

## CHAPTER V

### CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Conclusions

CaO–ZnO is one of the heterogeneous basic catalysts used for biodiesel production via transesterification of palm oil. In this work, the CaO-ZnO catalysts were prepared by co-precipitation (CP) and incipient wetness impregnation (IWI) methods.

In the effect of precursor concentration and type of precursor during catalyst preparation, it was found that at high precursor concentration (2 M Ca and Zn precursor : 0.5 M precipitant) for CP method, it has smaller particle size and higher surface area than the CP catalysts prepared at low precursor concentration. So, the CP catalyst prepared at high Ca-Zn precursor concentration gave the highest %FAME yield owing to its higher surface area and smaller particle size.

Moreover, the Ca:Zn atomic ratio 1:3 catalyst gave the highest biodiesel yield for both CP and IWI methods. The calcination temperature of CP catalysts is 800 °C while the calcination temperature of 900 °C is suitable temperature for the IWI catalysts. At reaction temperature of 60 °C, reaction time of 8 h, 1:15 molar ratio of palm oil to methanol, a catalyst amount of 6 wt%, and 300 rpm of stirrer speed gave the biodiesel yield of 81.73 and 83.82 for CP and IWI catalysts, respectively. From characterization, it indicated that basicity, particle size, and surface area of CaO-ZnO were the important parameters that affect to its activity in the transesterification. However, surface area has slightly affected to its biodiesel yield.

For the reusability test revealed that the CP catalysts show good ability than IWI catalysts because the % FAME yield of the CP catalyst has slightly decreased in the 2<sup>nd</sup> and 3<sup>rd</sup> runs slightly decreased while the catalytic activity of the IWI catalyst gradually after the 2<sup>nd</sup> and 3<sup>rd</sup> runs.

## 5.2 Recommendations

In order to reach high %FAME yield, some alkaline or alkaline earth metal should be added to CaO-ZnO catalyst for increase basic properties (basicity and basic strength). However, the leaching of added active metal from catalyst should be optimized to get higher regeneration time or high stability because some alkaline or alkaline earth metal can be easily dissolved in methanol.

In the part of transesterification process, it is very interesting to up-scale from the batch reactor to the fixed-bed reactor, or to operate the conditions closely to those in an industry. Besides, the extent of the contact time is attractive for this application. For instance, the reduction of feed flow rate, the higher amount of catalyst, and the longer of catalyst bed are totally involved in this parameter.