New Efficient Treatment of 2,3,3,3-Tetrafluoro-2-(Heptafluoropropoxy) Propanoic Acid (GenX) by Electrochemical Degradation on a Boron-Doped Diamond Electrode

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Background/Objectives. 2,3,3,3-Tetrafluoro-2-(Heptafluoropropoxy) Propanoic Acid (GenX) have been used recently as an alternative for perfluorooctanoic acid (PFOA) for different industrial and military applications like material surface coating and firefighting foams. The unsuccessful conventional treatment technologies to remove perfluoroalkyl substances (PFASs) from water result in detected PFASs in around 6 million Americans drinking water. GenX has been detected in the river water in North Carolina downstream from the Chemours plant. Owing to the strong fluorine-carbon bonds, PFASs are not biodegradable and have high resistance to the chemical and thermal degradations. The short chain length PFASs like GenX are even harder to break. Only a few methods, such as high-pressure RO membrane filtration, activated carbon adsorption, and electrochemical degradation, have shown promising removal of PFASs from water. Although the application of these methods is limited due to the high cost and energy demand of the RO membrane process and reactivation of activated carbons. In addition, the production of a highly concentrated PFAS waste stream is another limitation for these methods. The reported researches on using RO filtration and activated carbon for short chain length PFASs like GenX has no or partially removal. So, an efficient method is needed to remove GenX and other short chain length compounds from water without dealing with high concentrated waste.

Approach/Activities . In this work a new efficient electrochemical method is developed to degrade GenX from water using boron-doped diamond (BDD) electrodes. The high oxygen potential, long life span, and low adsorption ability with superior chemical stability and mechanical strength result in applying BDD electrodes to oxidize dyes, acetic acid, maleic acid, and perfluorinated compounds. A lab scale electrochemical setup with BDD as the working electrode, coiled platinum wire as the counter electrode and Ag/AgCl in a 3M NaCl salt bridge as the reference electrode are used. Desired current density is applied to the system for 8 hours. 1.5 mL of the samples were taken at different time intervals. The effect of current density, initial concentration of the contaminant and boron doping that are the most important factors on the efficiency of the electrochemical oxidation of GenX are evaluated.

Results/Lessons Learned. The effect of the current density was studied by applying three different current density 1.5, 3, and 6 mA/cm^2. The results showed total degradation of 10 ppb GenX after 4 hours with 6 mA/cm^2 and 7 hours with applying 3 mA/cm^2. 90 percent removal of 10 ppb GenX was also detected after 8 hours test with 1.5 with mA/cm^2. The samples with two different initial GenX concentration 10 and 100 ppb were compared by applying the same 6 mA/cm^2 current density. The total removal was detected for 100 ppb GenX after ~8 hours. The effect of the boron doping will be also evaluated using three different electrodes with 100, 1000, and 10,000 ppm boron doped diamond electrode (NeoCoat). Finally, using all these data, a model will be developed to find the optimal the parameters like current density for a desired GenX concentration to increase the efficiency of the process.