CHAPTER-5

CONCLUSIONS, SUMMARY AND RECOMMENDATIONS

6.1 General

The aim of the present study was to remove/reduce the dye Direct Blue 199 from simulated dye solution and industrial wastewater. This could be accomplished by using undoped, Fe/I doped TiO_2 photocatalysts prepared by citric acid assisted sol-gel technique.

6.1.1 The dye degradation with Fe doped TiO_2 photocatalysts

- Fe-doped TiO_2 photocatalysts, $Ti_{1-x}Fe_xO_2$ (x = 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09 and 0.10) were synthesized successfully by the sol-gel method.
- The synthesized $Ti_{1-x}Fe_xO_2$ (x = 0.01-0.10) photocatalysts were utilized for photodegradation of dye in simulated dye solution and industrial wastewater (Direct Blue 199) in a photochemical reactor (with both glass, quartz tube one at a time) and an open pan reactor under UV light and direct sunlight, respectively.
- In both types of reactors (UV-PCR and OPR), the $Ti_{0.96}Fe_{0.04}O_2$ photocatalyst showed the best photocatalytic activity among all the synthesized undoped and Fe-doped TiO_2 photocatalysts.
- The maximum photocatalytic activity was observed at 4% of Fe doping in TiO_2.
- The photocatalytic activity of the synthesized photocatalyst enhances with Fe doping in TiO_2 up to a certain concentration (1-4%) after that the activity starts to decline (5-10% Fe doping in TiO_2).

- The rate of dye degradation follows the pseudo-first-order kinetics in both types of reactors with both simulated dye solution and industrial wastewater.
- The photodegradation of the dye in industrial wastewater with the regenerated $Ti_{0.96}Fe_{0.04}O_2$ photocatalyst shows that the activity of photocatalyst decreases with the number of regeneration of the photocatalysts.
- The result of comparative study among the synthesized undoped TiO_2, $Ti_{0.96}Fe_{0.04}O_2$ and commercial Aeroxide P-25 shows that the $Ti_{0.96}Fe_{0.04}O_2$ photocatalyst has better photocatalytic activity than both undoped TiO_2 and Aeroxide P-25 photocatalysts.

6.1.2 The dye degradation with I doped TiO_2 photocatalysts

- I-doped TiO_2 photocatalysts with compositions $Ti_{1-x}I_xO_2$ (x = 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09 and 0.10) were prepared by a sol-gel route and their photocatalytic activities were determined by photodegradation of dye (Direct Blue 199) in simulated dye solution and industrial wastewater in UV-PCR and OPR.
- The results of dye degradation showed that the $Ti_{0.97}I_{0.03}O_2$ photocatalyst exhibited the best photocatalytic activity among all the synthesized undoped and I-doped TiO_2 photocatalysts in the both reactors.
- The maximum photocatalytic activity was observed at 3% of I doping in TiO_2.
- The photocatalytic activity of the synthesized photocatalyst enhances with I doping in TiO_2 up to a certain concentration (1-3%) after that the activity starts to decline (4-10% I doping in TiO_2).

- The rate of dye degradation follows the pseudo-first-order kinetics in both types of reactors with both simulated dye solution and industrial wastewater.
- The photodegradation results of industrial wastewater using regenerated $Ti_{0.97}I_{0.03}O_2$ photocatalyst revealed that the activity of the photocatalyst decreased with increasing number of regenerations.
- A comparison among the synthesized undoped TiO_2, $Ti_{0.97}I_{0.03}O_2$, and commercial Aeroxide P-25 revealed that the synthesized $Ti_{0.97}I_{0.03}O_2$ photocatalyst exhibited the highest photocatalytic activity among the three.

Summary

- Cations and anion doped TiO_2 photocatalysts were synthesized successfully by sol-gel method. In cations doping, the maximum photocatalytic activity among the (1-10%) Fe doped TiO_2 photocatalysts was observed at 4% of Fe doping in TiO_2 while in anion doping it was observed at 3% of I doping in TiO_2. The dye degradation process by the both synthesized photocatalysts (Fe doped TiO_2 and I doped TiO_2) follow pseudo-first order kinetics and approximately 80% of dye was degraded in first half an hour in UV photochemical reactor while it took 2 h in open pan reactor. The photodegradation rate of the dye was higher in UV photochemical reactor than open pan reactor. Kinetic studies with regenerated photocatalysts reveal that the activity of catalysts decreases with number of regeneration.

Recommendations of future studies

- The degradation of similar (Direct) dye should also be studied with the synthesized photocatalysts.
- There is a need to dope both cation (Fe) and anion (I) in TiO_2 and study the degradation of basic dyes.
- To handle large amount of dye-contaminated wastewater for dye degradation, the design and fabrication of photochemical reactor is required.