Field Demonstration: Electrochemical Degradation of PFAS Mass in Wastewaters

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Background/Objectives. As regulators globally ban or strictly administer the storage, handling and use of aqueous film forming foam (AFFF) because they contain fluorosurfactants, users are implementing foam transition programs. These transition programs include the removal of AFFF and the generation of PFAS-impacted decontamination wastewater. We have completed two field pilot demonstrations using an electrochemical advanced oxidation process to destroy PFAS mass contained within the solutions generated as part of these foam transition programs. The pilots have generated lessons regarding treatment method, optimization, and challenges that inform commercial application of electrochemical oxidation for PFAS destruction.

Approach/Activities. In 2021, a 3-month pilot demonstration of the DE-FLUORO™ electrochemical oxidation technology was completed at a facility in Australia. The pilot treated 13,200 liters (L) of redundant 'end-of-life' AFFF and 20,800 L of PFAS-impacted first flush wash-water. Affectionately nicknamed "Meg", the 20-foot system container houses six 40-L cylindrical reactors equipped with novel reactive membrane electrodes that are capable of continuously circulating wastewater without the need for on-site staff. Building on the lessons from Meg, we constructed a larger demonstration system–nicknamed Orca–and tested it on PFAS-laden wastes associated with a fire-training area. In each system, electrochemical oxidation (EO) reactors are assembled with recirculation pumps, chiller, human-machine interface, vapor emission control, and a foam suppression system. Key operational parameters, such as current density and flow rate, are fully adjustable and can be preset for automated operation. Each demonstration comprised a series of experiments under different treatment conditions and reactor configurations, including but not limited to different retention times / flow rates and current supply of 100 to 300, and up to 1200 amperes.

Time-course samples were collected and analyzed for PFAS (30 compounds), total oxidizable precursor assay (TOPA)-PFAS, select anions (fluoride, sulphate and perchlorate), total organic carbon (TOC), semivolatile organic compounds (SVOCs) and metals. Total organic fluorine (TOF) was also collected for mass balance evaluation.

Results/Lessons Learned. The presentation will compare the results of the two demonstration systems, contrasting their strengths and best application. Lessons on treating very high-concentration wastewater including optimized system conditions as well as methods for controlling foaming. After EO treatment of first-flush rinse water, concentrations of perfluorooctanoic acid (PFOA) were reduced by between 77% and 99% and the sum of perfluorooctane sulfonate (PFOS) and perfluorohexane sulfonate (PFHxS) were reduced by between 95% to 100%. TOF mass balance calculations indicated that under ideal operational parameters reductions of 96% of measurable and unmeasurable PFAS mass was achieved. AFFF concentrate requires longer treatment times and must employ foam management. The DE-FLUORO Meg system consumed 4.92 kWh of electricity per day. DE-FLUORO Orca demonstrated excellent foam control, with refinement to the reactor currently underway. Three pilot demonstrations coupling EO with concentrating technologies are scheduled to occur in 2023; these results will be shared.