CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

A study of hydrogen production from the steam reforming of methanol (SRM) over supported Au catalyst was carried out by using Au/ZnO and Au/ZnO-Fe_2O_3 catalysts. Both catalysts were prepared by a deposition-precipitation method and many parameters that affect to the performance of catalyst have been investigated; including the effects of Au content, calcination temperature, catalyst pretreatment, reaction temperature, and molar ratio of ZnO to Fe_2O_3. Moreover, the optimum condition for Au/ZnO and Au/ZnO-Fe_2O_3 catalysts were chosen for studying in the presence of decomposition of methanol (DM) and water gas shift (WGS) reactions. In addition, the deactivation tests of both catalysts were also performed for 24 hours. The main conclusions of this study can be summarized as follows.

. In the case of Au/ZnO-Fe_2O_3 catalysts, a 9:1 molar ratio of ZnO to Fe_2O_3 shows the best performance in terms of methanol conversion and hydrogen selectivity. The molar ratio of ZnO to Fe_2O_3 has affected on the catalytic performance of Au/ZnO-Fe_2O_3 catalyst. When an amount of Fe_2O_3 decreased, the activity and selectivity of Au/ZnO-Fe_2O_3 catalyst were increased. Moreover, TEM micrograph showed that when increasing the content of Fe_2O_3, a slight increase in gold particle size was observed.

The Au content on Au/ZnO and Au/ZnO-Fe_2O_3 catalysts was found to have a significant effect on both methanol conversion and hydrogen selectivity. The activity increased with increasing Au content. Therefore, 5% atom of Au content gave the highest methanol conversion and hydrogen selectivity for both catalysts. It can be concluded that the larger size of gold particles are preferred for methanol steam reforming reaction.

Calcination temperature significantly influenced the catalytic performance of Au/ZnO and Au/ZnO-Fe_2O_3 catalysts. For Au/ZnO catalyst, methanol conversion strongly increased with increasing calcination temperature. On the other hand, for Au/ZnO-Fe_2O_3 catalyst, it differs from Au/ZnO. With increasing calcination temperature, methanol conversion and hydrogen selectivity were decreased. The suitable calcination temperatures for Au/ZnO and Au/ZnO-Fe_2O_3 catalysts are 400 and 200°C, respectively.

The performance of Au/ZnO and Au/ZnO-Fe_2O_3 catalysts was found to be influenced by catalyst pretreatment. H_2 pretreatment at 400°C for 1 hour is preferred for Au/ZnO catalyst and O_2 pretreatment at 200°C for 1 hour is preferred for Au/ZnO-Fe_2O_3 catalyst.

For the effect of the reaction temperature on SRM, the higher reaction temperature, the higher methanol conversion and H_2 selectivity was observed. No deactivation was observed during 24 hours of testing for both catalysts. However, TPO result indicated that amorphous carbon occurred but it had no effect on the performance of both catalysts. The amount of carbon formation on Au/ZnO and Au/ZnO-Fe_2O_3 catalysts are 0.12 and 0.88% weight, respectively.

Finally, the performance of Au/ZnO and Au/ZnO-Fe_2O_3 catalysts at the optimum conditions were compared in methanol steam reforming reaction (SRM). The results showed that Au/ZnO-Fe_2O_3 catalyst.gave better performance in terms of methanol conversion and hydrogen selectivity than Au/ZnO catalyst. Moreover, the catalytic performance of the Au/ZnO-Fe_2O_3 catalyst is higher than that of the Au/ZnO catalyst in DM and WGS reaction.

5.2 Recommendations

From the result of this thesis, Au/ZnO-Fe_2O_3 catalyst is suitable for methanol steam reforming reaction but it has a problem about CO and CH_4 formation. Therefore, the further study is required to improve the best catalytic performance as follows:

The metal crystallite sizes are the most significant variable to the catalytic performance; therefore, the improvement of catalyst preparation method is necessary to investigate.

X-ray photoelectron spectroscopy (XPS) is recommended to characterize the catalyst, in order to explain the chemical state of gold that presents on the surface of catalyst and determine the relationship between states of gold and catalytic performance.

Additionally, the regeneration process should be studied in order to improve the catalytic performance for the application in PEM fuel cell.