CHAPTER V
CONCLUSION AND RECOMMENDATION

Addition of either Ce or Ru onto sol-gel synthesized TiO_2 catalyst promotes higher selectivity and conversion towards cyclohexene oxide. The tri-metallic catalyst is a matrix containing mixtures of the metal oxides and solid solution. It is evident that surface hydroxyl groups on the $Ce/Ru/TiO_2$ promote cyclohexene epoxidation. The highest performance is achieved (28.8 %conversion; 68.4 %cyclohexene oxide selectivity; 19.71 %yield) when the catalyst is optimized by having a composition of $0.5\%Ce/Ru/TiO_2$, calcined at 500 °C for 1 hour at a ramp rate of 1 °C/min and reacted in its optimum condition (0.5 g of catalyst, 30 mmol of cyclohexene, 30 mmol of hydrogen peroxide and 70 °C reaction temperature).

Future recommendation for continuation of the research is incorporating steam treatment of the catalyst to improve the surface hydroxyls. There have been debates on how the hydroxyl group is formed. A promising approach is by oxidation of adsorbed water (H_2O) studied by P.F Schwarz (1997). Water generating hydroxyl groups have also been observed by various researches. The hydroxyl group usually opens up free readicals or act as adsorption centers for reaction (K. Nagaveni *et al.*, 2004, M. El-Maazawi *et al.*, 2000, J. Shang *et al.*, 2002)