Thermal Destruction of PFAS during Full-Scale Reactivation of PFAS-Laden Granular Activated Carbon (GAC)

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Background/Objectives. Per- and polyfluoroalkyl (PFAS) compounds have been a class of contaminants of growing concern for a number of years. Much progress has been made in the development of various treatment strategies to remove PFAS from water, especially with sorbents and membranes. Of these, granular activated carbon (GAC) is one of the most widely deployed and well-established. However, a great deal of uncertainty still remains about how to effectively destroy PFAS compounds once they have been captured or separated. In particular, there is still a great deal of confusion around the method most commonly used to destroy organic contaminants, namely, thermal destruction.

Carbon reactivation is defined separately and not included in the definition of incineration. A carbon regeneration unit is defined as "any enclosed thermal treatment device used to regenerate spent activated carbon". Carbon reactivation is thermal treatment at high temperatures, up to 1800°F, to remove and destroy adsorbed contaminants. The process is designed to return the carbon to a virgin-like state for reuse and ensure no contaminants remain on the carbon.

During reactivation, the high temperatures employed in both the furnace and the downstream abatement system will volatilize and destroy organic compounds that were adsorbed on the GAC. However, given the high thermal stability of the carbon−fluorine bonds present in PFAS, it is natural to wonder if GAC reactivation can achieve high levels of destruction (i.e., ≥99.99%) of PFAS. What has been needed to demonstrate this is a carefully controlled program of testing of all inputs and outputs during the full-scale reactivation of a well-characterized load of spent, PFAS-laden GAC. The study detailed herein aims to do exactly that by describing a stack testing campaign carried out at a commercial carbon reactivation facility in which the incoming GAC and all outputs including stack gas, abatement dust, and reactivated carbon were tested for fluoride and PFAS to determine the level of PFAS destruction.

Approach/Activities. Reactivation of PFAS-laden spent carbon was conducted at a carbon reactivation facility owned and operated by Calgon Carbon Corporation. Alliance Source Testing LLC, a third-party vendor specializing in manufacturing emissions testing, was contracted to determine the emission rates of PFAS and hydrogen fluoride (HF) per established USEPA methodology. Three 4-h emission tests were conducted over the course of 2 days with gas-phase sample locations before and after the process abatement system. Additional sampling of solid and liquid-phase process inputs and outputs was conducted to define all sources of PFAS potentially entering or exiting the system. During testing, all standard operating procedures for the facility were followed to represent typical furnace and abatement conditions for the reactivation of GAC.

Results/Lessons Learned. We analyzed non-detect for all measurable PFAS on the reactivated carbon, indicating that PFAS is effectively removed from the spent carbon during CCC's proprietary reactivation process. We also demonstrated > 99.99% destruction for total PFAS (36 PFAS list measurable) across the furnace and abatement systems. We've demonstrated > 99.999% destruction for PFAS currently listed in the US EPA's Drinking Water Health Advisory Limits (PFOA, PFOS, GenX, and PFBS) across our process and abatement systems. Significant HF generation post-furnace (5.56 lb/h) and pre-abatement system supports a high degree of mineralization of PFAS under CCC reactivation conditions. The HF is removed downstream in an acid gas scrubber, which is why it is reported at the furnace. USEPA OTM-45 (air emissions) measurements were all below any state air emission levels currently in place and below any publicly available thermal oxidizer data for manufacturing sites.