## CLAIMS

1. An electrodeionization apparatus comprising:

an anode compartment provided with an anode;

a cathode compartment spaced from the anode compartment and provided with a cathode, wherein the anode and cathode are configured for coupling to a DC power source to effect an electric potential difference between the anode and the cathode and thereby influence transport of ionic material in liquid media and ion exchange media by the influence of the electric potential difference;

a feed inlet receiving a feed solution;

a product water outlet;

a plurality of anion exchange membranes and a plurality of cation exchange membranes alternately arranged between the anode compartment and the cathode compartment; and

a plurality of spacers, wherein said spacers and said anion and cation exchange membranes are arranged to form a first diluting compartment receiving feed solution from the feed inlet, a second diluting compartment in series with the first diluting compartment and delivering product water to the product water outlet, a first concentrating compartment and a second concentrating compartment in parallel with the first concentrating compartment wherein the first and second diluting compartments are bounded by an anion exchange membrane on the side closest to the anode and by a cation exchange membrane on the side closest to the cathode, and the first and second concentrating compartments are bounded by a cation exchange membrane on the side closest to the anode and by an anion exchange membrane on the side closest to the cathode;

wherein said spacers which form first and second diluting compartments and first and second concentrating compartments and said anion and cation exchange membranes together form an electrodeionization group, the electrodeionization apparatus comprising a plurality of repeating electrodeionization groups assembled together as a stack;

wherein the electrodeionization group comprises first and second diluting compartment spacers and first and second concentrating compartment spacers, wherein:

a first of said diluting compartment spacers forms first and second diluting compartments, said first diluting compartment spacer having an entrance port at one end and an exit port at an opposite end, where a first portion of the first diluting compartment spacer forms a first diluting compartment receiving feed solution from its feed inlet and a second diluting compartment receiving feed solution from said first diluting compartment,

a second of said diluting compartment spacers configured such that its entrance and exit ports are on opposite ends from that of the first diluting compartment spacer such that

flow through the second diluting compartment is in the opposite direction compared to the flow in the first diluting compartment spacer, wherein said second diluting compartment spacer forms first and second diluting compartments configured in series; and

each of said concentrating compartment spacers have an entrance port receiving concentrate stream in the middle of the concentrating spacer, the concentrating spacer directing incoming concentrate stream in two flow directions, wherein the concentrate compartment spacer forms the first and second concentrate compartments, wherein the first concentrating compartment receives a first portion of the concentrate stream directed in a first direction, and the second concentrating compartment receives a second portion of the stream directed in a second direction.

2. The electrodeionization apparatus of claim **1** wherein the electrodeionization group has first and second cation exchange membranes and first and second anion exchange membranes and is arranged with the first cation exchange membrane adjacent the first diluting spacer, the first concentrate compartment spacer adjacent the first cation exchange membrane, the first anion exchange membrane adjacent the first concentrate compartment spacer, the second diluting compartment spacer adjacent the first anion exchange membrane, the second cation exchange membrane adjacent the second diluting compartment spacer, the second concentrate compartment spacer adjacent the second cation exchange membrane, and the second anion exchange membrane adjacent the second concentrate compartment spacer.

3. The electrodeionization apparatus of claim **1** wherein the diluting compartments and concentrating compartments are between about 1.0 mm and 10.0 mm thick.

4. The electrodeionization apparatus of claim **1** wherein the thickness of said first diluting compartment is greater than the thickness of said second diluting compartment.

5. The electrodeionization apparatus of claim **4** wherein the thickness of said first diluting compartment is about two to four times greater than the thickness of said second diluting compartment.

6. The electrodeionization apparatus of claim **4** wherein the thickness of said first diluting compartment is about four to eight times greater than the thickness of said second diluting compartment.

7. The electrodeionization apparatus of claim **1** wherein the thickness of said first diluting compartment is less than the thickness of said second diluting compartment.

8. The electrodeionization apparatus of claim **7** wherein the thickness of said first diluting compartment is about two to four times less than the thickness of said second diluting compartment.

9. The electrodeionization apparatus of claim **7** wherein the thickness of said first diluting compartment is about four to eight times less than the thickness of said second diluting compartment.

10. An electrodeionization apparatus comprising:

an anode compartment provided with an anode;

a cathode compartment spaced from the anode compartment and provided with a cathode, wherein the anode and cathode are configured for coupling to a DC power source to effect an electric potential difference between the anode and the cathode and thereby influence transport of ionic material in liquid media and ion exchange media by the influence of the electric potential difference;

a feed inlet receiving a feed solution;

a product water outlet;

a plurality of anion exchange membranes and a plurality of cation exchange membranes alternately arranged between the anode compartment and the cathode compartment; and

a plurality of spacers, wherein said spacers and said anion and cation exchange membranes are arranged to form a first diluting compartment receiving feed solution from the feed inlet, a second diluting compartment in series with the first diluting compartment and delivering product water to the product water outlet, a first concentrating compartment and a second concentrating compartment in parallel with the first concentrating compartment wherein the first and second diluting compartments are bounded by an anion exchange membrane on the side closest to the anode and by a cation exchange membrane on the side closest to the cathode, and the first and second concentrating compartments are bounded by a cation exchange membrane on the side closest to the anode and by an anion exchange membrane on the side closest to the cathode;

wherein said spacers which form first and second diluting compartments and first and second concentrating compartments and said anion and cation exchange membranes together form an electrodeionization group, the electrodeionization apparatus comprising a plurality of repeating electrodeionization groups assembled together as a stack;

wherein the electrodeionization group has first and second cation exchange membranes and first and second anion exchange membranes and is arranged with the first cation exchange membrane adjacent the first diluting compartment, the first concentrate compartment adjacent the first cation exchange membrane, the first anion exchange membrane adjacent the first concentrate compartment, the second diluting compartment adjacent the first anion exchange membrane, the second cation exchange membrane adjacent the second diluting compartment, the second concentrate compartment adjacent the second cation exchange membrane, and the second anion exchange membrane adjacent the second concentrate compartment.

## CLAIMS

**1**. An electrodeionization apparatus comprising:

an anode compartment provided with an anode;

a cathode compartment spaced from the anode compartment and provided with a cathode, wherein the anode and cathode are configured for coupling to a DC power source to effect an electric potential difference between the anode and the cathode and thereby influence transport of ionic material in liquid media and ion exchange media by the influence of the electric potential difference;

a feed inlet receiving a feed solution;

a product water outlet;

a plurality of anion exchange membranes and a plurality of cation exchange membranes alternately arranged between the anode compartment and the cathode compartment; and

a plurality of spacers, wherein said spacers and said anion and cation exchange membranes are arranged to form a first diluting compartment receiving feed solution from the feed inlet, a second diluting compartment in series with the first diluting compartment and delivering product water to the product water outlet, a first concentrating compartment and a second concentrating compartment, in parallel with the first concentrating compartment wherein the first and second diluting compartments are bounded by an anion exchange membrane on the side closest to the anode and by a cation exchange membrane on the side closest to the cathode, and the first and second concentrating compartments are bounded by a cation exchange membrane on the side closest to the anode and by an anion exchange membrane on the side closest to the cathode;

wherein said spacers which form first and second diluting compartments and first and second concentrating compartments and said anion and cation exchange membranes together form an electrodeionization group, the electrodeionization apparatus comprising a plurality of repeating electrodeionization groups assembled together as a stack;

wherein the electrodeionization group comprises first and second diluting compartment spacers and first and second concentrating compartment spacers, wherein:

a first of said diluting compartment spacers forms first and second diluting compartments, said first diluting compartment spacer having an entrance port at one end and an exit port at an opposite end, where a first portion of the first diluting compartment spacer forms a first diluting compartment receiving feed solution from its feed inlet and a second diluting compartment receiving feed solution from said first diluting compartment,

a second of said diluting compartment spacers configured such that its entrance and exit ports are on opposite ends from that of the first diluting compartment spacer such that flow through the second diluting compartment is in the opposite direction compared to the flow in the first diluting compartment spacer, wherein said second diluting compartment spacer forms first and second diluting compartments configured in series; and

each of said concentrating compartment spacers have an entrance port receiving concentrate stream in the middle of the concentrating spacer, the concentrating spacer directing incoming concentrate stream in two flow directions, wherein the concentrate compartment spacer forms the first and second concentrate compartments, wherein the first concentrating compartment receives a first portion of the concentrate stream directed in a first direction, and the second concentrating compartment receives a second portion of the stream directed in a second direction.

**2**. The electrodeionization apparatus of claim **1** wherein the electrodeionization group has first and second cation exchange membranes and first and second anion exchange membranes and is arranged with the first cation exchange membrane adjacent the first diluting spacer, the first concentrate compartment spacer adjacent the first cation exchange membrane, the first anion exchange membrane adjacent the first concentrate compartment spacer, the second diluting compartment spacer adjacent the first anion exchange membrane, the second cation exchange membrane adjacent the second diluting compartment spacer, the second concentrate compartment spacer adjacent the second cation exchange membrane, and the second anion exchange membrane adjacent the second concentrate compartment spacer.

**3**. The electrodeionization apparatus of claim **1** wherein the diluting compartments and concentrating compartments are between about 1.0 mm and 10.0 mm thick.

**4**. The electrodeionization apparatus of claim **1** wherein the thickness of said first diluting compartment is greater than the thickness of said second diluting compartment.

**5**. The electrodeionization apparatus of claim **4** wherein the thickness of said first diluting compartment is about two to four times greater than the thickness of said second diluting compartment.

**6**. The electrodeionization apparatus of claim **4** wherein the thickness of said first diluting compartment is about four to eight times greater than the thickness of said second diluting compartment.

**7**. The electrodeionization apparatus of claim **1** wherein the thickness of said first diluting compartment is less than the thickness of said second diluting compartment.

**8**. The electrodeionization apparatus of claim **7** wherein the thickness of said first diluting compartment is about two to four times less than the thickness of said second diluting compartment.

**9**. The electrodeionization apparatus of claim **7** wherein the thickness of said first diluting compartment is about four to eight times less than the thickness of said second diluting compartment.