CHAPTER V

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

From the investigation of TiO_2 thin film characteristics on stainless steel plates using the sol-gel process, it was influenced by the different conditions. For instance, the addition of acetyl acetone, the calcination temperatures, the number of coating cycles and the appropriate wavelengths were interesting as the major parameters to be verified. The efficiency of the photocatalytic reduction of Cr (VI) removal using attainable TiO_2 thin film was also studied. It was important to note that different factors might also give the different circumstances correlating with the anatase structure of TiO_2, the thickness of the TiO_2 thin layers, the stability of the surface morphology, and the energy at different wavelengths that TiO_2 can adsorb to activate the electrons at the valence band moving on to the conduction band.

From this study, the results demonstrated that the best condition which is optimum to use with a fixed bed photocatalytic reactor was TiO_2 thin films prepared with acetyl acetone and calcined at 500 °C with 3-coating times. It was due to the efficiency of all experiments.

The results from all TiO_2 thin film properties derived from the sol-gel method can be concluded as follows:

5.1.1 ***The addition of acetyl acetone*** affected strongly on the surface morphology due to the smoothness. As seen in the results, the TiO_2 thin film prepared with acetyl acetone would make the highest efficiency in the mole ratio of titanium (IV) butoxide: ethanol: HCl: acetyl acetone at 1: 30: 0.5: 1, respectively. So, it was found that acetyl acetone played an important role on the film surface. The uniformity, compacted anatase structure and less cracking on the thin film surface were the advantages of acetyl acetone used as a stabilizing agent. As a result of the consistent anatase peak, acetyl acetone did not affect the crystal size.

5.1.2 ***Effects of the calcination temperatures on the film properties*** were investigated. It has been seen that when the calcination temperatures has been increased, the anatase structure of TiO_2 would be increased significantly. This could be suggested that the more anatase phase, the more efficiency of photocatalytic reduction of Cr (VI). However, in this study if the TiO_2 thin film was calcined over 500 °C, the surface of stainless steel would be changed by FeO (Ferrous oxide) which covered on the top of the surface. It was the limitation when stainless steel was used a carrier, but it was easy to develop in the industrial work.

5.1.3 ***Effect of the coating cycles*** were interested in their film thickness and the amount of the anatase structure. Besides, the best efficiency of photocatalysis was the 3-coating cycles. In order to their thickness, when TiO_2 thin film was coated more than three times, the efficiency would be decreased. The recombination can easily occur when the film has been coated over the optimum thickness that the electrons cannot be overcome from the valence band to the conduction band on the top of the surface. The excited electrons will recombine with the hole before the reduction reaction occurs.

5.1.4 ***Effects of the appropriate wavelengths*** were tested. It was found that the wavelength at 380 nm gave the energy equals to the band gap energy of TiO_2 (Eg = 3.2 eV). So, the efficiency of the photocatalytic reduction of Cr (VI) at 380 nm was the best condition. However, at 420 nm provided the worst condition because this wavelength is in the visible region, the energy is the lowest comparable to all wavelengths in this experiment. The energy is not enough to activate the electrons at the valence band moving to the conduction band. Meanwhile, at 254 nm showed the good efficiency of photocatalysis. It is clearly seen that the energy this wavelength gives quite high energy to stimulate the reaction, but it is not enough for the band gap energy of TiO_2.

In summary, the optimum condition of TiO_2 thin films derived from the sol-gel process for a fixed bed photocatalytic reactor is prepared in the mole ratio of titanium (IV) butoxide: ethanol: HCl: acetyl acetone at 1: 30: 0.5: 1, respectively calcined at 500 °C with the 3-coating cycles. The best UV wavelength is at 380 nm. So, these results from this research can be the fundamental information of TiO_2 thin film for environmental abatement.

5.2 Recommendations

For the apparent situation using TiO_2 thin film, these conditions from all experiment should be applied to produce the film that is suitable for industrial work. Some recommendations for future research progress were illustrated as follow:

5.2.1 This prototype of the fixed bed photoreactor should be developed to a large scale for the use in the industries.

5.2.2 This prototype of photoreactor may be modified to use other light sources such as the sun light. Perhaps the sun light will help to save the cost of the energy. It can give much more advantages than using the UV light.

5.2.3 The photocatalysis of other pollutants would be investigated such as some organics species. Photocatalytic oxidation and reduction can occur at the same time. So, some organic pollutants and some heavy metal dyes can also be treated at the same time.