WHAT IS CLAIMED IS:

1. A membrane separation unit comprising:

(a) a cartridge having an interior, an exterior, and a pair of ends;

(b) at least one membrane disposed within the cartridge;

(c) at least one seal plate for sealing one end of the cartridge, the seal plate comprising an outer groove and at least one venting hole that forms a passage between the interior of the cartridge and the outer groove; and

(d) a sealing ring seated in the outer groove, the sealing ring having a cross-sectional shape that forms a circular venting path between the sealing ring and the seal plate, wherein a cross-section of the sealing ring's top surface includes two flattened surfaces that meet in a peak along an outer surface of the sealing ring, and two flattened surfaces form an angle there between of between 100° and 160°.

2. The membrane separation unit of claim 1, wherein a cross-section of the sealing ring includes a rounded interior surface and two flat side surfaces.

3. The membrane separation unit of claim 1, wherein a cross-section of the sealing ring includes two flattened surfaces that meet in a peak along an outer surface of the sealing ring.

4. The membrane separation unit of claim 3, wherein the two flattened surfaces form an angle there between of between 90° and 175°.

5. The membrane separation unit of claim 1, wherein the outer groove includes a second groove therein that forms at least a portion of the circular venting path.

6. The membrane separation unit of claim 1, wherein an interior surface of the sealing ring includes a groove that forms a least a portion of the annular venting groove.

7. The membrane separation unit of claim 1, wherein the membrane disposed within the cartridge is in a spiral configuration.

8. The membrane separation unit of claim 1, wherein the sealing ring comprises at least one groove in a face thereof providing a venting path past the sealing ring.

9. A membrane separation device comprising:

(a) a device housing having an inside surface; and

(b) a plurality of membrane separation units disposed in series in the device housing, wherein each of the membrane separation units has the structure according to claim 1, wherein the plurality of membrane separation devices are seated within the device housing such that the sealing ring contacts the inside surface of the device housing to form a seal between the membrane separation units and the device housing.

10. The membrane separation device of claim 9, wherein the device housing is cylindrical.

11. A membrane separation unit comprising:

(a) a cartridge having an interior, an exterior, and a pair of ends;

(b) at least one membrane disposed within the cartridge;

(c) at least one seal plate for sealing one end of the cartridge, the seal plate comprising an outer groove; and

(d) a sealing ring seated in the outer groove, the sealing ring having its top surface's cross-sectional shape comprising two flattened portions that form an angle of between 100° and 160° there between along an outer perimeter of the sealing ring.

12. The membrane separation unit of claim 9, wherein the sealing ring includes one or more grooves in a face thereof.

13. The membrane separation unit of claim 9 or claim 10, wherein the seal plate comprises at least one venting hole providing a passage between the interior of the cartridge and the outer groove.

14. A seal plate for a membrane separation unit comprising:

(a) a first part defining at least two concentric passages there through, the first passage being defined by a central ring and the second passage being defined between the central ring and an outer ring, the central ring and the outer ring being connected by one or more spokes, the outer ring having an outer groove adapted to hold a sealing ring; and

(b) a second part comprising a disk defining a plurality of holes therein and a central passageway, the second part being adapted to be secured to the first

part such that the central passageway is aligned with the first passage of the first part and the plurality of holes are aligned with the second passage, wherein the outer ring defines at least one venting hole formed between an inner surface of the outer ring and the outer groove, wherein the outer ring of the first part includes an inner annular lip.

15. The seal plate of claim 14, wherein the outer ring of the first part includes an inner annular lip.

16. The seal plate of claim 14, wherein the one or more spokes comprise a hollow interior.

17. The seal plate of claim 14, wherein the second part includes one or more projections adapted to form a snap fit connection with a portion of the central ring of the first part.

18. A membrane separation unit comprising:

(a) a cartridge having an interior, an exterior, and a pair of ends;

(b) at least one membrane disposed within the cartridge;

(c) a seal plate according to claim 14; and

(d) a sealing ring seated in the outer groove of the seal plate, the sealing ring having a cross-sectional shape having two flattened portions that form an angle of between 90° and 175° there between.

19. A seal plate system comprising a plurality of seal plates as defined by claim 14, wherein the system includes a single first part design and a plurality of different second part designs each having a different arrangement of holes.

20. The seal plate system of claim 19, wherein each second part design has a unique color.

21. A seal plate for a membrane separation unit comprising at least an outer ring defining an outer groove adapted to hold a sealing ring, the outer ring comprising an inner annular lip, wherein the outer ring defines at least one venting hole formed between an inner surface of the outer ring and the outer groove.

22. A membrane separation unit comprising:

(a) a cartridge having an interior, an exterior, and a pair of ends;

(b) at least one membrane disposed within the cartridge;

(c) a seal plate according to claim 21; and

(d) a sealing ring seated in the outer groove of the seal plate, the sealing ring having a cross-sectional shape having two flattened portions that form an angle of between 90° and 175° there between.

CLAIMS

1. A membrane separation unit comprising:
(a) a cartridge having an interior, an exterior, and a pair of ends;
(b) at least one membrane disposed within the cartridge;
(c) at least one seal plate for sealing one end of the cartridge, the seal plate comprising an outer groove and at least one venting hole that forms a passage between the interior of the cartridge and the outer groove; and
(d) a sealing ring seated in the outer groove, the sealing ring having a crosssectional shape that forms a circular venting path between the sealing ring and the seal plate, wherein a cross-section of the sealing ring's top surface includes two flattened surfaces that meet in a peak along an outer surface of the sealing ring, and two flattened surfaces form an angle there between of between 100° and 160°.

2. The membrane separation unit of claim 1, wherein a cross-section of the sealing ring includes a rounded interior surface and two flat side surfaces.

3. The membrane separation unit of claim 1, wherein the outer groove includes a second groove therein that forms at least a portion of the circular venting path.

4. The membrane separation unit of claim 1, wherein an interior surface of the sealing ring includes a groove that forms at least a portion of the annular venting groove.

5. The membrane separation unit of claim 1, wherein the membrane disposed within the cartridge is in a spiral configuration.

6. The membrane separation unit of claim 1, wherein the sealing ring comprises at least one groove in a face thereof providing a venting path past the sealing ring.

7. A membrane separation device comprising:
(a) a device housing having an inside surface; and

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(b) a plurality of membrane separation units disposed in series in the device housing, wherein each of the membrane separation units has the structure according to claim 1, wherein the plurality of membrane separation devices are seated within the device housing such that the sealing ring contacts the inside surface of the device housing to form a seal between the membrane separation units and the device housing.

8. The membrane separation device of claim 7, wherein the device housing is cylindrical.

9. A membrane separation unit comprising:
(a) a cartridge having an interior, an exterior, and a pair of ends;
(b) at least one membrane disposed within the cartridge;
(c) at least one seal plate for sealing one end of the cartridge, the seal plate comprising an outer groove; and
(d) a sealing ring seated in the outer groove, the sealing ring having its top surface's cross-sectional shape comprising two flattened portions that form an angle of between 100° and 160° there between along an outer perimeter of the sealing ring.

10. The membrane separation unit of claim 7, wherein the sealing ring includes one or more grooves in a face thereof.

11. The membrane separation unit of claim 7 or claim 8, wherein the seal plate comprises at least one venting hole providing a passage between the interior of the cartridge and the outer groove.

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