CLAIMS

What is claimed is:

1. An electrochemical destruction system, comprising:

an electrochemical reactor that defines a contained volume, wherein the electrochemical reactor includes at least one anode and at least one cathode in or extending into the contained volume of the electrochemical reactor, wherein the at least one anode and the at least one cathode are configured to break down per- and polyfluoroalkyl substances (PFAS) in wastewater in the contained volume via electro-oxidation reactions;

a pH adjustment device containing at least one of an acid or a base and configured to inject the acid or base into the contained volume of the electrochemical reactor or into a volume in fluid communication with the electrochemical reactor to facilitate controlling the pH of the wastewater; and

a defoamer in the contained volume of the electrochemical reactor or in a volume in fluid communication with the electrochemical reactor and configured to defoam foam generated in the wastewater from the electro-oxidation reactions.

2. The electrochemical destruction system of claim 1, further comprising a chemical dosing system containing (a) hydrogen peroxide (H_2O_2) and at least one of (b) ferrous ions (Fe^{2+}) or ferric ions (Fe^{3+}), wherein the chemical dosing system is configured to inject these compositions into the contained volume of the electrochemical reactor or into a volume in fluid communication with the electrochemical reactor.

3. The electrochemical destruction system of claim 1, further comprising a voltage source in electrical communication with the at least one anode and with the at least one cathode.

4. The electrochemical destruction system of claim 1, further comprising:

a storage tank that contains the wastewater;

a first conduit coupling the storage tank with the electrochemical reactor and configured to transfer the wastewater from the storage tank to the electrochemical reactor; and

a second conduit coupling the storage tank with the electrochemical reactor and configured to transfer the wastewater from the electrochemical reactor back to the storage tank.

5. The electrochemical destruction system of claim 4, wherein the pH adjustment device is configured to inject the acid or base into the storage tank or wherein the defoamer is in the storage tank.

6. The electrochemical destruction system of claim 1, wherein the anode comprises boron-doped diamond or titanium suboxides.

7. The electrochemical destruction system of claim 1, wherein the cathode comprises at least one of titanium, stainless steel, mixed metal oxides or platinum, boron-doped diamond, or graphite.

8. The electrochemical destruction system of claim 1, wherein the defoamer is selected from a mechanical defoamer and an ultrasonicator.

9. The electrochemical destruction system of claim 1, further comprising a bath of the wastewater contained in the electrochemical reactor, optionally

further comprising a foam layer formed of a liquid film surrounding gas bubbles atop the bath of the wastewater, wherein the liquid film of the foam layer contains a higher concentration of PFAS than does the bath of the wastewater.

10. The electrochemical destruction system of claim 1, further comprising a PFAS concentration system in fluid communication with the contained volume of the electrochemical reactor, optionally

wherein the PFAS concentration system comprises at least one of a nanofiltration system, a reverse-osmosis system, an ultrafiltration system, a foam fractionation system, an ion-exchange system, or a granular-activated-carbon adsorption system.

11. The electrochemical destruction system of claim 1, wherein the wastewater includes a blend of PFAS and other organic chemicals.

12. A method for electrochemically destroying per- and polyfluoroalkyl substances (PFAS), comprising:

providing an electrochemical reactor containing a bath of wastewater that contains PFAS, wherein the electrochemical reactor includes at least one anode and at least one cathode immersed in the bath of wastewater;

adding an acid or a base to the wastewater to maintain a reaction pH in the electrochemical reactor at a targeted pH below 4.3;

in the electrochemical reactor, delivering an applied current and voltage to the immersed anode and cathode to electrochemically destroy at least some of the PFAS in the wastewater; and

defoaming foam produced in the electrochemical reactor.

13. The method of claim 12, wherein the wastewater further comprises additional organic carbon compounds.

14. The method of claim 13:

wherein the additional organic carbon compounds include organic carbon compounds produced in an earlier industrial process and organic carbon compounds introduced into the wastewater in an upstream wastewater treatment process; or

wherein at least 99% of the PFAS and the additional organic carbon compounds in the wastewater is destroyed in the electrochemical reactor; or further comprising:

adding hydrogen peroxide (H_2O_2) and at least one of ferrous ions (Fe^{2+}) or ferric ions (Fe^{3+}) to the wastewater; and

reducing the additional organic carbon compounds via a Fenton or electro-Fenton reaction utilizing hydroxyl radicals generated by the added hydrogen peroxide and the added Fe^{2+} and/or Fe^{3+} ions.

15. The method of claim 12:

(a) wherein the anode comprises boron-doped diamond or a titanium suboxide; or

(b) wherein the cathode comprises at least one of titanium, stainless steel, mixed metal oxides, and platinum, boron-doped diamond, or graphite; or

(c) wherein the foam comprises a liquid film surrounding gas bubbles atop the bath of the wastewater, wherein the liquid film of the foam contains a higher concentration of PFAS than does the bath of the wastewater; or

(d) further comprising concentrating PFAS in the wastewater from an upstream source and then delivering the wastewater with the concentrated PFAS to the electrochemical reactor, optionally wherein the PFAS is concentrated via a concentration system selected from at least one of nanofiltration, reverse osmosis, ultrafiltration, foam fractionation, ion exchange, or granular-activated-carbon adsorption.