PFAS Passive Sampler

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Background/Objectives. The development of a passive sampler to allow in situ and user-friendly methods to monitor per- and polyfluoroalkyl substances (PFASs) in natural waters has been a challenging task of interest for both scientists and regulatory agencies. EPA and DoD have identified hundreds of sites contaminated with PFAS that require characterization and remediation. This paper presents the first prototype of a new passive sampler to monitor PFASs contamination in aquatic systems.

Approach/Activities. The passive sampler consists of a commercially available reticulated polyurethane foam that serves as adsorptive phase for the PFASs in aquatic systems. The adsorptive phase is a solid that due to its surface properties interacts with PFAS and concentrates it on the solid. Subsequent extraction of the adsorptive phase results in formation of a solution with significantly higher analyte concentration compared to the sampled medium, allowing much lower detection limits compared to the standard water analysis. Concentration of the PFASs in the extracts can be analyzed by LC-MS/MS. Two types of polyurethane foam were tested: an ether based polyurethane and an ester based polyurethane. First, adsorption kinetics was determined from the depletion of the water phase in polyurethane batch experiments conducted in duplicates for both types of foam. The kinetics experiments were conducted both in static exposures and with addition to a vibrating device to enhance the equilibration times. In the next phase, pieces of the polyurethane were placed in solutions with varying concentrations of PFOS and PFOA and allowed to equilibrate for 8 days after which the concentration of the analytes on the solid and in the water phase were determined. The data was used to construct adsorption isotherms. Finally, efficiency of PFOS and PFOA extraction from the polyurethane foams using pH-modified ethanol was tested.

Results/Lessons Learned. Under static conditions, equilibration of polyurethane with PFOS and PFOA appeared to have reached equilibrium in about 8 days. Application of a vibrating probe significantly enhanced the adsorption kinetics of the analytes. The adsorption isotherms of both analytes onto the foam followed Langmuir model. PFOS was showed stronger sorption to both types of foam than PFOA, and ether-based foam showed stronger sorption of both analytes compared to ester-based foam. Mass-balance analysis showed that extraction of the spent foam form adsorption experiments using 1% NH_3 in ethanol resulted in over 80% recovery of the analytes. Sensitivity analysis calculations on the application of the passive sampler to different scenarios of contaminated aquatic ecosystems are presented here as well. This study presents a promising proof of concept for a PFAS passive sampler based on reticulated polyurethane foam.