Chapter 5

Conclusions

5.1 Conclusions

Color and COD removal of synthetic reactive dyes and industrial wastewater were investigated by using fluidized-bed Fenton process. The following conclusions can be derived from the study:

5.1.1 Synthetic dyeing wastewater

- The color removal efficiencies of reactive dyes of the carriers as SiO_2 system are higher than Al_2O_3 system. Together with COD removals in SiO_2 system were higher than that in Al_2O_3 system.

- For the purpose of color removal, 1-5 mg/l of ferrous ions were enough but for COD removal, higher ferrous dosage was needed. The color and COD removal efficiency were about 90% and 30%, respectively.

- The color removal was easier than the COD removal indicating that the chromophoric groups were destroyed during the degradation of dyes, and were partly mineralized to CO_2 and H_2O.

- Comparison of COD and color removal efficiency by using the same initial COD value and the same initial color value, the sequence of COD and color removal efficiency for synthetic reactive dyes was RO16 > RB5 > RB2.

- Although the target compounds were commercial dyes, %COD and color removal efficiency were also as high as these of reactive dyes with reagent grade. And it can be easy to remove by fluidized-bed Fenton process. %COD and %color removal efficiency were about 80% and 95%, respectively.

- The oxidation rate on COD and color removal of synthetic reactive dyes follow as the second-order kinetics.

- Overall kinetic equation for reactive dyes degradation by fluidized-bed Fenton process is:

  Reactive black5: $k_{obs} = 2x10^{-4} [Fe^{2+}]^{1.9}[H_2O_2]^{1.0}$

  Reactive blue2: $k_{obs} = 2x10^{-5} [Fe^{2+}]^{1.1}[H_2O_2]^{1.2}$

5.1.2 Industrial wastewater

- The Fenton system uses Fe^{2+} to react with H_2O_2, producing hydroxyl radicals with powerful oxidizing abilities to degrade certain toxic contaminants. Hydroxyl radicals may react with Fe^{2+} to form Fe^{3+} or react with organics. The optimum condition for industrial wastewater treatment was $[COD]:[Fe^{2+}]:[H_2O_2] = 1:0.95:3.17$, carriers = 74.07 g/l, initial pH= 3.

- COD and color removal efficiency dramatically decreased due to the scavenging effect of the OH· by H^+ is severe at low pH. When at a high pH , it also showed low COD and color removal efficiency. It may be explained by the hydrolysis of Fe^{3+} in the solution to reduce OH· producing rate. The optimum pH for industrial wastewater treatment was 3.

- Degradation rate of organic content increased when the H_2O_2 concentration increased under a critical H_2O_2 concentration. When the concentration was higher below a critical limit, the degradation rate of organic content decreased as a result of the so-called scavenging effect.

- Condition for treating the wastewater of Nan-Woei Industrial Co., Ltd was $[COD]:[Fe^{2+}]:[H_2O_2]$ = 1:0.95:7.94, carrier = 74.07 g/l, initial pH = 3 which the effluent COD and color meet the regulatory requirement of Taiwan.

5.2 Engineering Applications

In Taiwan typical processes for textile wastewater treatment includes biological activated sludge oxidation and post coagulation, followed by chemical oxidation of the final effluent by sodium hypochlorite (NaOCl) for color removal purpose. Although color can meet the discharge standard after hypochlorite oxidation, the toxicity of chlorinated oxidation products might pose a threat to aquatic life.

Fenton reactions exploit the reactivity of the hydroxyl radical (OH•), which has a very high oxidation potential and is able to oxidize almost all organic pollutants quickly with non-selectivity and non-toxic. It can reduce both organic pollutants and color.

Fluidized-bed Fenton process not only attains high COD and color removal efficiency but also reduces the large amount of iron sludge being produced. . As the continuous mode, the iron onto the surface of carriers can be used as the heterogeneous catalyst and the amount of iron sludge was also reduced. Therefore, this process was of interested to investigate and apply in full-scale in the future.

5.3 Recommendations for Future Work

This study focused only on determining the optimal conditions for the COD and color of reactive dyes. There are still many unexplored areas that need further investigation. Future studies may be conducted in the following areas:

- Optimization experiments for other operational parameters such as temperature, buffers, presence of anion, etc.

- Stepwise H_2O_2 addition to investigate the COD and color removal efficiency.

- Identification of intermediates to establish a more accurate pathway.

- Investigation the biodegradability of the wastewater by determining the ratio of BOD to COD (BOD/COD).

- Feasibility of fluidized-bed Fenton process at high COD and color removal of synthetic reactive dyes wastewater.

- Application to fluidized-bed Fenton process to industrial wastewater containing higher COD and color values.

- Investigate the behavior of fluidized-bed Fenton process under a continuous operation.

- Determine the effect of media reusability on the COD and color removal by fluidized-bed Fenton process.