CLAIMS

1. An electrodialysis device comprising:

an inlet for directing a feed stream into a plurality of first feed paths and a plurality of second feed paths; said feed stream is comprised of a first anionic scaling species and a first cationic scaling species;

said first cationic scaling species is transferred from said second feed paths to said first feed paths through a first membrane group, said first anionic scaling species is transferred from said first feed paths to said second feed paths through said first membrane group;

wherein the concentration of said first anionic scaling species in effluent exiting said first feed paths is less than about 90% of the concentration of said first anionic scaling species in the feed stream at the inlet of said electrodialysis device.

2. The electrodialysis device of claim 1 further comprising:

an electrodialysis vessel;

a pair of electrodes arranged in the electrodialysis vessel, said pair of electrodes respectively serving as an anode and a cathode;

an anode cell unit adjacent said anode, a cathode cell unit adjacent said cathode, and at least one general cell unit arranged between said anode cell unit and said cathode cell unit;

said cathode cell unit having a third membrane group comprised of one or more elements, and said general cell unit having a first membrane group comprised of one or more elements, a second membrane group comprised of one or more elements, a first feed path, and a second feed path;

said first membrane group comprising an anion exchange membrane and a cation exchange membrane;

said first feed path of one of said general cell units is defined by said first membrane group of said general cell unit and said third membrane group of an adjacent cathode cell unit; said first feed path of at least one of said general cell units is defined by said first membrane group of said general cell unit and said second membrane group of

an adjacent general cell unit; said second feed path of said one or more general cell units is defined by said first and second membrane groups.

3. The electrodialysis device of claim 1, wherein the concentration of said first cationic scaling species in effluent exiting said second feed paths is less than about 90% of the concentration of first cationic scaling species in the feed stream at the inlet of said electrodialysis device.

4. The electrodialysis device of claim 3, wherein the concentration of said first anionic scaling species in effluent exiting first feed paths is less than about 50% of the concentration of first anionic scaling species in the feed stream at the inlet of said electrodialysis device, wherein the concentration of said first cationic scaling species in effluent exiting said second feed paths is less than about 50% of the concentration of first cationic scaling species in the feed stream at the inlet of said electrodialysis device.

5. The electrodialysis device of claim 4, wherein the concentration of said first anionic scaling species in effluent exiting said first feed paths is less than about 20% of the concentration of first anionic scaling species in the feed stream at the inlet of said electrodialysis device, wherein the concentration of said first cationic scaling species in effluent exiting said second feed paths is less than about 20% of the concentration of first cationic scaling species in the feed stream at the inlet of said electrodialysis device.

6. The electrodialysis device of claim 1, wherein said first membrane group elements are selected from the group consisting of a monovalent selective anion exchange membrane, a monovalent selective cation exchange membrane, a divalent selective anion exchange membrane, or a divalent selective cation exchange membrane.

7. The electrodialysis device of claim 4, wherein said second membrane group is comprised of at least one anion exchange membrane element or at least one cation exchange membrane element.

8. The electrodialysis device of claim 7, wherein said third membrane group is comprised of at least one anion exchange membrane element or at least one cation exchange membrane element.

9. The electrodialysis device of claim 1, wherein said first cationic scaling species is selected from the group consisting of Mg^{2+}, Ca^{2+}, Sr^{2+}, and Ba^{2+}, and said first anionic scaling species is selected from the group consisting of SO_4^{2-}, HCO_3^-, CO_3^{2-}, OH^-, F^-, PO_4^{3-}, HPO_4^{2-}, and $H_2PO_4^-$.

10. The apparatus of claim 1, wherein said first feed paths and said second feed paths are in flow communication with a desalination plant intake, the contents of said first feed paths and said second feed paths are processed separately in said desalination plant.

11. The electrodialysis device of claim 1 further comprising:

at least two electrodialysis vessels, each vessel comprising a pair of electrodes, said pair of electrodes respectively serving as an anode and a cathode;

an anode cell unit adjacent said anode, a cathode cell unit adjacent said cathode, and at least one general cell unit arranged between said anode cell unit and said cathode cell unit; said anode cell unit, said cathode cell unit, and said at least one general cell unit spanning the electrodialysis vessels;

said cathode cell unit having a third membrane group comprised of one or more elements, and said general cell unit having a first membrane group comprised of one or more elements, a second membrane group comprised of one or more elements, a first feed path, and a second feed path;

said first membrane group comprising an anion exchange membrane and a cation exchange membrane;

said first feed path of one of said general cell units is defined by said first membrane group of said general cell unit and said third membrane group of an adjacent cathode cell unit; said first feed path of at least one of said general cell units is defined by

said first membrane group of said general cell unit and said second membrane group of an adjacent general cell unit; said second feed path of said one or more general cell units is defined by said first and second membrane groups.

12. The electrodialysis device of claim 1 further comprising:

one or more electrodialysis vessels having more than one hydraulic stage, each of said vessel comprising a pair of electrodes, said pair of electrodes respectively serving as an anode and a cathode;

said cathode cell unit having a third membrane group comprised of one or more elements, and said general cell unit having a first membrane group comprised of one or more elements, a second membrane group comprised of one or more elements, a first feed path, and a second feed path; said general cell unit, said first and second membrane groups, and said first and second feed paths each have a first and second part;

said first membrane group comprising an anion exchange membrane and a cation exchange membrane;

said first feed path of said one or more general cell units is at least partially defined by said first membrane group; said second feed path of said one or more general cell units is at least partially defined by said first membrane group and said second membrane group.

13. A method for passivating scaling species, comprising:

passing a direct current through a pair of electrodes in an electrodialysis device having a first feed path and a second feed path, so as to energize the pair of electrodes respectively as a cathode and an anode;

supplying a feed stream comprised of a first anionic scaling species and a first cationic scaling species to said first feed path and said second feed path;

said first feed path and said second feed path are separated by a first membrane group; and

transferring said first cationic scaling species from said second feed path to said first feed path through said first membrane group.

14. Said method of claim 13 further comprising:

transferring said first anionic scaling species from said first feed path to said second feed path through said first membrane group;

wherein said electrolysis device further comprising one or more electrodialysis vessels, each of said electrodialysis vessels containing said anode and cathode; an anode cell unit is adjacent said anode, a cathode cell unit is adjacent said cathode, and at least one general cell unit is arranged between said anode cell unit and cathode cell unit;

said cathode cell unit having a third membrane group comprised of one or more elements, and said general cell units having a first membrane group comprised of one or more elements, a second membrane group comprised of one or more elements, said first feed path, and said second feed path;

said first membrane group comprising an anion exchange membrane and a cation exchange membrane;

said first feed path of said one or more general cell units is at least partially defined by said first membrane group; said second feed path of said one or more general cell units is at least partially defined by said first and second membrane groups.

15. The method of claim 14 further comprising removing the effluent from said first and second feed paths;

wherein the concentration of said first anionic scaling species in effluent removed from said first feed path is less than about 90% of the concentration of first anionic scaling species in the feed stream entering said first feed path.

16. Said method of claim 15, wherein said second membrane groups are comprised of at least one anion exchange membrane or at least one cation exchange membrane.

17. Said method of claim 15, wherein said third membrane groups are comprised of at least one anion exchange membrane or at least one cation exchange membrane.

18. The method of claim 15 further comprising directing the effluent from said first and second feed paths to a desalination plant, the contents of said first feed path are processed separately from the contents of said second feed path.

19. The method of claim 13, wherein said electrodialysis device is further comprised of two or more electrodialysis vessels, each of said electrodialysis vessels having an anode and cathode; said anode cell unit, said cathode cell unit, and said one or more general cell units span said two or more electrodialysis vessels.

20. The method of claim 13, wherein said first cationic scaling species is selected from the group consisting of Mg^{2+}, Ca^{2+}, Sr^{2+}, and Ba^{2+}, and said first anionic scaling species is selected from the group consisting of SO_4^{2-}, HCO_3^-, CO_3^{2-}, OH^-, F^-, PO_4^{3-}, HPO_4^{2-}, and $H_2PO_4^-$.

CLAIMS

1. A method of reducing scale imparting ion content of a desalination unit (DSU) feed stream comprising:
   a) passing a direct current through a pair of electrodes in an electrolysis device (ED) so as to energize said pair of electrodes as a cathode and an anode respectively;
   b) feeding an aqueous stream to said ED, said aqueous stream having an anionic scale imparting species (ASIS), an anionic non-scale imparting species (ANSIS), a cationic scale imparting species (CSIS), and a cationic non-scale imparting species (CNSIS) therein, said ASIS being present in a first ASIS concentration and said CSIS being present in a first CSIS concentration;
   c) contacting said aqueous stream in said ED along a first feed path and along a second feed path separated by a first membrane group, said second feed path also being in fluid communication with a second membrane, and said first feed path also being in fluid communication with a third membrane group, said first membrane group permitting transfer of ASIS from the first feed path to the second feed path and permitting transfer of CSIS from the second feed path to the first feed path, said second membrane permitting passage of ANSIS therethrough and out of said second feed path, said third membrane permitting passage of CNSIS therethrough and out of said first feed path, whereby after passage of said aqueous stream through said first feed path a first effluent is provided and after passage of said aqueous stream through said second feed path a second effluent is provided, wherein said first effluent has a reduced ASIS concentration compared to said first ASIS concentration and said second effluent has a reduced CSIS concentration compared to said first CSIS concentration; and
   d) feeding either or both of said first and second effluents to said DSU as said DSU feed stream, with the proviso that when both said first and second effluents are fed to said DSU, they are fed separately and are not mixed.

2. The method of claim **1**, wherein said CSIS is selected from the group consisting of Mg^{2+}, Ca^{2+}, Sr^{2+}, and Ba^{2+}, and said ASIS is selected from the group consisting of SO_4^{2-}, HCO_3^-, CO_3^{2-}, OH^-, F^-, PO_4^{3-}, HPO_4^{2-}, and $H_2PO_4^-$.

3. The method of claim **2** wherein said CSIS is Ca^{2+} and wherein said ASIS is HCO_3^-.

4. The method of claim **2** wherein said CSIS is Ca^{2+} and wherein said ASIS is SO_4^{2-}.

5. The method of claim **2** wherein said CSIS is Ca^{2+} and wherein said ASIS comprises SO_4^{2-} and HCO_3^-.

6. The method as recited in claim **3** wherein said anionic selective exchange membrane is a monovalent HCO_3^- selective membrane.

7. The method as recited in claim **3** wherein said cation selective exchange membrane is divalent $Ca2^{2+}$selective membrane.

8. The method as recited in claim **4** wherein said anionic selective exchange membrane is a monovalent HCO_3^- selective membrane.

9. The method as recited in claim **4** wherein said cationic selective exchange membrane is divalent Ca^{2+} selective membrane.

10. The method of claim **9** wherein said cation selective exchange membrane is divalent Ca^{2+} selective membrane.

11. The method as recited in claim **9** wherein said anion selective exchange membrane comprises a first membrane component defined by a monovalent HCO_3^- membrane and a second membrane component defined by a divalent SO_4^{2-} membrane.

12. The method as recited in claim **1** wherein said first effluent comprises a reduced ASIS concentration of less than about 90% of said first ASIS concentration and said second effluent comprises a reduced CSIS concentration of less than about 90% of said first CSIS concentration.

13. The method as recited in claim **1** wherein said first effluent comprises a reduced ASIS concentration of less than about 50% of said first ASIS concentration and said second effluent comprises a reduced CSIS concentration of less than about 50% of said first CSIS concentration.

14. The method as recited in claim **1** wherein said first effluent comprises a reduced ASIS concentration of less than about 20% of said first ASIS concentration and said second effluent comprises a reduced CSIS concentration of less than about 20% of said CSIS concentration.