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SEMICONDUCTOR-SENSITIZED PHOTODEGRADATION OF DICHLORVOS IN WATER

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EXTENDED ABSTRACT

In this study, the photocatalytic degradation of dichlorvos, an organophosphorous insecticide, using two types of photocatalysts (TiO_2 and ZnO) has been investigated. The aim of the study was i) to evaluate the kinetics of pesticide disappearance, ii) to compare the rates of reaction assisted by the two photocatalysts in the absence as well as in the presence of an oxidant (H_2O_2), iii) to examine if complete mineralization is achieved. The influence of various parameters such as the mass of the catalyst, the initial concentration of the pollutant, the addition of an oxidant and the increase of temperature is also studied.

All experiments were carried out in a 500ml Pyrex UV reactor, equipped with a diving Philips HPK 125W high-pressure mercury lamp. A Pyrex filter blocked wavelengths bellow 290nm. Aliquots were withdrawn at specific time intervals and the concentration of the selected pesticide was determined by HPLC.

The blank experiments for either illuminated dichlorvos solution or the suspension containing TiO_2/ZnO and dichlorvos in the dark showed that both illumination and the catalyst are necessary for the destruction of the pesticide. Dichlorvos disappearance is achieved in ~20min when treated with illuminated TiO_2 and in ~120 min with illuminated ZnO. The disappearance of the organic molecule follows first-order kinetics according to the Langmuir-Hinshelwood model. It was observed that the initial rate increases linearly with an increase in the amount of catalyst up to a level where it reaches a plateau. Temperature has also a positive effect on the rate of the reaction.

The addition of an oxidant (H_2O_2) to the TiO_2 suspensions leads also to an increase in the rate of photooxidation and the system was studied at different H_2O_2 concentrations. On the contrary the addition of hydrogen peroxide in ZnO suspensions caused a decrease in the reaction rate.

Finally, in order to examine if complete mineralization is achieved DOC measurements were carried out. Illuminated TiO_2 suspensions were proved to be quite effective in mineralizing dichlorvos. Measurements of chlorine or phosphate ions gave valuable information about how this process is achieved. On the other hand ZnO suspensions could not lead to complete mineralization of the insecticide.

Key words: photocatalysis, dichlorvos, TiO_2, ZnO, oxidation, mineralization