

고급산화공정(AOP)을 이용한 Phthalates 와 Benzoic Acid의 분해 연구

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Degradation of Phthalate Compounds and Benzoic Acid by Advanced Oxidation Process (AOP)

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Introduction

The wastewater from agro industry and petrochemical and textile industries contain large amounts of refractory organic materials, which are considered to be highly toxic and found to inhibit biological treatment (Hamdi 1992, Borja et al. 1997). One such industry is the Terephthalic acid (TPA production), which is used as a raw material for making polyester fiber and polyethylene terephthalate (PET), where the wastewater contain organic materials like Isophthalic acid (IPA), benzoic acid (BA) and some amount of TPA. Considering health hazard caused by these organic chemicals, a simple and effective wastewater treatment method is very important.

Recently, advanced oxidation process (AOP) with UV radiation and photocatalyst titanium dioxide (TiO₂) is gaining growing acceptance for the treatment of organic materials (Gogate and Pandit 2004). This method has proven to be very effective for the treatment of textile dye effluent, and other organic chemicals (Xu 2001, Kaneco et al. 2004). However, very limited studies have been carried out so far on analyzing the performance of AOP system for the destruction of toxic organic chemicals such as TPA, BA and IPA (Heredia et al. 2001).

The objective of this study was to apply AOP treatment for evaluating the destruction efficiencies of three toxic organic chemicals such as TPA, IPA and BA. Initial organic concentration, solution pH, make-up solution chemical and the TiO₂ dosages were varied and the effect of organic destruction were evaluated.

Materials and Method

Ultraviolet light (TUV 36 SP T5, Philips, USA) was used as the irradiation light source (intensity $144 \mu\text{W}/\text{cm}^2$ and the wavelength was 253.7 nm and P-25 TiO_2 particles (Degussa, Germany) were used as photocatalyst. TiO_2 powder was suspended in water and used as slurry for photocatalysis. Pure TPA, IPA and BA chemicals were obtained from Samnam Chemicals, Korea.

Parameters such as the initial organic concentration, solution pH, TiO_2 concentration, and make-up solution chemicals were varied and the organic degradation efficiency was studied. The organic chemicals used in this study had very low solubility and was able to be dissolved in solution only at high pHs. It was not possible to decrease the solution pH below 6, when it tends to separate from the solution. In the alkaline range, two kinds of alkali chemicals, namely sodium hydroxide and sodium carbonate. The effect of these makeup chemical on photocatalytic efficiency was also studied.

Results and Discussion

Figure 1 shows the AOP degradation efficiencies of the three organic materials at various initial concentrations. It can be seen that TPA and IPA had greater removal efficiencies compared to BA. However, TPA and IPA had almost similar amounts of removal. This could possibly due to the presence of two carboxylic groups in TPA and IPA, whereas only one in the case of BA. Figure 2 shows the effect of initial pH. It was found that lower the pH, greater was the degradation efficiency. But, pH below 8 had very little improvement in removal efficiency. Figure 3 shows the AOP performance based on the make up chemical used. At a certain pH value (pH 10), it was found that using NaOH had a favourable effect on organic degradation. Figure 4 shows the effect of removal based on TiO_2 concentration. Increase in TiO_2 dosage up to 1 g/L gradually increased the photocatalytic efficiency. It was found that 1 g/L of TiO_2 was found to be optimum. Further increase in TiO_2 decreased the light penetrability and hence the photocatalytic degradation efficiency also declined. It is to be noted that in Figures 2 and 3 the initial organic concentration were 10 ppm, whereas in Figure 4, the concentration was 50 ppm. Hence the variation in destruction time.

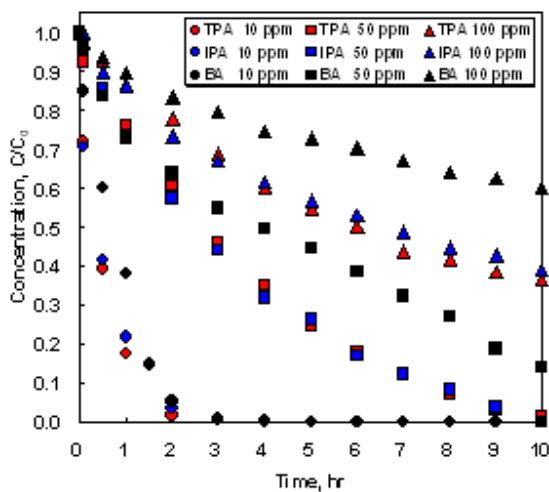


Fig. 1. Effect of initial organic concentration on the destruction of by UV/TiO₂ system.

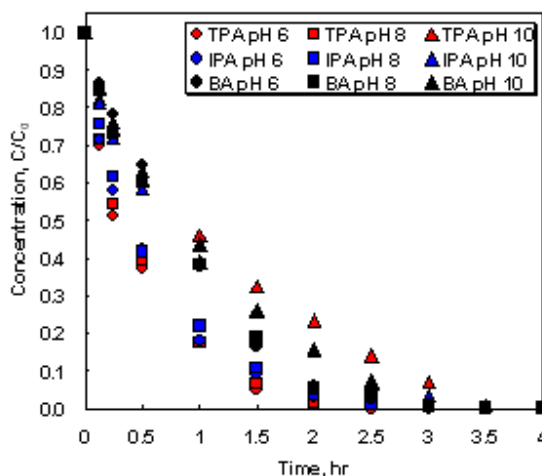


Fig. 2. Effect of initial solution pH on the destruction by UV/TiO₂ system.

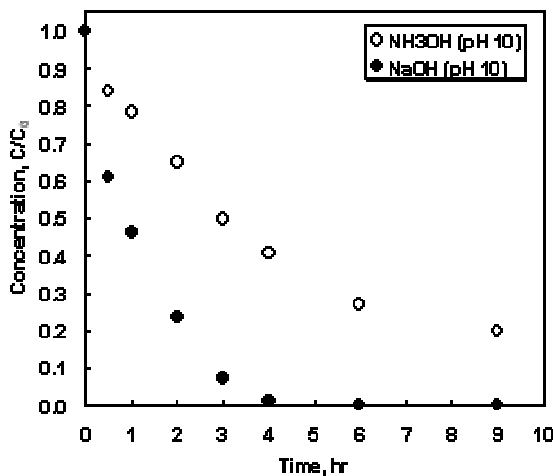


Fig. 3. Effect of using chemical on the destruction of TPA by UV/TiO₂ system.

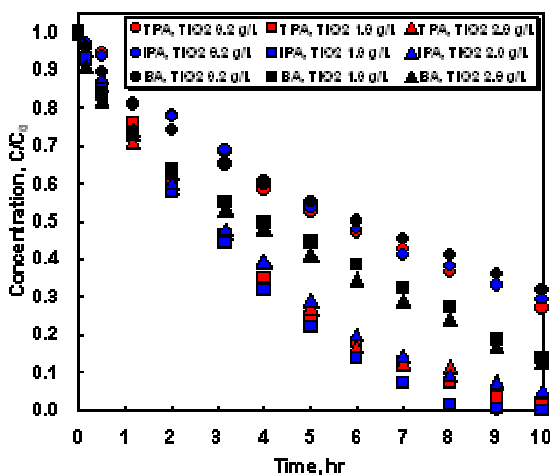


Fig. 4. Effect of TiO₂ amount on the destruction by UV/TiO₂ system.

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References

- Kaneco, S., Rahman, M.A., Suzuki, T., Katsumata, H., Ohta, K., 2004. "Optimization of solar photocatalytic degradation conditions of bisphenol A in water using titanium dioxide," *J. Photochem. Photobiol. A: Chem.*, 163, 419-424.
- Borja, R., Alba, J., Banks, C.J., 1997. Impact of the main phenolic compounds of olive mill (OMW) wastewater on the kinetics of acetoclastic methanogenesis. *Process Biochem.* 32, 121-133.
- Hamdi, M., 1992. Toxicity and biodegradability of olive mill wastewaters in batch anaerobic digestion. *Appl. Biochem. Biotechnol.* 37, 155-163.
- Gogate, P.R., Pandit, A.B., 2004. "A review of imperative technologies for wastewater treatment I: oxidation technologies at ambient conditions," *Adv. Envtl. Res.*, 8, 501-551.
- Xu, Y., 2001. Comparative studies of the $Fe^{3+/2+}$ - UV, H_2O_2 -UV, TiO_2 -UV/vis systems for the decolorization of a textile dye X-3B in water. 43, 1103-1107.