# CHAPTER 5

# CONCLUSION AND SUGGESTION FOR FURTHER WORKS

## 5.1 Conclusion

A laboratory facility for producing biodiesel under sub- and supercritical conditions was set up and it functioned well. The relationship between the operating variables and the biodiesel yield was determined. Effect of temperature was studied at 150, 300, 350 and 400 °C, with a molar ratio of methanol-to-oil of 43:1. It was found that the highest biodiesel yield was obtained at 300 °C. Effects of the holding time and molar ratio on biodiesel yield were also investigated. At 300 °C, the maximum yield could be obtained at the holding time of 70 and 10 min. for the molar ratio of methanol-to-oil at 8:1 and 22:1, respectively.

Kinetics of the methanolysis of palm oil to biodiesel was also investigated. The kinetics data was purposed in terms of the activation energy and the reaction rate. The investigation was performed under the allow ability condition that the facility could provide which was at 170-200 °C and 140-190 atm, molar ratio of methanol-to-oil at 43: The reaction rate was assumed to be the first- or the zero-order model. The activation energies were found at 56 kJ/mol (by the first order model) and at 52 kJ/mol (by the zero order model) The reaction rate expressed by the first- and the zero-order models were $r = (1580)e^{-\left[\frac{56000}{RT}\right]}C_{TG}$, and $r = (572)e^{-\left[\frac{52000}{RT}\right]}$, respectively.

## 5.2 Suggestion for further works

### 5.2.1 Ethanolysis of palm oil

Ethanolysis of palm oil is interesting because ethanol has several advantages over methanol. For example, ethanol is produced from agricultural by-products which are renewable while methanol is usually produced from petroleum sources. Ethanol also has less toxicity than methanol. Biodiesel of ethyl esters has slightly greater heating value than that of methyl ester because ethanol has higher number of carbon than methanol. Kinetics study of palm oil ethanolysis under sub or supercritical is rarely available from existing literature. The facility of the current work can be used for this purpose. Procedures and conditions of the experiment can be performed in similar fashion to this study so that the results could be compared.

### 5.2.2 Co-solvent Effect

Adding of co-solvents such as carbon dioxide, propane, monoglyceride, diglyceride, or methyl esters into the reaction is another interesting topic for non-catalytic biodesel production under sub- or supercritical condition. Co-solvent can increase solubility of oil and alcohol at considerably lower temperature and pressure conditions. Therefore, the reaction rate is increased due to increasing contact area. An experimental study on non-catalytic biodiesel production from palm oil and ethanol under pressurized carbon dioxide was carried out. The results were presented in the PACCON2009 international conference, shown in Appendix F. But more detailed investigation should be carried out.

5.2.3 Development of Remote Reactor Using Robot for Sample Collecting

As the supercritical methanol method has many advantages as described in section 1.2.8. However, it requires strong and reliable reactor which is expensive. Most laboratory dose not has such equipment. Therefore, low cost reactor may be developed. This reactor should have a minimum standard of safety. But it must be placed at an isolated area such as underground or remote area. A remote control device with a robot must be included for samples collecting. Therefore, the operator does not come close to the reactor.