Polyethylene Devices (PEDs): Customizable Tool for Unique Applications in a Variety of Environmental Scenarios

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Background/Objectives. Initial development of passive samplers, such as PEDs, was a response to the need for easier, more reliable and representative methods for measuring dissolved concentrations of hydrophobic organic contaminants (HOCs), which due to their low solubility typically achieve very low, though environmentally significant, concentrations. PEDs offer cost effective implementation, improved detection limits and more temporally representative results than the traditional methods, such as conventional water sampling. This presentation focuses on demonstrating capability and data from PED measurement conducted in different sampling media and with substantially different goals. It also discusses activities necessary to obtain high-quality data from PEDs.

Approach/Activities. PEDs were deployed for measurement of polycyclic aromatic hydrocarbons (PAHs) and/or polychlorinated biphenyl (PCBs) in a variety of environmental settings, exposure types, and with different goals in mind. In situ (field deployment) and ex situ (laboratory) exposures were performed to assess freely dissolved HOC in porewater, groundwater and surface water. Deployment in piezometers and wells was used to collect dissolved PCB concentrations in groundwater to assess fate and transport of PCBs from upland sites into nearby water bodies. In situ PEDs mounted on stainless steel frames were deployed across the sediment-water interface in a marine setting to measure dissolved PCBs in both porewater and surface water and the results were used to calculate dissolved PCB flux across the sediment-water interface. The PCB flux data were used to inform a sediment cap design. PEDs were also deployed buried in sediments from a freshwater stream to assess the bioavailability of PAHs associated with contamination from a nearby manufactured gas plant (MGP) site. Accurate dissolved concentrations determined from any application must take into consideration equilibrium conditions. Performance reference compounds (PRCs) were added to PEDs prior to deployment. PRC recoveries after deployment were used to correct for disequilibrium conditions. Three mass transfer models (first order, sampling rate, and diffusion) were evaluated to determine the most suitable to conduct the disequilibrium correction.

Results/Lessons Learned. PEDs provide a reliable tool for measuring dissolved HOC in a wide variety of settings. PED size and shape can be easily adjusted based on the modeling goals and site conditions. For example, for deployment in 1- or 2-inch monitoring wells, PEDs were cut into narrow strips which allowed us to attach them to the custom-made sampling apparatus in a single layer and provide a large surface area for contaminant exchange. For flux calculation, PEDs were half-buried into the sediment, offering a simultaneous measurement of porewater and surface water. When environmental conditions cause in situ sampling to become too challenging or risky (e.g. due to weather conditions or risk of sampler loss during deployment in high-traffic areas), ex situ exposure (exposure to sediment in a laboratory setting to determine porewater concentrations) offers a good alternative. This presentation demonstrates uses of PEDs that go beyond the classical “measurement of freely dissolved, hence highly bioavailable contaminant fraction” application. Attention should be given to selecting appropriate set of PRCs and a mass transfer model that adequately reflects the boundary conditions in the sampled environment.