CHAPTER V

CONCLUSIONS AND SUGGESTIONS

5.1 Conclusions

Biodiesel production from rice bran oil soapstock has been faced with the problems in separating methyl ester from oil, the percentage of water content in soapstock and reversible reaction to free fatty acid and methanol caused by inactived enzyme. In the industry, soapstock will be sold less than the past because the neutralization of soapstock to acid oil can be used in the biodiesel industry which will be more valuable than soapstock. The production of FAME from RBOSS will be more efficient when RBOSS is neutralized to acid oil.

Neutralization of rice bran oil soapstock gave 43% acid oil which was used as feedstock in biodiesel production. Another feedstock, with the same chemical property as acid oil, was rice fatty acid from physical refining of the rice bran oil, which was used, in this study.

Transesterification of remained triglyceride in acid oil using Novozyme 435 catalyst with 30 hrs reaction time as shown in the peak of glyceryl moiety in the chromatogram of ^{1}H NMR analysis result. Hence, the transesterification of remained triglyceride in acid oil by normal base catalyzed process. The advantage of base catalyst was less reaction time; 1 hr reacted with all triglycerides changed to methyl ester.

Optimal condition of biodiesel production by enzyme and base catalyzed process shown as following: the first esterification by enzyme catalyst condition was at temperature 30°C, 2:1 molar ratio of methanol to FFA, 10% Novozyme 435 and 2 hrs of reaction time, in the second transesterification by base catalyst, the condition was at temperature 65°C, 5:1 molar ratio between methanol to TG, 0.8% NaOH and 1 hr of reaction time.

Optimal condition of biodiesel production by acid and base catalyzed process shown as following: the first esterification by acid catalyst was at temperature 65°C, 9:1 molar ratio of methanol to TG, 1% H_2SO_4 and 90 minutes of reaction time, in the second esterification by acid catalyst was at temperature 65°C, 7:1 molar ratio of methanol to TG, 1%H_2SO_4 and 90 minutes of reaction time, in the third transesterification by base catalyst was at temperature 65°C, 5:1 molar ratio of methanol to TG, 0.8% NaOH and 1 hr. of reaction time.

The production of methyl ester by esterification of two catalyzed process including enzyme catalyzed and acid catalyzed esterification which gave nearly the percentage of conversion and biodiesel properties, but the enzyme catalyzed process gave the percentage of product more than the acid catalyzed process that methyl ester loose in washing step. The color of biodiesel produced by acid catalyzed is darker than that produced by enzyme catalyzed process. As it is widely known that the color of FAME obtained from acid-catalyzed esterification process is usually black.

Biodiesel properties were analyzed as the percentage of methyl ester, flash point, specific gravity and oxidation stability which were in range of fuel properties prescribed in standard biodiesel, except percentage of methyl ester which less than limit of fuel property. And oxidation stability of biodiesel from rice fatty acid by two step, enzyme and base catalyzed process was 10 hrs which more than the standard biodiesel (4 hrs) showing longer time storage.

The enzymatic process established in this study has the following advantages: the immobilized lipase can be used for a long period; thus, the production costs are reduced. In addition, the process is advantageous in the following respects, the reaction temperature is moderate; thus, the energy for heating can be saved, a process to remove the acid catalyst is not necessary, the waste water is neutral in pH and is free from salts. These advantages indicate that this enzymatic system is eco-friendly and

may be applicable to an industrial process for the production of biodiesel fuel from acid oil and rice fatty acid.

5.2 Suggestion

Rice fatty acid is new feedstock, more interest has been paid in the industrial biodiesel production because once parameter in biodiesel properties, oxidation stability was high to 10 hrs which is suitable to apply for biodiesel fuel.