CLAIMS

1. An electrodialysis system comprising:

one or more electrodialysis cells, wherein each of the one or more electrodialysis cells comprise:

an anode electrically coupled to a cathode, wherein each of the anode and the cathode comprises an electrode module operable for electrodialysis, the electrode module comprising:

a substrate; and

an array of electrodes arranged on the substrate, wherein each of the electrodes is shaped as a planar sheet and each planar sheet is a segment of the array of electrodes, wherein each segment is arranged apart from another segment, and wherein each segment has a different planar surface area from another segment;

and

a cation-selective membrane arranged between the anode and the cathode to define a concentrate channel and a diluate channel, wherein the anode and the cathode are arranged for segments of the anode and segments of the cathode having identical planar surface area face each other.

2. The electrodialysis system of claim 1, wherein each of the one or more electrodialysis cells is operable to have a first voltage applied thereto in a first direction which produces the anion in the concentrate channel from the layer of insoluble salt at the cathode.

3. The electrodialysis system of claim 1 or 2, wherein each of the one or more electrodialysis cells is operable to have a second voltage applied thereto in a second direction which regenerates the layer of insoluble salt at the anode.

4. The electrodialysis system of any one of claims 1 to 3, wherein the concentrate channel and/or the diluate channel comprise a thickness ranging from 10 µm to 1000 µm.

5. The electrodialysis system of any one of claims 1 to 4, wherein a spacer is disposed in the concentrate channel and/or the diluate channel.

6. The electrodialysis system of any one of claims 1 to 5, wherein each of the anode and the cathode has a conductive paste or a conductive film disposed in contact therewith.

7. The electrodialysis system of any one of claims 1 to 6, wherein the electrodialysis system is operable for desalination of seawater, or as a pre-treatment prior to desalination of seawater, or as a battery.

8. A method of controlling desalination efficiency in electrodialysis comprising:

applying a voltage to one or more electrodialysis cells, wherein each of the one or more electrodialysis cells comprise:

an anode electrically coupled to a cathode, wherein each of the anode and the cathode comprises an electrode module operable for electrodialysis, the electrode module comprising:

a substrate; and

an array of electrodes arranged on the substrate, wherein each of the electrodes is shaped as a planar sheet and each planar sheet is a segment of the array of electrodes, wherein each segment is arranged apart from another segment, and wherein each segment has a different planar surface area from another segment;

and

a cation-selective membrane arranged between the anode and the cathode to define a concentrate channel and a diluate channel, wherein the anode and the cathode are arranged for segments of the anode and segments of the cathode having identical planar surface area face each other; and

operating a pair of segments of the array of electrodes at a different potential difference from another pair of segments, wherein one pair of segments comprises a

segment from the anode and another segment of identical planar surface area from the cathode.

9. The method of claim 8, wherein applying the voltage comprises applying a first voltage in a first direction which produces the anion in the concentrate channel from the layer of insoluble salt at the cathode.

10. The method of claim 8 or 9, wherein applying the voltage comprises applying a second voltage in a second direction which regenerates the layer of insoluble salt at the anode.

11. The method of any one of claims 8 to 10, wherein operating a pair of segments of the array of electrodes at a different potential difference from another pair of segments comprises:

operating a first pair of segments at a first potential difference ranging from 60 mV to 90 mV;

operating a second pair of segments at a second potential difference ranging from 120 mV to 160 mV;

operating a third pair of segments at a third potential difference ranging from 180 mV to 230 mV; and

operating a fourth pair of segments at a fourth potential difference ranging from 240 mV to 300 mV.