CLAIMS

1. A method of removing carbon dioxide from a fluid, the method comprising:

contacting the fluid with an aqueous solution comprising ions capable of forming an insoluble carbonate and/or hydroxide salt;

contacting the aqueous solution with an electrode that induces alkalinization, thereby inducing the precipitation of a carbonate and/or hydroxide solid(s) from the solution.

2. The method of claim 1, wherein the fluid is a gaseous fluid.

3. The method of claim 1 or 2, wherein the gaseous fluid comprises between 0.04 to 100 vol. % $CO_2$.

4. The method of any one of claims 1 to 3, wherein the gaseous fluid is atmospheric air.

5. The method of any one of claims 1 to 4, wherein the gaseous fluid is flue gas emitted from a natural gas-fired power plant, a coal-fired power plant, an iron mill, a steel mill, a cement plant, an ethanol plant, or a chemical manufacturing plant.

6. The method of any one of claims 1 to 5, wherein the aqueous solution contains an amount of dissolved carbon dioxide that is in equilibrium with the gaseous fluid.

7. The method of any one of claims 1 to 6, wherein the aqueous solution is in thermal equilibrium with the gaseous fluid.

8. The method of any one of claims 1 to 6, wherein the aqueous solution is not in thermal equilibrium with the gaseous fluid.

9. The method of any one of claims 1 to 6, wherein the aqueous solution contains an amount of dissolved carbon dioxide that is not in equilibrium with the gaseous fluid.

10. The method of claim 1, wherein the fluid is a liquid fluid.

11. The method of any one of claims 1 to 10, wherein the ions capable of forming an insoluble carbonate salt comprise ions including one or more of: Ca, Mg, Ba, Sr, Fe, Zn, Pb, Cd, Mn, Ni, Co, Cu, and Al.

12. The method of any one of claims 1 to 11, wherein the aqueous solution has a concentration of NaCl of about 1,000 ppm or more.

13. The method of any one of claims 1 to 12, wherein the aqueous solution has a concentration of NaCl of about 30,000 ppm or more.

14. The method of any one of claims 1 to 13, wherein the aqueous solution comprises seawater.

15. The method of any one of claims 1 to 14, wherein the electrode comprises a metallic, a non-metallic, or a carbon- based mesh.

16. The method of any one of claims 1 to 15, wherein the method utilizes an end-to-end energy intensity of about 2.5 MWh or less per ton of carbon dioxide mineralized.

17. The method of any one of claims 1 to 16, wherein the aqueous solution contains an amount of dissolved carbon dioxide that is buffered to atmospheric abundance.

18. The method of any one of claims 1 to 17, wherein the electrode produces an increased alkaline condition, *in situ*, in the aqueous solution within about 2 to 20000 μm of the electrode.

19. The method of claim 18, wherein the alkalinized condition is a pH of 8 or greater.

20. The method of any one of claims 1 to 19, wherein the electrode comprises a metallic, a non-metallic, or a carbon-based material.

21. The method of claim 20, wherein the electrode contains stainless steel, titanium oxide, carbon nanotubes, polymers, graphite, or any combination thereof.

22. The method of any one of claims 1 to 21, wherein the electrode comprises pores having a diameter in the range of about 0.1 μm to about 10000 μm.

23. The method of any one of claims 1 to 22, wherein the electrode comprises an electroactive mesh, and inducing the precipitation of the carbonate and/or hydroxide solid(s)includes rotating a cylinder consisting of the electroactive mesh in the solution, while applying suction to draw the solution onto the outer surface of the mesh.

24. The method of any one of claims 1 to 23, wherein the solution is a brine solution.

25. The method of any one of claims 1 to 24, wherein the solution is an alkaline metal-containing solution.

26. The method of any one of claims 1 to 25, wherein inducing precipitation of the carbonate and/or hydroxide solid(s) includes inducing precipitation of at least one carbonate or hydroxide of Ca, Mg, Ba, Sr, Fe, Zn, Pb, Cd, Mn, Ni, Co, Cu, or Al.

27. A flow-through electrolytic reactor comprising an intake device in fluid connection with a rotating cylinder comprising an electrode, and a scraping device and/or liquid-spray based device for separating a solid from a surface or solution.

28. The flow-through electrolytic reactor of claim 27, further comprising an aqueous solution comprising carbon dioxide, Ca ions, and Mg ions.

29. The flow-through electrolytic reactor of claim 27 or 28, wherein the electrode is capable of inducing removal of dissolved inorganic carbon by precipitation of a carbonate and/or hydroxide solid from an aqueous solution comprising carbon dioxide and ions capable of forming an insoluble carbonate and/or hydroxide salt.

30. The flow-through electrolytic reactor of any one of claims 27 to 29, wherein the electrode contains a metallic or carbon-based mesh.

31. The flow-through electrolytic reactor of claim 30, wherein the electrode contains stainless steel, titanium oxide, carbon nanotubes, polymers, graphite, or any combination thereof.

32. The flow-through electrolytic reactor of any one of claims 27 to 31, wherein the reactor comprises a plurality of electrodes.

33. The flow-through electrolytic reactor of claim 32, wherein the plurality of electrodes are arranged in a series of planar cells in parallel or cylindrical cells in parallel.

34. The flow-through electrolytic reactor of any one of claims 27 to 33, wherein the reactor is in fluid communication with a desalination device.

35. The method of claim 10, wherein the liquid fluid is an aqueous fluid.

36. The method of claim 35, wherein a gaseous stream is bubbled through the liquid fluid before the liquid fluid is contacted with the aqueous solution.