reactor. The influence of basic properties and the physical structure on the catalytic activity was also evaluated. Additionally, the deactivation and the regeneration of catalysts were also investigated. In the last part of study, KOH/bentonite was assessed in a continuous reactor to determine the appropriate condition for biodiesel production with several parameters such as catalyst weights, flow rates/retention times, and percentage of loading potassium. The reaction rate and stability of the catalyst were tested. Finally, the fuel properties of the biodiesel were determined.