CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Almost all technologies for drinking water sterilization are expensive and require high maintenance. As a consequence, the possibility of the new idea of using silver supported on alumina surface for drinking water sterilization was studied in this work in order to develop a low cost and low maintenance water purification/sterilization system. Although no literature has been published about this idea, preliminary studies were performed and concluded.

We believe that the well-known silver catalyst used in ethylene oxidation reaction can show its oxidizing power on killing bacteria. The surface mechanism we are focusing on is the ability of silver metal to produce reactive oxygen molecule. This active oxygen is then believed to oxidize bacteria in water. All catalysts used in this study were prepared without both surface treatments and promoter modifications. There were two techniques used to prepare the silver catalysts for the work. The use of silver-amine complex solution as precursor solution is known as the ion-exchange technique. It is believed by many studies that this technique can produce more highly dispersed silver metal on support because of stronger metal-support interaction. This can also reduce the mobility of silver on the support surface. Moreover, the technique of producing silver mirror was applied to reduce the silver-amine complex to metallic silver deposited on the surface. This was acchieved by dipping moist catalysts into formaldehyde solution. It was found in this study that catalysts prepared by this technique were better bound on the surface when compared to catalysts prepared by the other techniques, particulary when the catalysts were reduced in hot formaldehyde solution. Unfortunately, the catalysts prepared by this technique were less active. The basic suspicion is that there might be formaldehyde polymers formed and which block the active sites on the surface. By SEM, it was found that the silver crystallites of catalysts prepared were much smaller than the catalysts prepared by the thermal reduction method. Comparing among the catalysts prepared by this method, the catalysts with higher silver loadings were more effective but resulted in higher silver concentration in the effluent.

The second technique used to prepare the catalysts was dipping into silver nitrate precursor solution and followed by thermal reduction. The basic idea of thermal reduction is that it should produce more active catalysts than the catalysts prepared by the ion-exchange method. This is because silver compounds formed on the surface should be turned to metallic silver at high temperature if long enough calcination time is allowed. However , too high a temperature such as 800 °C as used in this study might reduce catalyst stability, change the surface properties, and produce very large silver particles. Because of this, silver loss from surface was found to be higher than the catalysts prepared by ion-exchange technique. Further study should be done at different calcination temperatures. Impurities, ionic species in water, pH of water and water flow rate are possible parameters of silver loss.

The followings are the summary of the findings :

1. The catalyst prepared by ion-exchange technique and reduced in formaldehyde solution was less active but the silver was better bound to the

surface than the catalyst prepared in silver nitrate solution and reduced by thermal reduction.

2. The catalyst reduced in hot formaldehyde solution was slightly more active and better bound to the surface than the catalyst reduced in formaldehyde solution at room temperature.

3. The catalyst prepared by silver-amine complex solution produced much smaller silver particles than the catalyst prepared by silver nitrate solution.

4. For the higher silver loading, the higher killing efficiency was obtained.

5. For the longer contact time, the more silver eroded. However, the correlation of silver loss was not linear.

6. For the longer contact time, the more *E.coli* killed. Nevertheless, multiplication was observed for some catalysts.

5.2 Recommendations

It is recommended that other supports should be tried. Eventhough the use of monolith has some advantages, the bacteria suspended in the water can partially contact to the silver on the surface because of the straight width of the channel. So it is hard to achieve highest killing when high water flow rate is used. As suggested the use of alumina pellets is another alternative in which the water can completely contact to the surface as thin film. This was high silver loading may not be required. Another reason is that the water flowing through the pellets packed-bed is likely to be plug flow. The silver loss might be less because of laminar pattern. However, the pellet sizes should be big enough to minimize pressure drop in the column.

If monolith is still used, the phases of alumina might affect the metal-support interaction. So it is suggested to study this effect by varying calcination temperatures. Calcination time and calcination atmospheres such as in hydrogen, nitrogen or ammonia atmosphere are other factors. Surface pretreatments such as pre-heated monolith at 500 ° C might reduce organic contaminations on the surface. Effect of promotors such as cesium and rubidium on surface properties as studied in several works might be applied. Effect of crystal structures of silver catalysts is another interesting area.

Water prefilter is recommended to use prior to allow water passing through the sterilization column. This is because some particulate or ionic impurities might either poison the catalyst or form the dissoluable salts with metallic silver deposited on the surface. Ion-exchange resin might help solving this problem

After the catalyst development, further study should be done with other microorganisms. As the conclusion, the catalytic water sterilizer/purifier system is ultimate goal of this study.