

Electrochemical Oxidation Pilot Reactor Demonstration Project, Coupling Technology for PFAS Destruction

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Background/Objectives. Per- and poly-fluoroalkyl substances (PFAS) have been widely used and released into the environment over the last 60+ years. Among the broad category of PFAS, the occurrence and environmental impact of perfluoroalkyl acids (PFAAs), such as perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) have been studied and characterized globally. PFAS have chemical structures involving the extremely strong carbon-fluorine (C-F) covalent bond, representing a class of chemicals that are extremely challenging to remediate. The current trends for treating PFAS impacted water rely on mass transfer technologies (e.g., granular activated carbon [GAC], ion exchange resin [IX-R], reverse osmosis [RO]) that do not destroy PFAS but concentrate PFAS on the selected media. The spent media generated will require off-site incineration in the case of GAC and single use IX-R or on-site regeneration for reusable IX-R. IX-R regeneration is not the only water treatment technology to produce wastes concentrated with PFAS that will require further management and/or treatment. Emerging separation technologies such as ozone fractionation (OF) and ex situ foam fractionation (FF) will also generate a PFAS laden waste. Advances are being made in destructive technologies, such as electrochemical oxidation (EO), sono-chemistry and plasma, with all producing promising results in the laboratory. This paper will present the latest developments, including optimization modifications and proof of demonstration results using a pilot scale EO reactor to treat various real world PFAS impacted liquids.

Approach/Activities. The demonstration project was undertaken in Newcastle, Australia, using a proprietary electrode to destroy dissolved PFAS via EO. The electrode was fabricated and used to mineralize C4~C12 PFAAs and their precursors with evidence of complete defluorination and desulfurization. PFAS are destroyed via direct electron transfer on “nonreactive” anodes and hydroxyl radicals generated under room temperature and atmospheric pressure with relatively low energy consumption. This EO reactor was developed as a coupling technology to treat PFAS concentrated in different wastes generated as a result of separation technologies. This project treated six different types of PFAS impacted liquids, including 1) RO reject; 2) soil washing effluent; 3) OF concentrate; 4) FF concentrate; 5) untreated wastewater; and 6) IXR still bottoms. Before completion (early 2019), the project also hopes to treat aqueous film forming foam (AFFF) concentrate and PFAS-impacted groundwater commingled with volatile organic compounds (VOCs). Pre- and post-treated samples were analyzed for 31 different PFAS using liquid chromatography (LC – MS/MS). The same samples were also tested for total oxidizable PFAS (TOP) assay; perchlorate, chloride, fluoride, sulphate, metals and VOCs.

Results/Lessons Learned. The EO pilot demonstration treated PFAS from low to high concentration ranges in water and PFAS concentrates in liquid waste. For instance, results for the treatment of IX-R still bottoms indicated 100% removal of measurable PFAS and 300% + of fluoride concentration as an end product. Indicating the successful mineralization of unquantified PFAA precursors as well as measurable PFAAs. It was also discovered that this technology was capable of simultaneously decomposing high concentrations of total organic carbon (8,000 parts per million [ppm]). This presentation will discuss the results of all testing

conducted to date, it will also share the challenges faced during the development including the limitations of the technology.