

Transfer of organic wastewater contaminants from microplastics to natural dissolved substances

SVEN SEIDENSTICKER, GRETA FELLEBERG,
CHRISTIANE ZARFL, PETER GRATHWOHL

Center for Applied Geosciences, Tuebingen University,
Germany; sven.seidensticker@uni-tuebingen.de

A remarkable part of hydrophobic organic contaminants in aqueous environments is not freely dissolved but associated with several types of particles. Recently, the contamination of water bodies with microplastic particles (MP), i.e. plastic debris smaller than 5 mm, came into the focus of both public and research. Besides likely impairments due to their mere presence, MP are suspected to serve as a transport vector for organic contaminants either additives or wastewater compounds. Wastewater as well as receiving waters contain dissolved organic matter (DOM), whose influence on pollutant partitioning and mass transfer kinetics has not been investigated so far. Hence, this study aims to investigate the potential of MP to act as a pollutant transport vector and how this changes in the presence of DOM.

Polyethylene (PE) is among the most detected plastic materials in the environment and hence was chosen as a representative type of MP. Humic acid as a common type of DOM was used as a model substance. Sorption interactions were studied in batch experiments with a constant concentration of MP (1 g/L) and different concentrations of DOM (0, 0.15, 0.25, 0.50, 0.75, 1.00 g/L). MP were spiked with common wastewater pollutants allowing both to study desorption from MP and to monitor transfer to DOM in dependence of its concentration. Samples were taken at 11 times from 10 min to 240 h. Kinetics were analysed with film and intraparticle diffusion models.

Log partition coefficients (K_{PE}) between MP and water were 4.0, 4.5, 3.8, and 1.9 for phenanthrene, tonalide, 4-nonylphenol, and benzophenone, respectively, while mean Log partition coefficients between DOM and water were 3.7, 3.7, 4.0, and 3.6, respectively. Increasing amounts of DOM came along with a significant reduction of K_{PE} . Kinetics were fast and limited by external mass transfer if no or small amounts of DOM are present. At high DOM concentrations the mass transfer resistance shifted towards the MP hence intraparticle diffusion was governing desorption kinetics, which in a batch system slows down mass transfer despite decreasing partition coefficients. These results allow to scale and to evaluate the vector function of MP for organic pollutants in the presence of DOM in both wastewater and freshwater.