Al/Cu Pillared Clay: catalytic performance in photo-Fenton to mineralize Diazinon

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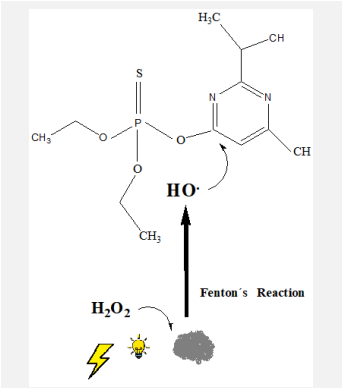

Diazinon (DZN) is an organophosphate pesticide that is used as insecticide to control soil and foliage pests and insects in a wide range of crops in Mexico and this causes it to infiltrate and, by dragging, reach water bodies. Thus, its removal from water is relevant. This work aimed to assess the performance of Al/Cu pillared clay as catalyst of the photo-Fenton process to mineralize DZN. For this purpose the main assessed variables were reaction time, radiation source wavelength, addition of H_2O_2 and catalyst loading. The response variables were DZN concentration and TOC removal percentage. It was found that the variable affecting the most the DZN removal percentage is wavelength. With foto-Fenton UV a 100% degradation DZN at 10 minutes was achieved when conducting the experiment at the natural pH of 6.8. After 1 h of treatment, the highest mineralization (28%) removal percentage was achieved with a 0.5 g_{cat}/L catalyst loading.

Introduction

Diazinon (DZN) is an organophosphate pesticide that is used as an insecticide, acaricide and nematicide. DZN is used to control soil and foliage pests and insects in a wide range of crops such as rice, fruits, grapes, sugarcane, corn and potatoes [1]. This causes it to infiltrate and, by dragging, reach bodies of water, such as the Madín Dam near Mexico city, in which values of 13 ng/L have been reported [2]. This causes damage to ecosystems and an example of this, is the decrease of the common carp species (*C. carpio*) in the Madín dam due to the effect of embryotoxicity caused by the organic contaminants present in the water of this dam. Therefore, the objective of this work was to evaluate the effect of Al/Cu-PILC as a catalyst in the photo-Fenton-like process for the degradation of DZN.

Material and Methods

Al/Cu-PILC was prepared following the procedure reported by Hurtado, 2022 [3]. The catalyst characterization was carried out by X-ray diffraction (XRD). DZN degradation by photo-Fenton-like experiments was carried out in a Pyrex glass reactor where a 0.1 L of aqueous solution of DZN (C_0 = 20 000 ng/L) was loaded in all experiments. The temperature of the reaction system (298 K) was controlled by a thermal bath. An UVP-Pen Ray Model 3SC-9 high-pressure mercury lamp (8W) was employed as the light source providing radiation at 254 nm and three Visible ligth lamps were used to establish the effect of wavelenght. The effect of catalyst loading was established in the range of 0.25-1 g_{cat}/L. The catalyst was dispersed in the DZN solution by stirring at 800 rpm followed by the incorporation of a stoichiometric amount of H_2O_2 into the system, and finally, illumination was turned on. Samples were periodically withdrawn from the reactor to determine total organic carbon (TOC) and DZN concentration by UHPLC content at different times.

Results and Discussion

Regarding the effect of catalyst loading (0.25, 0.5, and 1 g_{cat}/L), the experiment with 0.5 g_{cat}/L showed slightly superior performance in comparison to the loading of 0.25 and 1 g_{cat}/L. The lower catalyst loadings showed better mineralization rates. The experiment with 0.5 g_{cat}/L overperform 3-times, the mineralization attained with 1 g_{cat}/L.

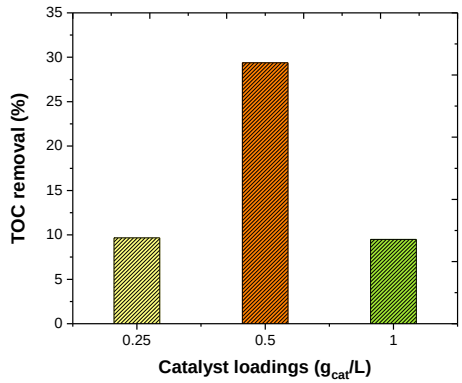

Figure 1. Removal TOC (%) at different catalyst loadings during the photo-Fenton-like process. Reaction conditions: V = 0.1 L; T = 298 K; C_0 = 20 000 ng/L (DZN); initial pH_0 = 6.8.

Al/Cu Pillared Clay catalyzes the photo-Fenton process and allows complete DZN degradation only with the photo-Fenton-like UV in the first 10 minutes, followed by photo-Fenton-like Vis with 53% and finally with adsorption only 8% was achieved. The variable with the highest impact on DZN mineralization extent was found to be radiation wavelenght.

Table 1. Results of the degradation DZN by UHPLC using 0.5 g_{cat}/L as catalyst loading

Process	Degradation DZN (%)
adsorption	8
photo-Fenton-like UV	100
photo-Fenton-like Vis	53

[a] at 10 minutes.

Conclusions

DZN, at real concentration in water bodies, is readily degraded by photo-Fenton UV process catalyzed by bentonite pillared with Al/Cu followed by photo-Fenton-like Vis with 53% and finally with Al/Cu adsorption only 8% using 0.5 g_{cat}/L as catalyst loading at the natural pH of 6.8.

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