

CLAIMS

1. A module, comprising:

a cell stack comprising a plurality of alternating ion depleting compartments and ion
5 concentrating compartments; and

a housing enclosing the cell stack, the housing comprising:

an inlet manifold configured to facilitate a flow of fluid into the cell stack, the inlet
manifold comprising a first flow distribution system integral to the inlet manifold and
configured to promote uniform flow velocity across the cell stack, the first flow distribution
10 system comprising a first ramp and a plurality of radially spaced baffles; and

~~a first flow distribution system, associated with the inlet manifold, including a first
ramp to promote the circulation of the flow of fluid in the inlet manifold~~

an outlet manifold configured to facilitate a flow of fluid out of the cell stack, the
outlet manifold comprising a second flow distribution system integral to the outlet manifold,
15 the second flow distribution system comprising a second ramp, the first and the second ramps
having different radii of curvature.

~~2. The module of claim 1, wherein the first flow distribution system further comprises a
plurality of radially spaced baffles.~~

~~32.~~ 32. The module of claim 21, wherein the plurality of radially spaced baffles comprises at
least one of ribs and teeth.

~~43.~~ 43. The module of claim 1, wherein the first ramp is positioned on at least one of a
25 bottom and a top of the first flow distribution system.

~~54.~~ 54. The module of claim 1, wherein the first flow distribution system is configured to
promote uniform fluid distribution to the cell stack.

~~65.~~ 65. The module of claim 1, wherein the first flow distribution system comprises a
30 plurality of first ramps.

76. The module of claim 65, wherein the plurality of first ramps are spaced to define a plurality of first grooves.

8. ~~The module of claim 1, further comprising an outlet manifold configured to facilitate flow of fluid out of the cell stack.~~

9. ~~The module of claim 8, further comprising a second flow distribution system associated with the outlet manifold.~~

10. ~~The module of claim 9, wherein the second flow distribution system comprises a second ramp.~~

117. The module of claim 10, wherein the second ramp is positioned on at least one of a bottom and a top of the second flow distribution system.

128. The module of claim 10, wherein the second flow distribution comprises a plurality of second ramps.

13. ~~The module of claim 12, wherein the first and the second ramp have different radii of curvature.~~

149. The module of claim 128, wherein the plurality of second ramps are spaced to define a plurality of second grooves.

10. The module of claim 1, wherein the flow velocity of fluid in the cell stack has a variance of less than about $\pm 20\%$.

11. The module of claim 10, wherein the flow velocity of fluid in the cell stack has a variance of less than about $\pm 10\%$.

15. ~~A method of facilitating uniform fluid flow distribution in an electrochemical separation apparatus having a cell stack comprising a plurality of alternating ion-depleting compartments and ion-concentrating compartments, the method comprising:~~

—providing a first flow distribution system in fluid communication with the cell stack, the first flow distribution system comprising a first ramp to promote the redirection of fluid flow into the cell stack.

5 16.—The method of claim 15, further comprising providing an inlet manifold associated with the first flow distribution system.

17.—The method of claim 16, wherein providing the first flow distribution system comprises inserting the first flow distribution system into the inlet manifold.

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18.—The method of claim 15, further comprising providing a plurality of radially spaced baffles in the first flow distribution system.

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19.—The method of claim 18, wherein providing a plurality of radially spaced baffles comprises providing at least one of ribs and teeth.

20.—The method of claim 18, wherein the first flow distribution system comprises a plurality of first ramps.

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21.—The method of claim 20, wherein the plurality of first ramps are spaced to define first grooves.

22.—The method of claim 15, further comprising providing an outlet manifold in fluid communication with the electrochemical separation apparatus.

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23.—The method of claim 15, further comprising providing a second flow distribution system associated with the outlet manifold.

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24.—The method of claim 23, wherein providing the second flow distribution system comprises inserting the second flow distribution system into the outlet manifold.

25.—The method of claim 23, wherein providing the second flow distribution system comprises providing an outlet manifold having an injection molded second flow distribution system.

26. — ~~A flow distribution system, comprising:
a ramp to promote the redirection of fluid flow towards an electrochemical cell stack.~~

5 27. — ~~The system of claim 26, further comprising a plurality of ramps.~~

28. — ~~The system of claim 27, wherein the plurality of ramps are spaced to define grooves.~~

29. — ~~The system of claim 26, further comprising a plurality of radially spaced baffles.~~

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30. — ~~The system of claim 29, wherein the radially spaced baffles comprise at least one of
ribs and teeth.~~

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31. — ~~The system of claim 26, wherein the system is configured to be received or integrated
into a frame of an electrochemical separation module housing the cell stack.~~

32. — ~~The system of claim 28, wherein the system achieves less than about 20% deviation
in fluid velocity among points along various fluid passageways within the cell stack.~~

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33. — ~~The system of claim 26, configured to transform a fluid flow from a turbulent flow to
at least one of a transition flow and a laminar flow.~~