Insights into the oxidation of microplastics by the Fenton process

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Abstract

The widespread presence of microplastics (MPs) in aquatic ecosystems constitutes one of the most challenging environmental issues nowadays. The small size of these solids coupled with their low chemical and biological reactivity makes their removal from aqueous matrices particularly complex. Although advanced oxidation processes (AOPs) have been widely studied for the treatment of persistent contaminants in waters, there are only a few works focused on MPs degradation. In this study, a homogeneous and heat-activated Fenton treatment has been proposed to evaluate the changes that MPs can suffer along this oxidation process. Polystyrene (PS) particles (100-250 µm), obtained from commercial plastic trays by cryogenic milling, and commercial glitter were used as MPs. The degradation experiments (5 days) were carried out at 80ºC and pH 3 in a glass reactor under constant stirring (200 rpm). The reactor volume and MP mass were established at 75 mL and 100 mg, respectively. The initial concentrations of Fe3+ and H2O2 were set at 10 mg/L and 1000 mg/L, respectively. To enhance the oxidation yield, three additional H2O2 doses (75 g/L) were added per day once complete consumption of H2O2 was reached. In the same line, an additional dose of Fe3+ (750 mg/L) was also added once a day (with the first H2O2 dosage). The images taken by optical microscopy revealed slight surface changes in the studied MPs, especially in PS, where semitransparent regions were appreciated due to the decrease in the thickness of the particle in these areas. Furthermore, an analysis of the FTIR spectra revealed small changes after Fenton treatment, denoting the presence of new functional groups. Nevertheless, the mass loss observed was relatively low (5-10%), which indicates that MPs mainly undergo surface changes. These modifications can modify the MPs hydrophobicity and thus, the Fenton treatment could improve their further separation from water.

Keywords: microplastic, water treatment, Fenton oxidation, polystyrene, glitter

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