Evaluation of Short-Chain Per- and Polyfluoroalkyl Substance Removal via Adsorptive Treatment Technologies

Scott Crawford, M.Sc., P.E. (crawford@xdd-llc.com), Laurel Crawford, M.Sc. (lcrawford@xdd-llc.com), and Michael Marley, M.Sc. (marley@xdd-llc.com) (XDD Environmental, Stratham, NH, USA)
Ryan Thomas, PhD (ryan.thomas@ghd.com) and Sophia Dore, PhD (sophia.dore@ghd.com), (GHD, Niagara Falls, NY, USA)
Fred Taylor, P. Eng. (fred.taylor@ghd.com) (GHD, Waterloo, ON, Canada)
Jim Occhialini (jocchialini@alphalab.com) (Alpha Analytical, Westborough, MA)
Taryn McKnight (Taryn.McKnight@Eurofinset.com) (Eurofins Environmental Testing America, West Sacramento, CA)
Norman Farmer (Norman.Farmer@sgs.com) (SGS North America, Orlando, FL)

Background/Objectives. Activated carbon (AC) adsorption continues to be the default technology to remove low levels of per- and polyfluoroalkyl substances (PFAS) from water, despite varying reports of relatively early breakthrough of short-chain PFAS and high operating costs. Ion-exchange processes using regenerable and single-use media have been emerging as practical alternatives which may provide improved treatment and system performance. However, long-term performance with respect to the more difficult to remove short-chain PFAS such as perfluorobutanoic acid (PFBA) and perfluorobutanesulfonic acid (PFBS) is less often reported and can vary widely based on site-specific conditions. The primary objective of this study was to conduct a side-by-side comparison of several ion-exchange and adsorptive technologies and to compare removal efficiency and breakthrough of selected short-chain PFAS.

Approach/Activities. Treatability testing was conducted using PFAS-impacted groundwater from a private supply well. Adsorbents tested included surface-modified natural media, synthetic resin, and activated carbon. Batch-equilibration reactors and column flushing apparatus experiments were implemented to compare removal efficiency, breakthrough, and longevity of the selected media.

Results/Lessons Learned. Results indicated that both surface modified natural media and activated carbon achieved >99 percent removal of all detected PFAS after approximately 10,000 bed volumes (16 weeks) of column flushing, and outperformed the selected resin under site-specific conditions. In addition, unconventional breakthrough patterns (i.e., breakthrough of longer chain PFAS prior to shorter chain PFAS) were observed for some of the PFAS molecules including perfluoropentanoic acid (PFPeA), perfluorohexanesulfonic acid (PFHxS), and perfluorooctanesulfonic acid (PFOS). The results suggest that batch sorption and/or column flushing studies on water sources to be treated at scale is the preferred approach to evaluate potential adsorptive technologies for determining technical and cost implementation conditions.