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Photocatalytic remediation of an organophosphorus pesticide using the composite SnO_2/Fe_2O_3 with visible light irradiation

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Abstract

Pesticides are considered hazardous organic pollutants. It is estimated that about a third of the total mass of pesticides applied to the soil remains as a soil-bound residue in agricultural areas. Widely used worldwide as an insecticide and avicide, Fenthion (O, O-dimethyl-O-(4-methylmercapto)-3-methylphenylthio-phosphate) is a thioether organophosphorus pesticide detected as residue in several agricultural products (SANTOS *et al.*, 2021). The development of methods and suitable materials to remove organic pollutants from water and other matrices has been a major concern among researchers. Photocatalysis is one type of advanced oxidative process (AOP) considered a green technique with the potential for eliminating toxic chemicals in the environment using sunlight. Herein, we evaluated the photocatalytic performance of the composite SnO_2/Fe_2O_3 on fenthion degradation, which is non-toxic and responsive to visible light. The composite SnO_2/Fe_2O_3 was synthesized from the Pechini method in a ratio SnO_2:Fe_2O_3 of 3:1 and characterized by XRD, DRS, SEM, EDS, FT-IR, and ASAP. The photocatalytic reactions were performed under visible light irradiation ($\lambda > 420$ nm) using 100 mg of photocatalyst, 100 mL of fenthion solution 30 mg L^{-1}, at pH 4.0, 6.5 and 10, and hydrogen peroxide in different concentrations. The required adsorption time before irradiation was determined for each pH condition (Fig. 1a). HPLC with a DAD detector was used to monitor the decrease in fenthion concentration during irradiation. The condition that resulted in the highest fenthion photodegradation was at pH 4 with 200 mg L^{-1} hydrogen peroxide (Fig. 1b and c). This condition led to 91% degradation of fenthion in 4 hours, with an apparent rate constant of 1.05 x 10^{-2} min^{-1}. This value is much larger than that obtained through photolysis (5.7 x 10^{-3}) and catalysis (6,9 x 10^{-3}) experiments (Fig 1d). Further, our results are also much higher than those already published, such as fenthion degradation under UVA A (5.5× 10^{-3} min^{-1}) and UVB B (9.9×10^{-3} min^{-1}) irradiation and under natural sunlight (3.3 × 10^{-4} min^{-1}) (SANTOS *et al.*, 2021; SAKELLARIDES *et al.*, 2003), which demonstrates the potential of the composite SnO_2/Fe_2O_3 in fenthion remediation under sunlight irradiation.

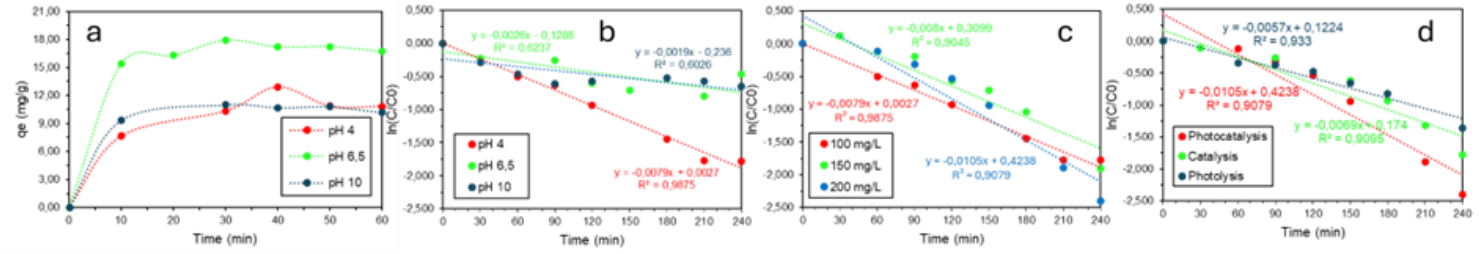

Figure 1. Adsorption curves in different pH (a) and linear pseudo-first-order graphics: Different pHs (b); Different H_2O_2 concentrations (c); Type of remediation treatment (d).

Keywords: Photocatalysis, Pesticides*, Visible light*

References

SANTOS et al., **Environmental Technology** (2021)

SAKELLARIDES et al. **Int J Environ Anal Chem.** (2003) 83, 33

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