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Water remediation by UV–vis/H_2O_2 process, photo-Fenton-like oxidation, and zeolite ZSM5

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ABSTRACT

The present work shows the application of the UV–vis/H_2O_2 process, Fenton-and photo Fenton-like reactions in presence of zeolite material ZSM5 in the degradation of a pharmaceutical pollutant recently found in environmental aquatic systems, the anti-inflammatory drug naproxen (NPX). Three commercial iron oxide powders (hydrated hematite, hematite, and magnetite) for Fenton-like reaction were tested against 10 mg L^{-1} of NPX. An UV–vis simulator source was employed in order to contrast the performance of the photo Fenton-like reaction during 120 min of irradiated conditions in a no-buffered almost neutral pH 6.5 ± 0.5. ZSM5 zeolite was tested as adsorbed material in mechanical mixtures with or without iron oxide powders in order to improve the physical removal along with the oxidative stress. Effects of non-photocatalytic control test (such as UV–vis photolysis, H_2O_2 oxidation, and oxide iron complex formation) were previously evaluated. Negligible effect was evidenced for Fenton-like reaction and adsorption in dark conditions by the use of neither iron oxide species nor zeolite (<0.01 mmol NPX L^{-1} min^{-1}). In contrast, the photo-Fenton-like reaction promotes the total elimination of initial 10 mg L^{-1} of NPX with a concomitant 50–60% of mineralization by the use of Fe_2O_3 and Fe_3O_4, respectively, with 18 and 14 mmol L^{-1} min^{-1} initial NPX degradation rate. Improvement of dissolved organic carbon (DOC) reduction by adsorption due to the presence of ZSM5 was not observed under illuminated conditions and biodegradable character of the final effluent was not improved. The presence of a heterogeneous material such as zeolite ZSM5, promotes only a benefit effect on DOC removal in absence of H_2O_2 reagent and results are antagonist to Fenton-like and photo-Fenton-like reactions due to the well-differentiated reaction mechanism and the concomitant likely dissimilar by-products generated. Residual by-products are not suitable for a post-biological operation due to the formation of recalcitrant polymers not further degraded by photo-Fenton-like reaction with iron oxides.

Keywords: Photo-Fenton like reaction; Iron oxides; Organic pharmaceutical pollutants

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