CLAIMS

1. An electrochemical separation system, comprising:

a first electrode;

a second electrode;

a first electrochemical separation modular unit including a plurality of alternating depleting compartments and concentrating compartments positioned between the first and second electrodes;

a second electrochemical separation modular unit including a plurality of alternating depleting compartments and concentrating compartments, the second electrochemical separation modular unit arranged in cooperation with the first electrochemical separation modular unit and positioned between the first electrochemical separation modular unit and the second electrode; and

a spacer, disposed between and adjacent the first and second electrochemical separation modular units, configured to reduce current loss within the system.

2. The system of claim 1, wherein the spacer is configured to promote current flow to the depleting and concentrating compartments within the system.

3. The system of claim 1, wherein each electrochemical separation modular unit includes a cell stack defining the plurality of alternating depleting compartments and concentrating compartments and a support system configured to maintain vertical alignment of the cell stack.

4. The system of claim 3, wherein the support system comprises a frame surrounding the cell stack.

5. The system of claim 4, wherein the frame includes a manifold system.

6. The system of claim 5, wherein the frame includes a flow distribution system in fluid communication with the manifold system.

7. The system of claim 6, wherein the flow distribution system comprises at least one bypass path configured to reduce current loss within the system.

8. The system of claim 1, wherein the first and second electrochemical separation modular units are arranged in parallel.

9. The system of claim 1, wherein the first and second electrochemical separation modular units are removable.

10. The system of claim 9, wherein the first and second electrochemical separation modular units are mounted in a vessel.

11. The system of claim 10, further comprising a source of water to be treated fluidly connected to an inlet of the vessel.

12. The system of claim 11, wherein the plurality of depleting compartments and concentrating compartments each has an inlet in fluid communication with the inlet of the vessel.

13. The system of claim 5, wherein the flow distribution system comprises an insert, and wherein the frame defines a recess configured to receive the insert.

14. The system of claim 13, wherein the insert defines a lattice structure configured to promote uniform flow distribution to the cell stack.

15. The system of claim 1, wherein the first and second electrochemical separation modular units are configured to provide non-radial flow within the system.

16. The system of claim 1, wherein the first and second electrochemical separation modular units are configured to provide a uniform liquid flow velocity profile within the system.

17. The system of claim 1, wherein the system is constructed and arranged to achieve at least about 85% fluid contact with respect to surface area of ion exchange membranes defining the electrochemical separation modular units.

18. The system of claim 1, wherein at least one of the depleting compartments and concentrating compartments comprises a blocking spacer or a flow redistributor.

19. The system of claim 1, wherein the system is configured such that a direction of flow through the depleting compartments is different than a direction of flow through the concentrating compartments.

20. The system of claim 1, wherein the system is configured such that the direction of flow through the depleting compartment is substantially perpendicular to the direction of flow through the concentrating compartments.

CLAIMS

1. An electrochemical separation system, comprising:

a first electrode;

a second electrode;

a first electrochemical separation modular unit including a plurality of alternating depleting compartments and concentrating compartments positioned between the first and second electrodes;

a second electrochemical separation modular unit including a plurality of alternating depleting compartments and concentrating compartments, the second electrochemical separation modular unit arranged in cooperation with the first electrochemical separation modular unit and positioned between the first electrochemical separation modular unit and the second electrode; and

a spacer, disposed between and adjacent the first and second electrochemical separation modular units, configured to reduce current loss within the system, wherein the system is configured such that the direction of flow through the depleting compartment is substantially perpendicular to the direction of flow through the concentrating compartments.