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Investigation of chlorimuron-ethyl degradation by Fenton, photo-Fenton and ozonation processes

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HIGHLIGHTS

- AOP have been proved to be efficient for the mineralization of an herbicide solution.
- Combination of ozone with UV or H_2O_2 was able to achieve high mineralization levels.
- Photo-Fenton process was the best AOP when the objective was to mineralize.
- Residual Fe in photo-Fenton was below the limit allowed of disposal in Brazil.

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ABSTRACT

In this work, the degradation of chlorimuron-ethyl, which belongs to the class of sulfonylurea herbicide, was performed by Fenton, photo-Fenton and ozonation. At the used experimental conditions, photo-Fenton degradation was influenced by the initial H_2O_2 and Fe^{2+} concentration. In the case of its degradation by ozonation, the best results were achieved when ozone was combined with UV and H_2O_2. Among the studied AOPs, photo-Fenton presented the best result concerning mineralization and chlorimuron-ethyl degradation, achieving degradations higher than 85% after 90 min of reaction. Based on the obtained results, the photo-Fenton system can be an important technique to be applied in the treatment of wastewater containing this pesticide.

1. Introduction

The scarcity of fresh water and adequate access to it can be expected to worsen as a result of population growth and industrial demands for water. In addition, liquid effluents containing toxic substances are generated by a variety of chemistry-related industrial processes, as well as by a number of common household or agricultural applications. The inadequate management of these residues can cause contamination of soil and ground and surface water [1]. Chemical and pesticide industries are considered as the largest producers of hazardous effluents due their effluents contain toxic and non-biodegradable substances that may persist in environment even after treatment by conventional methods [2].

Agribusiness in Brazil occupies a prominent position in the economy, in 2011 Brazilian agricultural exports totaled US$ 94.6 billion and the trade surplus stood at US$ 77.5 billion dollars [3]. The contribution of agribusiness, which has the soybeans as the main product in the Gross Domestic Product (GDP) is around 22% [3]. As agricultural production in Brazil is huge, the need for using agricultural pesticides is also notable. According to SINDAG (National Union of Products Industry for Agricultural Protection) a great part of the agricultural trade corresponds to the herbicide market [4]. However, the use of these compounds has caused a series of human health problems, with record more than 5000 cases of poisoning and about 170 deaths in the country in 2009 [5].

Herbicides such as chlorimuron-ethyl, which belongs to the sulfonylurea group are pesticides widely used in agriculture of soybeans. They were discovered around 1970 and became widely used because they improve productivity, have low rate of application (2–75 g ha^{-1}), good selectivity and relatively low toxicity in

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