

Degradation of the herbicide tebuthiuron by electrochemical advanced oxidation processes using a BDD anode.

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Keywords: Pesticide, Fenton, degradation, EAOPs, BDD.

Introduction

Due to contamination of the environment by pesticides and their mishandling, there is the need for treatment of contaminated sites and correct disposal of materials containing them. In recent years, electrochemical advanced oxidation processes (EAOPs) have shown great potential for treating water contaminated with pesticides. Tebuthiuron (TBH) is the most commonly used herbicide for weed control in the sugar cane cultivation in Brazil. Only a few studies have reported its degradation by TiO₂ photocatalysis, photo-Fenton, and electro-oxidation (EO) with boron-doped diamond (BDD) anode [1-3]. In the present study, the performance of EO, electro-Fenton (EF) and UVA- or solar-assisted photoelectro-Fenton (PEF and SPEF, respectively) regarding the degradation of this herbicide or its commercial formulation (Combine 500C[®]) has been comparatively studied at laboratory scale and using a pre-pilot flow plant.

Results and Discussion

The total organic carbon (TOC) removal has demonstrated the overall mineralization of TBH by EF and PEF with BDD using a laboratory scale system (Figure 1).

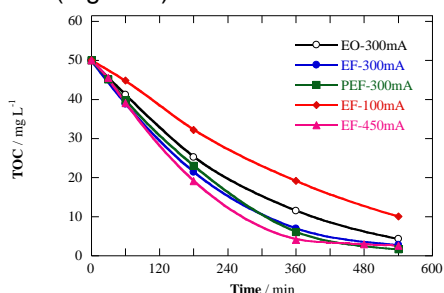


Figure 1. Mineralization of 100 mL of 50 mg L⁻¹ TOC (TBH) solutions in 0.05 M Na₂SO₄ of pH 3 using an open and undivided cell with a 3 cm² boron-doped diamond (BDD) anode and 3 cm² O₂-diffusion cathode at 25 °C. EF with 0.5 mM Fe²⁺; PEF with 0.5 mM Fe²⁺ under 6 W UVA irradiation at λ_{max} = 360 nm.

Moreover, TOC removal has demonstrated a greater mineralization of the commercial TBH formulation by

EF and, especially, by SPEF using a pre-pilot flow plant (Figure 2).

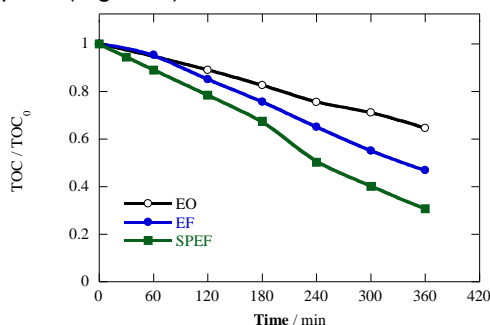


Figure 2. Mineralization of 2.5 L of a 20 mg L⁻¹ TOC of commercial TBH formulation in 0.05 M Na₂SO₄ of pH 3 by three EAOPs using a pre-pilot flow plant with a 20 cm² BDD anode and 20 cm² O₂-diffusion cathode at 35 °C and 1 A. EF and SPEF were performed with 0.5 mM Fe²⁺.

Conclusions

Based on TOC removal trends, the best results for TBH mineralization were obtained upon application of the Fenton-based EAOPs using both, the laboratory scale system and the pre-pilot flow plant.

Acknowledgements

The authors wish to thank MINECO (Spain) for financial support under project CTQ2013-48897-C2-1R, co-financed with FEDER funds, and from FUNDECT, CAPES and CNPq (Brazil). The Ph.D. grants awarded to A. Thiam from MAEC-AECID (Spain) and to F. Gozzi from CAPES (Brazil) are also acknowledged.

¹ Bahnemann, W.; Muneer, M. and Haque, M. M. *Catalysis Today*. **2007**, 124, 133.

² Silva, M. R. A.; Vilegas, W.; Zanoni, M. V. B. and Nogueira, R. F. P. *Water Research*. **2010**, 44, 3745.

³ Alves, S. A.; Ferreira, T. C. R.; Sabatini, N. S.; Trientini, A. C. A.; Migliorini, F. L.; Baldan, M. R.; Ferreira, N. G. and Lanza, M. R. V. *Chemosphere*. **2012**, 88, 155.