Thermal Treatment of PFAS in Spent GAC and PFAS-Impacted Soil

Pavankumar Challa Sasi, PhD (pchallasasi@eaest.com) and Frank Barranco, PhD (EA Engineering, Science, and Technology, Inc., PBC, Hunt Valley, Maryland, USA)
Feng (Frank) Xiao, PhD and Ali Alinezhad (University of Missouri, Columbia, Missouri, USA)

Background/ Objectives. Per- and polyfluoroalkyl substances (PFAS) are a class of > 6000 compounds used in the production of several consumer and industrial products. Due to lack of regulations and their persistent nature these pollutants are now commonly found in indoor and outdoor environments. The presence of PFAS in the environment is due to their use in polymers, waterproofing and as aqueous film-forming foam (AFFF) during fire-fighting training activities. The presence of carbon-fluorine bond makes these compounds chemically and thermally stable. Most treatment methods for PFAS focus on removing them from the source while the residual PFAS still needs further handling. Adsorption by granular activated carbon (GAC) is widely used to remove PFAS however, the PFAS-saturated GAC needs further treatment. Thermal treatment of soils and spent media (GAC) containing PFAS compounds is a promising technology to destroy their forever cycle.

The intent of this presentation is to give an overview of studies conducted on thermal treatment of PFAS both in lab scale and pilot scale and to relay the current state of the technology. Topics will include the thermal stability of various PFAS compounds, the fate of PFAS during GAC reactivation process, the effect of GAC on the thermal decomposition, the thermal treatment conditions required to achieve >99% decomposition, scalability and optimization of full-scale systems.

Approach/Activities. The approach and findings with respect to three particular studies will be highlighted, including 1) two lab scale studies conducted by the presenter and 2) a field study conducted by EA and TD*X. Lab scale studies were conducted using 11 PFAS compounds containing short-chain, long-chain, perfluoroalkyl carboxylic acids (PFCAs), perfluoroalkyl sulfonic acids (PFSAs) and one perfluoroalkyl ether carboxylic acid (PFECA) compound. Experiments were performed in a two-zone quartz tube furnace for high temperature (>500 ^{o}C) and a muffle furnace for low to mid temperature range (150 – 500 ^{o}C). During these studies PFAS destruction was investigated under three different test conditions, only PFAS (*T1*), PFAS in the presence of GAC (*T2*) and PFAS pre-adsorbed on GAC (*T3*) in a closed system. EA completed a proof-of-concept two-phase pilot study to evaluate the effectiveness of ITD/TO technology to treat solid PFAS-impacted IDW and achieve "irreversible destruction" of long and short chain PFAS and precursors in soil. The objective was to demonstrate that ITD can treat PFAS in soil to part per billion levels (or lower) and achieve a destruction and removal efficiency (DRE) in TO of at least 99.99% for gaseous emissions of PFAS contaminant mass removed from treated feed material. For AFFF-spiked soil test runs, PFAS removal exceeded 97% at 500°C, and 99.7% at 650°C (all within or below the low parts per billion target level range).

Results/Lessons learned. Decomposition of PFCAs initiated at temperatures as low as 200 ^{o}C. PFECA decomposed more readily than a PFCA with same chain length. PFSAs required much higher temperature (>450 ^{o}C) to decompose. The presence of GAC has accelerated PFAS decomposition at low to moderate temperatures (<400 ^{o}C). The demonstration test on AFFF impacted soil was also able to achieve >99.99% destruction removal efficiencies using TD/TO. The presentation will discuss remaining data gaps with respect to thermal treatment, including the potential intermediate compounds that might be generated and the potential mechanisms by which PFAS are being destroyed.