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Use of pipe deposits from water networks as novel catalysts in paraquat peroxidation

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HIGHLIGHTS

- Pipe deposits from drinking water networks have been used as catalysts.
- Heterogeneous oxidation of paraquat by Fenton's reaction was carried out using pipe deposits.
- Composition and pH_{pzc} of the solid affects the catalytic performance, allowing operating in a wide pH range.
- Stability of the materials is improved at neutral conditions.

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ABSTRACT

The present work intends to evaluate the possibility of using real pipe deposits as peroxidation catalysts (i.e., in the heterogeneous Fenton-like oxidation process) to degrade the pesticide paraquat in water. The valorisation of these loosely or firmly attached materials, often discarded after networks cleaning or maintenance, respectively, is envisaged in off-line waste water treatment applications. They may however be also applicable *in situ*, for instance in case of a contamination event of water networks.

Four iron-containing real deposits, herein called S1, S2, S3 and S4, were considered. The results revealed that two of them (samples S1 and S2) exhibit good catalytic performance in the pesticide degradation and mineralization. Another one (sample S3) has goethite and also some metals in its composition that can decompose the hydrogen peroxide, compromising the peroxidation process. The calcium rich deposit, S4, is only useful as catalyst when the medium pH is adjusted to the required acidic values of Fenton's reaction. Even so, other deposits showed good performances even at neutral pH values, which is related with their low pH_{pzc} values. It was found that depending on the solid nature, the catalytic performance can be predominantly due to the presence of the solid phase, but in some cases the homogenous process resulting from leached ions play an important role. With the deposit that exhibited the best performance, an exhaustive study of the pH effect was done, showing the stability of these materials at neutral conditions.

1. Introduction

Contamination of water courses with chemical compounds, namely pesticides, is an increasing concern due to their toxicity. Among pesticides, paraquat (PQ) is one of the most hazardous, being also of concern its high solubility in water (620 g/L). Its use in agriculture as a pesticide and its high mobility in the soils have led to increasing levels of this compound in ground water. Even at very low doses, this herbicide can pass some treatment steps in a water treatment plant and reach the drinking water of the water distribution systems [1]. For these reasons, paraquat represents a threat to human health. Beyond the natural occurrence of paraquat in water due to its large usage in some countries, it could be found in this matrix by other ways. Actually, the present work is part of a European project whose main objective is to detect anomalous situations and treat the water of distribution systems in case of a deliberate contamination event (SecurEau, [2]). In those circumstances, the paraquat concentration in water could be very high, fact that is possible due to its high solubility in water.

In this study, the peroxidation (or Fenton) process is proposed to degrade paraquat. The Fenton's reagent is a non-expensive technology, widely used in wastewater treatment. The process involves a complex mechanism in which the parent molecules are

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