Photo-Fenton Oxidation of Microplastics: Impact of Polymer Nature

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Abstract

Plastics have been widely used across a multitude of fields such as agriculture, industry, medicine, or daily needs. Consequently, vast amounts of waste are being generated, leading to environmental contamination. Microplastics (MPs), particles smaller than 5 mm, are highly persistent and act as pollutant carriers, posing risks for both the environment and public health. Advanced Oxidation Processes are promising technologies for removing MPs from water, but they have been scarcely investigated. The effectiveness of Photo-Fenton oxidation for nanoplastics removal has been demonstrated, but its feasibility for MPs elimination remains unclear. This work analyzes the effectiveness of the Photo-Fenton process for MPs (50–100 μm) removal, focusing on the influence of the polymer nature (EPS, PET, LDPE, PC, PVC). Experiments were conducted in a 0.5L glass photoreactor equipped with a medium-pressure mercury lamp (UV-Vis) and a cooled quartz chamber, under selected operating conditions ((MPs)0=20 mg L-1, (Fe3+)0=1 mg L-1, (H2O2)0 =500 mg L-1 (additional doses every 20 min), T=25^{o}C, pH0=3, t=8 h). Photo-Fenton oxidation was highly effective, achieving MPs weight loss values of up to 46% within 8 h of oxidation, which clearly improve the results reported in the literature so far. The removal yields of the MPs showed the following trend: EPS> LDPE> PC> PET> PVC (46%, 42%, 35%, 29% and 28% weight loss, respectively). Notably, the bulk density of the particles was identified as one of the main reasons behind such reactivity trend towards oxidation. A clear trend was found between the weight loss and the density of MPs (Figure 1). These results suggest that the increased porosity and exposed surface area of MPs favor their oxidation. In fact, an increase of the carbonyl index on particles surface was proved by FTIR analysis, which allowed to confirm that oxidation proceeds from the surface to the core of MPs.

Keywords: water treatment, microplastics, Photo, Fenton oxidation, water contamination.

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