CHAPTER I
INTRODUCTION

Over the past two centuries, 90% of the energy used for transportation and industry is derived from petroleum. However, there are two major limitations in using petroleum as an energy source. First, the demand of energy continues to increase each year but petroleum has a limited supply, leading to a lack of petroleum to supply in the approaching future. Second, petroleum contains sulfur and nitrogen-containing compounds that can cause damage to the environment when it is burned (Steinberg *et al.*, 1999). Therefore, the development of a sustainable energy is important to satisfy the rapid increase of the global energy consumption, as well as to reduce the toxic and greenhouse gases.

There are a number of sustainable alternative energy sources that can replace the petroleum-based energy, including hydropower, geothermal energy, wind energy, solar energy, and biomass. One of the promising alternative energy sources is bio-diesel, which can be produced from renewable raw materials and can be considered as a potential sustainable alternative to petroleum-based fuels in the future. Biodiesel is referred to as fatty acid methyl ester (FAME) or mono-alkyl esters of fatty acids derived from bio-oils such as vegetable oils and animal fats. The biodiesel is mainly produced via a transesterification reaction (Lee *et al.*, 1998, Srivastava *et al.*, 2000, and Delibes *et al.*, 2002) but this production route has several economic considerations mainly attributed to the price and availability of the main byproduct glycerol. The large numbers of unit operation in biodiesel production require high investments (Knothe *et al.*, 2005). Moreover the product obtained from this reaction has higher viscosity and oxygen content than the conventional diesel. This may cause engine problems especially at low temperature. However, alkane (non-oxygenate) biodiesel is also available. The bio-based diesel-like hydrocarbon is called *renewable diesel*, *green diesel* or *hydrogenated biodiesel*.

Hydrogenated biodiesel can be produced by the hydrotreating of triglyceride or fatty acid at standard hydrotreating conditions (300 °C to 450 °C, 500 psia to 2000 psia) with conventional hydrotreating catalysts (e.g. sulfided $NiMo/Al_2O_3$) via the catalytic hydrodeoxygenation reaction.

Hydrogenated biodiesel is superior to regular biodiesel in high heating value, high cetane number and low oxygen content. In order to produce hydrogenated biodiesel on a commercial scale, the technology and economics of this process must be evaluated. Marker et al., UOP, (2005) studied economics comparisons for green diesel and biodiesel processing options. The results shown that with greases as the feedstock, the capital cost of biodiesel process is significantly higher than that of green diesel process and the overall cost of biodiesel production is projected to be nearly twice that of green diesel.

In this study, the technology and economics of hydrogenated biodiesel are compared to that of biodiesel production by using palm oil as feedstock which is different from UOP study. The experiment focus on the development of process flowsheets and simulation models to assess the technology and economics of hydrogenated biodiesel process compared to the conventional biodiesel process by using ICAS and PRO/II® program. In the case of hydrogenated biodiesel, an option of having steam methane reforming (SMR) is also studied. Beside the simulation study, the large scale reactor (100 ml catalyst volume) is constructed for producing 30 liters hydrogenated biodiesel from jatropha oil for engine test.