

itself rather than the annular space between the element 11 and the housing 10. If the flow 140 were not directed primarily into the element structure the velocity of the feed flow over the membrane sheet would be reduced which would impact the separation performance of the membrane sheet. Conventional systems provide an elastomeric seal in a circumferential grooved depression 16 located on the outer surface of a seal plate 12 as shown in sectional Fig. 2A. A commonly used elastomeric seal 25 is shaped a cup form as shown in Fig. 2B which creates an effective seal but requires that the element be inserted into the housing in one direction as the seal cannot be pushed a reverse direction. A symmetrical elastomeric seal such as an O-ring 26 could be used within the element seal late groove as sown in figure 2C. This permits movement in either direction but relies on a greater amount of deformation of elastomeric seal in order to function as an effective seal. This results in greater force needed to insert the element into the cylindrical housing and is the principal reason for the preference for the cupped shaped elastomeric seal.

~~BRIEF SUMMARY OF THE INVENTION~~

[0008] A radial seal for a filtration system comprises one or more annulus having an outer circumference and an inner circumference and a thickness. Each annulus may have a diameter of the inner circumference that fits in a groove in an outer surface of a seal plate and each annulus has a diameter of the outer circumference selected to be larger than the diameter of an inner surface of a cylindrical housing that receives the seal plate. A gap in the annulus of the ring centered along a radius of the at least one annulus has a width selected to enable the annular element to deform sufficiently to permit insertion of the at least one annulus into the cylindrical housing.

[0009] The inner and outer diameters of the annuli and the width of the gap may be selected to obtain a tight fit between the outer circumference of the at least one annulus and the inner surface of the cylindrical housing. The tight fit is maintained by a restoring force reactive to compression of the annular element, the magnitude of the restoring force being related to the width of the gap and the materials used to fabricate the at least one annulus. The width of the gap can be selected to permit a controlled degree of leakage when an annulus is installed in the groove and the seal plate is inserted in the cylindrical housing.

[0010] In some embodiments, the seal comprises two or more annuli configured such that the gaps of the annuli are misaligned when the annuli are installed in the groove, thereby minimizing leakage in operation. A registration system includes a registration element that cooperates with a registration element of the other annulus to ensure misalignment of the gaps of the pair of annuli. The registration system can comprise a raised element provided on a surface of one of pair of annuli that fits in the gap of an adjacent annulus and/or a raised element provided on a surface of one of pair of annuli that fits in a groove provided on a surface of an adjacent annulus.

[0010a] In a first aspect, there is provided the use of a radial seal in a filtration system, comprising at least one annulus defined by an outer circumference and an inner circumference and a thickness and having:

a diameter of the inner circumference that is selected to fit in a groove in an outer surface of a seal plate;

a diameter of the outer circumference that is selected to be larger than the diameter of an inner surface of a cylindrical housing that receives the seal plate;

a gap in the at least one annulus and centered along a radius of the at least one annulus, wherein the gap has a width selected to enable the annular element to deform sufficiently to permit insertion of the at least one annulus into the cylindrical housing, wherein

the inner and outer diameters of the at least one annulus and the width of the gap are selected to obtain a tight fit between the outer circumference of the at least one annulus and the inner surface of the cylindrical housing.

[0011] Methods for sealing a spiral membrane element inserted into a cylindrical housing of a filtration system are provided. A method according to certain ~~embodiment~~aspects of the ~~disclosure~~invention includes steps of providing at least one split ring seal in a groove located on an outer surface of a seal plate of the spiral membrane element, inserting the seal ring into the cylindrical housing, including inserting the seal ring includes a step of compressing the at least one split ring seal.

[0011a] In a second aspect, there is provided a method of sealing a spiral membrane element configured to be inserted into a cylindrical housing of a filtration system, comprising:

providing at least one split ring seal in a groove located on an outer surface of a seal plate of the spiral membrane element, wherein the split ring seal has an outer diameter exceeding the diameter of an inner surface of the cylindrical housing; and

inserting the seal ring into the cylindrical housing, wherein inserting the seal ring includes a step of compressing the at least one split ring seal, wherein

a gap in the split ring has a width selected to enable the annular element to deform in response to the compressing step sufficient to enable the at least one split ring seal to fit within the cylindrical housing.

[0011b] In a third aspect, there is provided the use of a split-ring seal for maintaining a seal between a filtration element and a housing of a filtration system, comprising a rigid annulus having a discontinuity therein, wherein:

the annulus has an inner diameter selected to allow the annulus to fit a groove provided in an outer surface of the filtration element;

the annulus has an outer diameter is selected to be larger than the diameter of an inner surface of the housing;

the discontinuity accommodates a reduction of inner and outer diameters of the annulus in response to a compressive force received during insertion of the filtration element into the housing; and

the annulus is configured to resist changes in its cross-sectional profile in response to the compressive force.

[0011c] In a fourth aspect, there is provided a filtration system comprising spiral membrane elements inserted into a cylindrical housing, wherein the spiral membrane element has a radial seal as defined herein or a split-ring seal as defined herein, and the spiral membrane element can be moved along an axis of the cylindrical housing in either direction without destruction of the radial seal or the split-ring seal.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Figs. 1A-1C illustrates a filtration system that includes a plurality of sealed filtration elements.

[0013] Fig. 2A shows a groove provided in a seal plate and Figs. 2B-2C show prior art elastomeric seals provided in groove of Fig. 2A.

[0014] Fig. 3A shows a seal element according to certain aspects of the invention.

[0015] Fig. 3B shows a profile of seal element of Fig. 3A.

[0016] Figs. 4A and 4B shows, in cross-section, one or more seal elements according to certain aspects of the invention provided in the groove of a seal plate.

[0017] Figs. 5A-5D show examples of split ring seals with a variety of gap profiles according to certain aspects of the invention.

[0018] Fig. 6 shows a cross-sectional view of one embodiment of the annular seal suitable for installation in a groove of a seal plate.

[0019] Figs. 7A-7C show examples of seals having compound gap profiles according to certain aspects of the invention.