

Sorption of polycyclic aromatic hydrocarbons (PAHs) on microplastics in the freshwater, brackish, and saline environments

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ABSTRACT

This study aims to examine the sorption behavior of polycyclic aromatic hydrocarbons (PAHs) on microplastics in the freshwater, brackish, and saline environments. Batch adsorption experiments were conducted (1) to compare the sorption behaviors of PAHs on microplastics; (2) to determine to which kind of microplastic PAHs have more affinity to; (3) to know the effect of changing salinity on the sorption behaviors of PAHs on microplastics; and (4) to determine the effect of the co-existence of different microplastics on the sorption of PAHs. Phenanthrene was used as the model PAH and polyethylene (PE) and polystyrene (PS) were used as the model microplastics. The sorption equilibrium of phenanthrene on PE and PS was reached within 5 minutes of contact time and that PE had greater sorption capabilities than PS. Additionally, the results best fitted the linear isotherm model (with non-zero intercept). Partition coefficient K of PE were higher by around 30 to 40 times to PS. This difference can be explained by the fact that PE is a rubbery polymer and has specific surface area three times greater than that of PS, a glassy polymer. Furthermore, PE and PS may have an interaction with each other as the composite additive model did not work out. Aggregation may have occurred between the PE and PS particles as aggregation can decrease the SSA, which in turn, decreases the sorption capabilities of the sorbent. The possible main sorption mechanisms are hydrophobic interactions and van der Waals forces. Furthermore, more phenanthrene is sorbed on PS and PE in more saline environments possibly due to the salting-out effect. Since the marine environment is the ultimate sink for both microplastics and PAHs, this may pose a risk on the organisms living in there. Additionally, PE is one of the most found and widely used plastic so disposal and handling of PE must be properly managed in the future as it can store more PAHs.

Keywords: Sorption, polycyclic aromatic hydrocarbons, microplastics, freshwater, brackish, saline, phenanthrene, polyethylene, polystyrene, linear isotherm model, hydrophobic interactions, van der Waals forces, salting-out effect