CHAPTER V

CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

5.1.1 Biodiesel could be produced by solid acid catalyzed transesterification of purified palm oil and esterification of palm fatty acid in supercritical methanol. The reactions were found to be completed in a very short time. Compared with the liquid catalytic processes, the separation of products is much simpler and the process is more environmentally friendly.

5.1.2 The SO_4^{2-}/ZrO_2 catalyst can considerably improve the transesterification reaction of purified palm oil and the esterification of palm fatty acids in supercritical methanol. It is probable that the addition of an appropriate type and amount of solid catalyst can decrease the vigorous conditions and allow the reaction to be carried out under milder conditions.

5.1.3 In this work, the suitable preparation condition of SO_4^{2-}/ZrO_2 catalyst was to immerse 40 g of ZrO_2 in 18 ml of 0.1 mol/liter of H_2SO_4 for 30 minutes at 70 °C, after which the catalysts were dried at 110 °C for 24 hours, and was calcined at 500 °C for 2 hours.

5.1.4 The most suitable conditions for transesterification reaction of purified palm oil in supercritical methanol with SO_4^{2-}/ZrO_2 catalyst were the molar ratio of methanol to reactants of 24:1 and the catalyst to reactants mass ratio of 0.5 % at 250 °C and the reaction was 10 min. For palm fatty acid, the ratio of methanol to reactants of 6:1, the catalyst to reactants mass ratio of 0.5 % at 250 °C, and the reaction time of 1 min were the most optimal. About 80 % FAMEs was produced for both purified palm oil and palm fatty acid.

5.1.5 The limitation of SO_4^{2-}/ZrO_2 catalyst was its rapid deactivation. The fatty acid methyl ester yield decreased with the number of the catalyst recycling.

5.2 Recommendations

5.2.1 The catalyst leaching and deactivation should be investigated for the transesterification and esterification in supercritical methanol.

5.2.2 The possibility regenerate SO_4^{2-}/ZrO_2 catalyst by re-impregnation and re-calcinations could be investigated to increase the recyclability of the catalyst for the transesterification and esterification in supercritical methanol.

5.2.4 To improve the overall yield, two-step supercritical process should be investigated in which the by-product (glycerol and/or water) and SO_4^{2-}/ZrO_2 catalyst in the first reaction step were removed. The obtained biodiesel in the first step was then reacted again in the second step under some specified conditions.

5.2.4 The catalytic activity can be enhanced by employing SO_4^{2-}/ZrO_2 catalyst using chlorosulfonic acid (Yadav et al., 2004) instead of the sulfuric acid impregnation could be determined.