CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The methylation of benzene in the presence of methane can take place over indium containing ZSM-5. In/HZSM-5 treated with hydrogen followed by oxygen provided the highest benzene conversion in the case of nitrogen carrier. Moreover, the hydrogen treated followed by oxygen carrier shows more higher conversion but there are the drawback in toluene selectivity which significantly dropped. The different conversion and selectivity possibly ascribe to the redox behavior of indium cation which can exchange between In^+ and InO^+ when using different treatment atmosphere. The increasing of indium to aluminum ratios provided better benzene conversion and toluene selectivity due to the higher amount of indium cation active species. The reaction condition e.g. reaction temperature, space velocity or methane to benzene feed ratio are also affect to the benzene conversion and toluene selectivity which are described by the thermodynamic principles.

5.2 Recommendations

This experiment is focused on only the solid-state ion exchange technique which used an agate mortar to mix the ingredients. The drawback of this method is the low reproducibility of catalyst preparation. The better mixing method should be performed by using ball mill technique. The other metal loading techniques which are impregnation and liquid ion exchange should be studied to compare with the solid-state ion exchange technique.

The indium precursor of catalyst was not compared among indium(III)chloride and the others (e.g. indium oxide, indium nitrate) yet, the catalyst might provide the different activity from the different precursor. The Bronsted acidity of zeolite support should also affect to the catalyst activity as shown in TPD results, this effect can study by using various Si/Al ratios of HZSM-5. The characterization for proving the exact active species was also not fully clear, the pyridine adsorption technique or XPS should be the attractive technique to confirm this.