Bench-Scale Evaluation of PFAS Removal from Landfill Groundwater by Adsorptive Media Containing Biochar

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Background/Objectives. PFAS-impacted groundwater at an industrial landfill has been treated with a permeable barrier containing a mixture of soil and wood chips to prevent migration of the contaminants via adsorption. Treatment of PFAS-contaminated water has been traditionally performed by separation methods using ion exchange resins or granular activated carbon (GAC). For an in situ application such as a permeable barrier, other media such as biochar, a carbon-rich product obtained by thermal decomposition of organic biomass, may be more cost-effective than GAC or resins. The objective of this study was to demonstrate and evaluate the removal of PFAS from groundwater by different mixtures of media containing soil, wood shavings, and biochar.

Approach/Activities. A bench-scale treatability study was conducted in two phases with emphasis on the removal of perfluorooctanoic acid (PFOA) and perfluorooctanoic sulfonic acid (PFOS). *Phase 1* was focused on batch experiments to screen for adsorption by media materials at different compositions. The first experiment determined removal of PFAS at four initial concentrations using media mixtures consisting of 100% soil, 50% soil and 50% wood shavings, 50% soil and 50% biochar type A (medium particle size), and 50% soil and 50% biochar type B (large particle size). A second batch experiment was performed to optimize the media composition by determining the extent of PFAS removal using different proportions of wood and biochar amendments. To better mimic field conditions, *Phase 2* consisted of a column experiment to determine the retention of PFAS by the following media compositions: 1) 14% wood shavings, 1% biochar, and 85% soil; 2) 10% wood shavings, 5% biochar, and 85% soil; 3) 5% biochar and 95% soil; and 4) 100 % soil (control).

Results/Lessons Learned. Results from the first batch experiment from *Phase 1* indicated that mixtures containing both types of biochar outperformed the other mixtures, achieving 100% removal of PFOS and PFOA. The soil mixture achieved removals between 69% and 79% for PFOS and removals between 14% and 28% for PFOA. The mixture containing soil and wood shavings achieved removals between 66% and 73% for PFOS and removals between 16% and 23% for PFOA. Results from the second batch experiment indicated that the best media composition had 15% of wood shavings, 5% of biochar, and 80% of soil with removals of PFOA and PFOS at 98.5% and 96.5%, respectively, after 11 days of treatment. Results from the *Phase 2* column experiment showed that the media containing 5% biochar and 95% soil had the highest retention of PFAS; breakthrough for PFOA and PFOS was at more than 6.7 pore volumes. This mixture had the highest adsorption capacity of PFOA and PFOS, at 2.23 g/m^3 and 0.22 g/m^3. These results demonstrate that biochar is an amendment that increases the removal of PFAS compounds significantly when added to soil. A permeable barrier can then be designed based on the total mass of PFAS to be removed and the percentage of biochar amended to the mixed media. Depending on the source, biochar may be a more sustainable and cost-effective amendment than other adsorbents for the implementation of permeable barriers to achieve in situ treatment of PFAS-impacted groundwater at landfills.