Adsorbents Treatability Evaluation for PFAS Removal from Groundwater Infiltrating into a Chrome-Plating Facility Basement

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Background/Objectives. Groundwater infiltrating into the basement of an abandoned former chromium plating facility has been impacted with 1,4-dioxane, chlorinated volatile organic compounds (VOCs), various metals, and per- and polyfluoroalkyl substances (PFAS), including perfluoroethylcyclohexane sulfonate (PFECHS). Site investigations revealed a maximum concentration of PFECHS as high as 13,000 ng/L in water that infiltrated into a building basement. As part of this investigation, EGLE and AECOM established the objective to evaluate traditional and novel PFAS sorbent treatment technologies to meet remedial and cost objectives for removing and treating the water from the basement prior to the planned demolition of the building.

Approach/Activities. A bench-scale treatability program was designed to provide proof-of-concept and evaluate effectiveness of adsorption-based PFAS treatment technologies. The study included batch and flow-through experiments. Batch isotherm tests evaluated eight commercially available adsorbents at six doses to screen for the highest performing products in terms of adsorption capacity; these products included four ion exchange (IX) resins (two regenerable), one granular activated carbon (GAC), one nanoscale iron oxide, and one cyclodextrin polymer. The three best adsorbents were selected based on their adsorption capacities and removal efficiencies for rapid small-scale column tests (RSSCTs) to assess adsorption of PFAS under flow through conditions with an empty bed contact time of 5 minutes. Analytical constituents included PFAS (including PFECHS), total organic carbon, and volatile organic compounds in both study phases.

Results/Lessons Learned. Isotherm results indicated a superior adsorption capacity from the cyclodextrin polymer (up to 99.9% removal of individual PFAS, including PFECHS) among all adsorbents, whereas IX resins were superior to GAC and the iron oxide products. The cyclodextrin, one regenerable IX resin, and one single-use IX resin, were selected for RSSCT evaluation, as they showed PFAS removals above 99%. RSSCT results showed removal of PFAS in effluents from all sorbents tested, with the single-use IX resin producing the longest retention of PFAS, followed by the regenerable IX resin in second place, and the cyclodextrin in third place. Breakthrough above 5% of the influent concentration of total PFAS did not occur during the entire RSSCT operation (>50,000 bed volumes) for the IX resins, whereas the cyclodextrin's total PFAS effluent concentration broke through at 26,000 bed volumes. The cyclodextrin's lower performance in the RSSCT may be attributed to adsorption kinetics limitation due to the low contact time. These results have demonstrated and compared adsorbent effectiveness to remove PFAS from the impacted basement water. The RSSCT metrics obtained in this study may be used to inform a pilot-scale design to evaluate the removal of PFAS on-site. Future bench-scale activities will evaluate spent sorbent regeneration and the use of PFAS destructive technologies that may be coupled with adsorption-based technologies.