CLAIMS

1. A filtration module assembly comprising:

a vessel;

a header coupled to an end of the vessel, the header including a housing having an open-ended upper end and a lower end;

an end cap including a portion that mates with a complimentary structure defined by the inner wall of the open-ended upper end of the housing to removably engage with the housing, the end cap defining a passageway for fluid to flow out of the vessel; and

a filtration cartridge disposed within the vessel, the filtration cartridge including an upper end removably coupled to the lower end of the housing.

2. The module assembly of claim 1, wherein the filtration cartridge comprises a plurality of permeable hollow fiber membranes extending between the lower end of the filtration cartridge and the upper end of the filtration cartridge.

3. The module assembly of claim 2, wherein the vessel comprises a screen extending between the lower end of the filtration cartridge and the upper end of the filtration cartridge and surrounding the plurality of permeable hollow fiber membranes.

4. The module assembly of claim 3, further comprising a filtrate collection chamber defined by the end cap and the upper end of the filtration cartridge.

5. The module assembly of claim 4, wherein the passageway includes a filtrate communication passageway in fluid communication between the filtrate collection chamber and a first fluid transfer manifold.

6. The module assembly of claim 5, wherein the end cap further comprises a shut off valve constructed and arranged to fluidly isolate the filtrate collection chamber from a filtrate communication port.

7. The module assembly of claim 5, wherein the first fluid transfer manifold is coupled to the header and includes a filtrate passageway and is further coupled to a second fluid transfer manifold of a second module assembly to provide fluid communication between the filtrate

passageway of the first fluid transfer manifold and a filtrate passageway of the second fluid transfer manifold.

8. The module assembly of claim 4, wherein the passageway includes a filtrate communication passageway defined by a side surface of the end cap and an internal surface of the housing.

9. The module assembly of claim 1, wherein the filtration cartridge includes an external diameter smaller than an internal diameter of the housing.

10. The module assembly of claim 2, wherein the filtration cartridge includes fluid communication openings defined in a potting sleeve surrounding a portion of the membranes, the fluid communication openings in fluid communication between a feed passageway in the housing and outer surfaces of the membranes.

11. The module assembly of claim 1, wherein the removable end cap includes screw threads configured to engage with mating screw threads provided on an upper portion of an inner wall of the housing.

12. A filtration system comprising:

a first filtration module including a first fluid communication opening and a first header having a first removable end cap engaged with an upper end of the first header and a first filtration cartridge having an end disposed in a lower end of the first header;

a second filtration module including a second fluid communication opening and a second header having a second removable end cap engaged with an upper end of the second header and a second filtration cartridge having an end disposed in a lower end of the second header; and

a first common fluid transfer manifold in fluid communication with the first fluid communication opening and the second fluid communication opening positioned between the first filtration module and the second filtration module.

13. The filtration system of claim 11, wherein the first common fluid transfer manifold is in fluid communication with lumens of membrane fibers included in the first filtration module and with lumens of membrane fibers included in the second filtration module.

14. The filtration system of claim 11, further comprising a second common fluid transfer manifold located between the first header and the second header, and in fluid communication with external surfaces of membrane fibers included in the first filtration module and with external surfaces of membrane fibers included in the second filtration module.

15. The filtration system of claim 11, wherein the first header includes an internal diameter greater than an external diameter of the first filtration cartridge header includes an internal diameter greater than an external diameter of the second filtration cartridge.

16. The module assembly of claim 11, wherein one or more fluid communication openings defined in each of the first housing and the second housing are in fluid communication with both the first filtration cartridge and the second filtration cartridge.

17. The module assembly of claim 11, wherein the first removable end cap is engaged with the first open-ended housing to define a filtrate collection chamber between the first removable end cap and the first filtration cartridge.

18. The module assembly of claim 17, wherein the first removable end cap includes a fluid communication passageway in fluid communication between the filtrate collection chamber and the first fluid communication opening.

19. A method of operating a filtration system comprising:

passing a feed through a plurality of filtration modules each including a filtration cartridge, the plurality of filtration modules fluidly connected by a common feed transfer manifold and a common filtrate transfer manifold, the plurality of filtration modules each including respective removable end caps disposed in respective open-ended upper housings;

isolating the filtration cartridge of a first filtration module of the plurality of filtration modules from the common filtrate manifold and taking the first filtration module out of operation by engaging a shut-off valve in the end cap of the first filtration module;

disengaging the removable end cap from the open-ended upper housing of the first filtration module;

accessing the filtration cartridge of the first filtration module by longitudinally displacing the filtration cartridge of the first filtration module through the housing of the first filtration module;

re-engaging the removable end cap with the housing of the first filtration module assembly; and

returning the first filtration module assembly to operation.

20. The method of claim 19, wherein disengaging the removable end cap from the housing of the first filtration module assembly includes rotating the removable end cap of the first filtration module relative to the housing of the first filtration module, disengaging screw threads formed on the removable end cap of the first filtration module from mating screw threads provided on an upper portion of an inner wall of the housing of the first filtration module.

CLAIMS

1. A filtration module assembly comprising:

a vessel;

a header coupled to an end of the vessel, the header including a housing having an open-ended upper end and a lower end;

an end cap including a portion that mates with a complimentary structure defined by the inner wall of the open-ended upper end of the housing to removably engage with the housing, the end cap defining a passageway for fluid to flow out of the vessel; and

a filtration cartridge disposed within the vessel, the filtration cartridge including an upper end removably coupled to the lower end of the housing,

wherein the filtration cartridge includes an external diameter smaller than an internal diameter of the housing.

2. The module assembly of claim 1, wherein the filtration cartridge comprises a plurality of permeable hollow fiber membranes extending between a lower end of the filtration cartridge and the upper end of the filtration cartridge.

3. The module assembly of claim 2, wherein the vessel comprises a screen extending between the lower end of the filtration cartridge and the upper end of the filtration cartridge and surrounding the plurality of permeable hollow fiber membranes.

4. The module assembly of claim 3, further comprising a filtrate collection chamber defined by the end cap and the upper end of the filtration cartridge.

5. The module assembly of claim 4, wherein the passageway includes a filtrate communication passageway in fluid communication between the filtrate collection chamber and a first fluid transfer manifold.

6. The module assembly of claim 5, wherein the end cap further comprises a shut off valve constructed and arranged to fluidly isolate the filtrate collection chamber from a filtrate communication port.

7. The module assembly of claim 5 or claim 6, wherein the first fluid transfer manifold is coupled to the header and includes a filtrate passageway and is further coupled to a second fluid transfer

manifold of a second module assembly to provide fluid communication between the filtrate passageway of the first fluid transfer manifold and a filtrate passageway of the second fluid transfer manifold.

8. The module assembly of claim 4, wherein the passageway includes a filtrate communication passageway defined by a side surface of the end cap and an internal surface of the housing.

9. The module assembly of claim 2, wherein the filtration cartridge includes fluid communication openings defined in a potting sleeve surrounding a portion of the membranes, the fluid communication openings in fluid communication between a feed passageway in the housing and outer surfaces of the membranes.

10. The module assembly of any one of claims 1 to 9, wherein the removable end cap includes screw threads configured to engage with mating screw threads provided on an upper portion of an inner wall of the housing.

11. A filtration system comprising:

a first filtration module including a first fluid communication opening and a first header having a first removable end cap engaged with an upper end of the first header and a first filtration cartridge having an end disposed in a lower end of the first header;

a second filtration module including a second fluid communication opening and a second header having a second removable end cap engaged with an upper end of the second header and a second filtration cartridge having an end disposed in a lower end of the second header; and

a first common fluid transfer manifold in fluid communication with the first fluid communication opening and the second fluid communication opening positioned between the first filtration module and the second filtration module'

wherein the first header includes an internal diameter greater than an external diameter of the first filtration cartridge and the second header includes an internal diameter greater than an external diameter of the second filtration cartridge.

12. The filtration system of claim 11, wherein the first common fluid transfer manifold is in fluid communication with lumens of membrane fibers included in the first filtration module and with lumens of membrane fibers included in the second filtration module.

13. The filtration system of claim 11 or claim 12, further comprising a second common fluid transfer manifold located between the first header and the second header, and in fluid communication

with external surfaces of membrane fibers included in the first filtration module and with external surfaces of membrane fibers included in the second filtration module.

14. The filtration system of any one of claims 11 to 13, wherein one or more fluid communication openings defined in each of the first housing and the second housing are in fluid communication with both the first filtration cartridge and the second filtration cartridge.

15. The filtration system of any one of claims 11 to 13, wherein the first removable end cap is engaged with the first open-ended housing to define a filtrate collection chamber between the first removable end cap and the first filtration cartridge.

16. The filtration system of claim 15, wherein the first removable end cap includes a fluid communication passageway in fluid communication between the filtrate collection chamber and the first fluid communication opening.

17. A method of operating a filtration system comprising:

passing a feed through a plurality of filtration modules each including a filtration cartridge, the plurality of filtration modules fluidly connected by a common feed transfer manifold and a common filtrate transfer manifold, the plurality of filtration modules each including respective removable end caps disposed in respective open-ended upper housings and engaged with an upper end thereof;

isolating the filtration cartridge of a first filtration module of the plurality of filtration modules from the common filtrate manifold and taking the first filtration module out of operation by engaging a shut-off valve in the end cap of the first filtration module;

disengaging the removable end cap from the upper end of the open-ended upper housing of the first filtration module;

accessing the filtration cartridge of the first filtration module by longitudinally displacing the filtration cartridge of the first filtration module through the open-ended upper housing of the first filtration module;

re-engaging the removable end cap with the upper end of the open-ended upper housing of the first filtration module; and

returning the first filtration module to operation.

18. The method of claim 17, wherein disengaging the removable end cap from the upper end of the open-ended upper housing of the first filtration module includes rotating the removable end cap of the first filtration module relative to the housing of the first filtration module, disengaging screw threads formed on the removable end cap of the first filtration module from mating screw threads provided on

an upper portion of an inner wall of the upper end of the open ended upper housing of the first filtration module.