Supercritical Water Oxidation for PFAS Destruction in Various Matrices

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Background/Objectives. Supercritical water oxidation (SCWO) is rapidly emerging as the technology of choice for PFAS destruction. The reasons are the many advantages of the technology, namely the ability of SCWO to (1) rapidly and effectively mineralize all organofluorine and PFAS compounds (including low molecular weight ones) without the formation of secondary PFAS (e.g., volatile PFAS); (2) to treat other organic co-contaminants; and (3) to destroy PFAS on solid matrices such as granular activated carbon (GAC) or ion exchange (IX) resins. In this paper, we will unveil our containerized AirSCWO™ 6 system, and present and discuss recent results on the mineralization of PFAS in various matrices (aqueous solutions, and slurries of GAC and IX). We will conclude with projected cost data applied to specific use cases.

Approach/Activities. We have investigated PFAS destruction in SCWO systems at different scales. These included a continuous pilot SCWO system that can treat up to 1 ton of waste per day used for the treatment of PFAS rinsates, landfill leachate, AFFF dilutions, spent GAC and IX and a bench-scale SCWO apparatus for fundamental studies such as kinetic determinations, fate of organofluorine and closure of fluorine balance. We have also recently completed the construction of our first article commercial AirSCWO system with a capacity of 6 wet ton per day, able to treat 0.5 to 1.5 ton per day of dry material such as GAC of IX resin. That system is commercially available.

Results/Lessons Learned. Detailed treatment data for selected PFAS wastes will be presented and discussed. This includes large-scale treatment of rinsates and various waste matrices containing PFAS, in some instances with PFAS concentrations up to 1 g/L. Generally, elimination of greater than 99% of total influent PFAS was observed, and in many cases even higher elimination, often yielding non-detect PFAS concentrations in the treated effluent. Notably, there was no evidence of transformation of high molecular weight PFAS into lower molecular weight PFAS or into volatile species. Test runs conducted with spent GAC and IX demonstrated that these could be treated with very high PFAS elimination efficiencies. Generally, PFCAs were eliminated to a greater degree than PFSAs or precursors, and elimination of short chain (<C6) PFAS was lower than long chain PFAS. Even so, elimination of PFAS could be tailored to achieve a specific degree of destruction by adjusting reaction time and temperature. The focus of laboratory SCWO determinations was on kinetic determinations and closing of the fluorine balance. Specific rate constants were obtained for individual PFAS, confirming the above mentioned trend of reactivity. These detailed investigations also showed that SCWO breaks the carbon-fluorine bonds within PFAS molecules resulting in 100% mineralization of the organofluorine to inorganic fluoride. Scaling up from the 1 ton/day system was conducted and construction of the first AirSCWO article was completed. The system is housed in a standard 40 ft shipping container for easy mobilization. It uses air as the oxidant. The presentation at the conference will include a description of the system, its specification, and a discussion of its capabilities in terms of treatment of various matrices, and how the AirSCWO system can be integrated with various remediation activities (AFFF replacement, GAC/IX treatment, etc.). Cost models will be presented and discussed.