Influence of microplastic (LDPE, PET and uPVC) aging on the sorption of ten organic contaminants in water

Mariana N. Miranda*†[1,2], Ana R. Lado Ribeiro[1,2], Adrián M. T. Silva[1,2], and M. Fernando R. Pereira[1,2]

[1]LSRE-LCM - Laboratory of Separation and Reaction Engineering - Laboratory of Catalysis and Materials, Faculty of Engineering, University of Porto – Rua Dr. Roberto Frias, Porto, 4200-465, Portugal

[2]ALiCE - Associate Laboratory in Chemical Engineering, Faculty of Engineering, University of Porto – Rua Dr. Roberto Frias, Porto, 4200-465, Portugal

Abstract

As microplastics in the environment undergo aging due to diverse degradation mechanisms and pathways, their characteristics change over time. These modifications can have implications on their behavior in the Earth's systems, including on the interaction with biota and other substances. In some scenarios, such as in a wastewater treatment plant, microplastics coexist with other contaminants, with the potential further degradation of the microplastics during the treatment stages and the sorption of those co-occurring substances on their surface. Therefore, the main goal of this study is to assess the changes in the sorption capacity of LDPE – low-density polyethylene, PET – poly(ethylene terephthalate), and uPVC – unplasticized poly(vinyl chloride) microplastic particles after undergoing different levels of aging. Ten substances were selected as sorbates, including pesticides and pharmaceutical substances. Trace concentrations of these substances were used during the sorption experiments conducted with four types of samples of each polymer: virgin, artificial ozone exposed, real rooftop weathering, and real rooftop weathering with addition of rainwater according to the precipitation pattern. The study also included the determination of one of the pesticides – pentachlorophenol – equilibrium isotherms, as this was the most sorbed substance on LDPE and PET. The results showed an increase in the sorption capacity of the substances studied, particularly on weathered LDPE and uPVC, and on ozone-aged PET. Different affinities were observed for the organic substances and polymers and were related to the modifications detected from the characterization of the virgin and aged microplastic particles. This study supports the theory that microplastics can be transport vectors for other contaminants, while also highlighting the importance of the aging degree on the sorption capacity of microplastic particles and the potential enhanced risk of pollutant-sorbed aged microplastics.

Keywords: degradation, ozone, pesticides, pharmaceuticals, UHPLC MS/MS, weathering

*Speaker

†Corresponding author: mmiranda@fe.up.pt