CLAIMS

1. Method of reducing ion concentration in an influent solution comprising:

in a deionization phase of operation, feeding said influent to a membraneless electrodeionization (EDI) stack comprising alternating layers of porous anion exchange materials (AIX) and cation exchange materials (CIX) interposed between a cathode and an anode, of said AIX and CIX and defining at least one interfacial area between an AIX and CIX, passing said influent over said AIX and CIX whereby said ion concentration is reduced via ion exchange with said AIX and CIX;

collecting deionized product from said EDI stack; and

in a regeneration phase of operation, imparting a voltage across said electrodes and feeding flush water as influent to said EDI stack and across said AIX and CIX materials, whereby water splitting occurs along at least one of said interfacial areas resulting in formation of H^+ and OH^- ions which migrate to and replenish said AIX and CIX materials, and recovering a waste stream as effluent.

2. Method as recited in claim 1 wherein said influent is water with dissolved Na^+ and Cl^- ions therein.

3. Method as recited in claim 2 wherein said CIX materials comprise beads having fixed SO_3^{-2} ions therein.

4. Method as recited in claim 2 wherein said AIX materials comprise beads having fixed quaternary ammonium ions therein.

5. Method as recited in claim 1 wherein said EDI stack further comprises at least one mixed ion exchange material therein interposed between an AIX and CIX.

6. Electrodeionization apparatus comprising a stack of alternating layers of anion exchange materials AIX and cationic exchange materials CIX interposed between a cathode and an anode, said stack of alternating layers defining at least one interfacial area between an AIX and a CIX, said stack being devoid of ion exchange membranes.

7. Apparatus as recited in claim 6 wherein said AIX comprises beads having fixed SO_3^- ions therein.

8. Apparatus as recited in claim 6 wherein said AIX comprises beads having fixed quaternary ammonium ions therein.

9. Apparatus as recited in claim 6 further comprising at least one mixed ion exchange material in said stack and interposed between an AIX and CIX.

CLAIMS

1. Method of reducing ion concentration in an influent solution comprising:
in a deionization phase of operation, feeding said influent to a membraneless electrodeionization (EDI) stack comprising layers of porous anion exchange materials (AIX) and cation exchange materials (CIX) interposed between a cathode and an anode, a plurality of said layers being positioned in alternating AIX and CIX layer pairs defining an interfacial area between each said AIX and CIX layer in each pair, passing said influent over said AIX and CIX whereby said ion concentration is reduced via ion exchange with said AIX and CIX;

collecting deionized product from said EDI stack; and

in a regeneration phase of operation, imparting a voltage across said electrodes and feeding flush water as influent to said EDI stack and across said AIX and CIX materials, whereby water splitting occurs along at least one of said interfacial areas resulting in formation of H^+ and OH^- ions which migrate to and regenerate said AIX and CIX materials, and recovering a waste stream as effluent, said deionization phase and said regeneration phase alternating in time.

2. Method as recited in claim **1** wherein said influent is water with dissolved $Na^+$and Cl^- ions therein.

3. Method as recited in claim **2** wherein said CIX materials comprise beads having fixed SO_3^{-2} ions therein.

4. Method as recited in claim **2** wherein said AIX materials comprise beads having fixed quaternary ammonium ions therein.

5. Method as recited in claim **1** wherein said EDI stack further comprises at least one mixed ion exchange material therein disposed in said stack.

6. Electrodeionization apparatus for reducing ion concentration from an influent stream, said apparatus comprising layers of anion exchange materials AIX and cationic exchange materials CIX interposed between a cathode and an anode, a plurality of said layers being positioned in contiguous, alternating AIX and CIX layer pairs defining an interfacial area between each said AIX and CIX layer in each pair, said stack of alternating layers defining at least one interfacial area between an AIX and a CIX, said stack being devoid of ion exchange membranes, said apparatus configured for selective alternate operation between a deionization phase of operation in which said ion concentration is reduced via ion exchange with said AIX and CIX layers and a regeneration phase of operation in which water spitting occurs along at least one of said interfacial areas resulting in formation of H^+ and OH^- ions which migrate to and regenerating said AIX and CIX layers.

7. Apparatus as recited in claim **6** wherein said CIX comprises beads having fixed SO_3^- ions therein.

8. Apparatus as recited in claim **6** wherein said AIX comprises beads having fixed quaternary ammonium ions therein.

9. Apparatus as recited in claim **6** further comprising at least one mixed ion exchange material in said stack and interposed between an AIX and CIX.