CLAIMS

1. An electrodialysis stack, comprising:

a cathode, the cathode being disposed in an electrode solution in a cathode chamber;

an anode, the anode being disposed in the electrode solution in an anode chamber; and

a membrane stack, the membrane stack including:

a plurality of chambers defined by a corresponding plurality of membranes, the plurality of membranes being alternately disposed ones of one or more cation exchange membranes and one or more anion exchange membranes;

a first mediation chamber interposed between the cathode chamber and a first chamber of the plurality of chambers, a first membrane of the membrane stack being disposed between a first stream in the first chamber and a mediation solution in the first mediation chamber, a cathode chamber membrane being disposed between the first mediation chamber and the cathode chamber; and

a second mediation chamber interposed between the anode chamber and a last chamber of the plurality of chambers, a last membrane of the membrane stack being disposed between a last stream in the last chamber and a mediation solution in the second mediation chamber, an anode chamber membrane being disposed between the second mediation chamber and the anode chamber.

2. The electrodialysis stack as recited in claim 1, wherein a transport path of the selected ions from any one of the first stream and the last stream to the electrode solution in a respective one of the cathode chamber and the anode chamber is blocked by a respective one of the first mediation chamber and the second mediation chamber, and wherein the mediation solution is a recirculating stream distinct from any one of a concentrate stream and a dilute stream, the concentrate stream and the dilute stream being respective streams flowing through respective ones of the plurality of chambers.

3. An electrodialysis stack comprising:

a cathode, the cathode being disposed in an electrode solution in a cathode chamber;

an anode, the anode being disposed in the electrode solution in an anode chamber; and

a membrane stack, the membrane stack including:

a plurality of chambers defined by a corresponding plurality of membranes, the plurality of membranes being alternately disposed ones of one or more cation exchange membranes and one or more anion exchange membranes;

a first mediation chamber interposed between the cathode chamber and a first chamber of the plurality of chambers, a first membrane of the membrane stack being disposed between a first stream in the first chamber and a mediation solution in the first mediation chamber, a cathode chamber membrane being disposed between the first mediation chamber and the cathode chamber; and

a second mediation chamber interposed between the anode chamber and a last chamber of the plurality of chambers, a last membrane of the membrane stack being disposed between a last stream in the last chamber and a mediation solution in the second mediation chamber, an anode chamber membrane being disposed between the second mediation chamber and the anode chamber,

wherein each of the first membrane and the last membrane is selected to block selected ions from transporting into the first mediation chamber and the second mediation chamber, respectively,

and wherein the first membrane is a cation exchange membrane selected to block the selected anions from transporting from the first mediation chamber into the first chamber.

4. The electrodialysis stack as recited in claim 3, wherein the last membrane is a cation exchange membrane selected to block the selected anions from transporting from the last chamber into the last mediation chamber.

5. The electrodialysis stack as recited in claim 3, wherein the cathode chamber membrane is an anion exchange membrane, the anion exchange membrane being selected to block the selected cations from transporting into the cathode chamber.

6. The electrodialysis stack as recited in any one of claims 1 to 2, wherein the first membrane is an anion exchange membrane selected to block the selected cations from transporting from the first chamber into the first mediation chamber,

and wherein the last membrane is an anion exchange membrane selected to block the selected cations from transporting from the last mediation chamber into the last chamber,

and wherein the cathode chamber membrane is a cation exchange membrane, the cation exchange membrane being selected to allow the selected cations from transporting into the cathode chamber and block the anions from transporting into the first mediation chamber,

and wherein similar cations are present in the mediation solution and in the electrode solution.

7. The electrodialysis stack as recited in claim 3, wherein the cathode chamber membrane is selected to block the selected ions from transporting between the first mediation chamber and the cathode chamber.

8. The electrodialysis stack as recited in any one of claims 3 to 5, wherein the mediation solution is a recirculating stream distinct from any one of a concentrate stream and a dilute stream flowing through respective ones of the plurality of chambers.

9. The electrodialysis stack as recited in claim 8, further comprising one or more monovalent selective cation exchange membranes and one or more anion exchange membranes alternately disposed between the plurality of chambers, wherein all of the one or more monovalent selective cation exchange membranes and all of the one or more anion exchange membranes are disposed between the first mediation chamber and the second mediation chamber.

10. The electrodialysis stack as recited in claim 9, wherein the one or more monovalent selective cation exchange membranes are selected to block a transport of multivalent cations therethrough, wherein the multivalent ions comprise divalent ions.

11. The electrodialysis stack as recited in any one of claims 8 or 9, further comprising one or more monovalent selective anion exchange membranes and one or more cation exchange membranes alternately disposed between the plurality of chambers, wherein all of the one or more monovalent selective anion exchange membranes and all of the one or more cation exchange membranes are disposed between the first mediation chamber and the second mediation chamber.

12. The electrodialysis stack as recited in any one of claims 8 or 9, wherein the one or more monovalent selective anion exchange membranes are selected to block a transport of multivalent anions therethrough.

13. The electrodialysis stack as recited in any one of claims 8 to 12, wherein the first stream is a concentrate stream and the first membrane is an anion exchange membrane, and wherein the anion exchange membrane is selected to deter a transport of cations, including divalent cations, from the concentrate stream to the first mediation chamber.

14. The electrodialysis stack as recited in any one of claims 8 to 12, wherein the first stream is a dilute stream and the first membrane is a monovalent selective cation exchange membrane, and wherein the monovalent selective cation exchange membrane is selected to deter a transport of divalent ions from the dilute stream to the first mediation chamber.

15. The electrodialysis stack as recited in claim 3 , comprising a plurality of selective ion exchange membranes disposed between the plurality of chambers; and
separate flow paths for each one of a mediating solution, a stripping solution, and a feed solution,

wherein the stripping solution and the feed solution are fed to alternate ones of the plurality of chambers, and wherein the mediating solution is fed solely to the first mediation chamber and the second mediation chamber,

and wherein selected ones of the plurality of chambers are configured to be concentrate chambers,

and wherein a clean stripping solution is flowable through each of the concentrate chambers to provide a stripping solution effluent stream enriched in the selected ions,

and wherein the stripping solution effluent stream is clean of target ions and/or charged organic molecules,

and wherein large species are prevented from transporting from the dilute chambers into respective adjacent ones of the concentrate chambers, the large species being any one or more selected from the group consisting of multivalent ions, organic compounds, microorganisms, virus, and pathogens.