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Photocatalytic Degradation of Emergents Pollutants in Nanoparticles Solution

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ABSTRACT

Among different advanced oxidation processes (AOPs), heterogeneous photocatalysis has emerged as a promising process of water treatment. Its effectiveness results from an oxidation by radicalizing way initiated by the attack of a very reactive radicalizing entity generated in the medium (the radical hydroxyl, HO.). This work aims to study the effectiveness of heterogeneous photocatalysis in water treatment containing emerging pollutants. The experiments were carried out in an aqueous suspension of titanium dioxide and zinc oxide with the use of the sun such as natural radiation. The comparative study between the two catalysis indicates that the degradation of paracetamol is very effective with zinc oxide.

Keywords: Nanoparticle, Photocatalytic, zinc oxide, titanium oxide.

1 Introduction

Many pharmaceuticals, such as antibiotics, are not susceptible to degradation by biological treatments. Paracetamol is a very common analgesic and antipyretic drug that has been widely used all over the world [1], it is regularly detected in the surface waters. Photocatalysis has been proposed as an effective Advanced Oxidation Process (AOP) for the degradation of this class of compounds in waters. This technique may permit not only to remove the contaminant from the polluted system, but also to completely degrade it without giving rise to undesired by-products. Which may be even more noxious than the parent compound [2,3]. Solar photocatalysis for wastewater treatment has proven to be a highly effective technology which most researchers have employed [4]. Photocatalytic degradation of organic pollutants in water and air using semiconductive particles, such as TiO_2, Nb_2O_5 and ZnO, has attracted extensive attention in the past two decades. Titanium dioxide is widely used as photocatalyst because it is photochemically stable, nontoxic and low cost. ZnO also has attracted much attention with respect to the degradation of various pollutants due to its high photosensitivity, stability and wide band gap. While TiO_2 is widely employed as a photocatalyst, ZnO is a suitable alternative to TiO_2 as it has a similar band gap energy (3.2 eV), larger quantum efficiency than TiO_2 and higher photocatalytic efficiencies have been reported [5].

2 Experimental

Paracetamol $C_8H_9NO_2$ is extensively used as analgesic and antipyretic drug was provided by Saidal Company for Pharmaceutical Industry (Algeria). A commercial available titanium dioxide and zinc oxide were used as a photocatalyst. All the experiments were performed under natural sun light. The new solar photocatalytic reactor used in this experiment is based on Compound Parabolic Collectors (CPC) supported by an aluminum frame. The collector consists of 07 glass tubes in the form of a coil 30 cm long and 2.6 cm internal diameter placed on an aluminum frame with reflectors placed under the tubes to increase the solar

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flow intensity. Paracetamol degradation was evaluated by measuring the absorbance with spectrophotometer UV-VISIBLE type Shimadzu UV1800. The UV absorption spectrum of paracetamol in aqueous solution. The maximum absorption band is located at 243 nm.

3 Results and Discussion

Preliminary experiments were carried out to determine the photocatalysis performance for paracetamol (Figure1). An initial three successive experiments were undertaken: the first one was carried out in the presence of TiO_2 without radiation (Adsorption); the second is in the solar radiation without titanium dioxide (photolysis); and the third one was carried out under solar radiation and in the presence of suspended TiO_2 catalyst. After 150 min of radiation, only 1% of the initial active molecules were adsorbed. Photolysis process shows that the paracetamol degradation rate is also insubstantial; it reaches a value of 5% after 150 min of the reaction time. In the case of the photocatalysis process, the combined system of titanium dioxide and U.V. (solar) radiation increased the removal efficiency of the paracetamol up to 80%, after the same time of the reaction used in photocatalysis and adsorption. Thus, in comparison to the mechanism of photocatalytic degradation, the kinetics of adsorption and photolysis were negligible. The second part of this work was to compare the efficiency of two types of catalyst titanium dioxide TiO_2 and zinc oxide ZnO (Fig. 2). The use of TiO_2 as a catalyst enables a good degradation of paracetamol which can achieve a disposal rate of 79 % after 150 min with a TiO_2 concentration of 0.5g/L. However, the removal rate can achieve 93% by zinc oxide ZnO after 120 min.

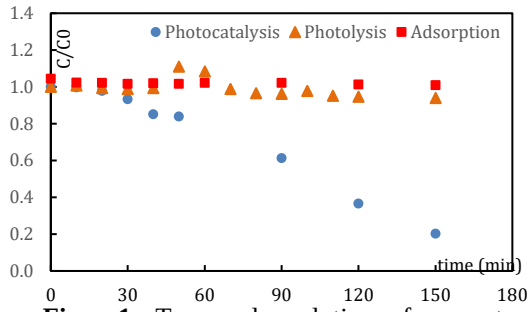

Figure1: Temporal evolution of paracetamol reduced concentration for different processes. CPR = 10mg.L^{-1} Free pH, CTiO_2= 0.5 mg/L.

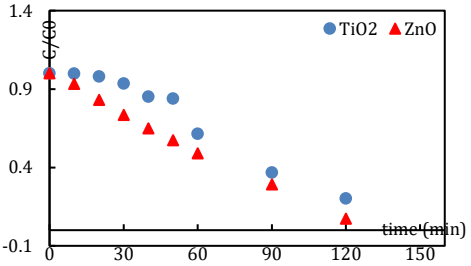

Figure2: Temporal evolution of paracetamol reduced concentration for different Catlysts. CPR = 10 mg.L-1 Free pH, C = 0.5 mg/L.

4 Conclusions

In this work, the degradation efficiency of paracetamol was investigated via the heterogeneous system with titane dioxide as photocatalyst in tubular photocatalytic reactor under natural solar radiations. The results show that the photocatalytic process U.V./TiO_2 seems to be very efficient on the removal of paracetamol resistant to conventional techniques. Paracetamol has been degraded by both ZnO and TiO_2 catalysts. However important (92%) degradation was observed after 120 min by ZnO. Therefore, it may be concluded that for solar applications ZnO will be the best catalyst for the pollutants degradation. For less catalyst loading and less time of treatment, best degradation rate was observed.

References

[1] Thi V-T., Lee B-K. (2017) Effective photocatalytic degradation of paracetamol using La-doped ZnO photocatalyst under visible light irradiation. Materials Research Bulletin 96, 171–182.

[2] Shen and Andrews S. A. (2011) Demonstration of 20 pharmaceuticals and personal care products (PPCPs) as nitrosamine precursors during chloramine disinfection, Water Research, 45, 944 .

[3] Wang W.-K., Chen J.-J., Gao M., Huang Y.-X., Zhang X. and Yu H.-Q. (2016) Photocatalytic degradation of atrazine by boron-doped TiO2 with atunable rutile/anatase ratio, Applied Catalysis B, 195, 69.

[4] Fernández-Ibáñez, P. 1., Blanco, J., Malato, S., & De Las Nieves, F. J. (2003). Application of the colloidal stability of TiO2 particles for recovery and reuse in solar photocatalysis. Water Research, 37(13), 3180-3188.

[5] Chekir N., Benhabiles O., Tassalit D., Laoufi N. A. and Bentahar F. (2016) Photocatalytic degradation of methylene blue in aqueous suspensions using TiO2 and ZnO. Desalination and Water Treatment, 57, 6141–6147.

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