Applications of Electrochemical Oxidation for PFAS Destruction in Water, Liquid and Solid Wastes

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Background/Objectives. PFAS compounds have been ubiquitous in the environment because they have been used in industrial and consumer applications for more than six decades. Once releases, PFAAs as subclass of PFAS are persistent and do not biodegrade in the environment. PFAAs also bioaccumulates in the biological tissues with potential adverse impact to human health and the environment. Current practice of treating PFAS in water is to separate PFAS from the environmental media using granular activated carbons or ion exchange resin (IX-R). IX-R has gained increased attention because it treats wider range of PFAS and can be regenerated on site. Destruction of PFAS has been developed in recent years for mass removal (not mass transfer) and for achieving the ultimate risk reduction. The destruction technologies such as electrochemical oxidation (EO), plasma technology and sonochemistry have demonstrated degradation and mineralization of PFAS in the laboratory environment. The promising results have led to field scale demonstrations. This paper presents the latest development on scaling up EO technology for water treatment and its applications for destroying PFAS in the PFAS concentrates including liquid and solid wastes.

Approach/Activities. The approach of studies is built upon a series of effective treatment of spiked PFAAs in the water solutions using low-cost titanium based electrodes. The spiked solutions were originally used to account for the mass balance before and after the PFAS destruction and to understand complete destruction kinetics and mechanisms. Laterally, this EO technology has been applied to treat (1) low ppb to high ppm of PFAAs and PFAA precursors; (2) PFAS impacted groundwater; (3) PFAS concentrate in liquid waste generated from ion exchange resin regeneration processes; (4) PFAS concentrate in liquid waste from a proprietary treatment waste stream; (4) pretreatment sludge containing PFAS; and (5) PFAS impacted soil. Additionally, pilot scale reactors were built to treat wastewater in a semi-continuous flow process.

Results/Lessons Learned. The PFAS contaminated industrial wastewater and groundwater are commonly require pre-treatment or post-treatment processes for removing other co-contaminants (including organic and inorganic contaminants), these pre- and post-treatment processes generate solid and liquid wastes containing PFAS. We realize the need of developing PFAS destruction technologies for not only water solutions but also waste streams in order to provide a total solution of leaving no PFAS waste behind. The EO studies have successfully demonstrated the treatment of PFAS from low to high concentration ranges and PFAS concentrates in liquid waste. We have found 100% removal of measurable PFAS and 300+% of fluoride concentrations as end product in the IX-R waste. This finding suggests (1) the loading of non-measureable PFAA precursors to the IX-R; and (2) Successful mineralization of PFAS including PFAAs and PFAA precursors. The EO technology is also found effective on decomposing 8000 ppm TOC together with mineralization of PFAS. When high TOC is encountered, coupling EO with pre-treatment technologies may be needed to reduce energy consumption. The presentation will also discuss the progress of reducing perchlorate as unwanted byproducts.