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Simulated Sunlight Photodegradation of 2-Mercaptobenzothiazole by Heterogeneous Photo-Fenton Using a Natural Clay Powder

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Highlights.

- Natural clay powders, when irradiated by UVA-Vis, can be used as photocatalysts for abatement of POPs.
- The photodegradation of MBT follows pseudo-first order kinetics, $HO^{\bullet}$ being the main reactive species.
- Suitable explanations are given for the role of O_2, pH, H_2O_2 and NCP dose in the process.
- The highest TOC removals were obtained using UVA at pHs, in the absence of O_2.

Abstract

The efficiency of 2-mercaptobenzothiazole (MBT) degradation by heterogeneous photo-Fenton process using local natural clay powder (NCP) is described. Experiments were conducted at natural pH with a batch reactor equipped with a medium-pressure Hg lamp emitting mainly at 366 nm. The natural clay was characterized by SEM-EDS, UV-Vis diffuse reflectance spectroscopy, XRF and XRD analysis. The specific BET surface area of the clay was 30.2 $m^2 \cdot g^{-1}$.The photodegradation of MBT follows first order (for direct photolysis) and pseudo-first order kinetics (for photocatalysis). Direct photolysis of MBT showed a negligible effect both upon 254 and 365 nm irradiation, while 42.5% and 62% of MBT was eliminated in three hours under 310 nm irradiation in the presence of H_2O_2 and under sunlight irradiation (using NCP), respectively. Kinetic runs carried out with $5.0 \cdot 10^{-5}$M MBT and 0.5g$\cdot L^{-1}$clay showed both higher MBT conversion and photodegradation rate at basic pH (10) and in oxygen saturated media. The presence of oxalic acid and H_2O_2 significantly enhanced MBT photodegradation. The photodegradation of MBT is mainly attributed to reaction with $HO^{\bullet}$, leading to different intermediates that have been identified by HPLC-MS. A reaction mechanism is proposed. The highest TOC removals were obtained using UVA at low pHs (2.6), and in the absence of O_2 with 68% and 65% TOC removal respectively in two hours, whereas MBT transformation is faster (t½ = 7 min) and higher (90%) at pH = 10. The obtained results strongly support the use of natural clay rich in iron oxides as inexpensive, clean and efficient pho