

GASKET AND ENDBLOCK FOR SEPARATION MODULE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority under 35 U.S.C. §119(e) to U.S. Provisional
5 Application Serial No. 63/432,832 titled “GASKET AND ENDBLOCK ASSEMBLY FOR
ELECTRODEIONIZATION MODULE” having a filing date of January 27, 2023,
incorporated herein by reference in its entirety for all purposes.

FIELD OF TECHNOLOGY

10 Aspects and embodiments disclosed herein are generally related to separation devices,
and more specifically, to gasket and endblock assemblies for separation devices.

SUMMARY

In accordance with one aspect, there is provided a system for water treatment. The
15 system may comprise a housing. The system may comprise at least one endblock
dimensioned to be positioned within the housing. The system may comprise a gasket having a
face and a lip extending from the face, the face dimensioned to be positioned between the
endblock and an active area of the water treatment, and the lip dimensioned to be positioned
over an outer edge of the endblock adjacent to the housing to form a seal.

20 In some embodiments, the system may further comprise an o-ring dimensioned to be
positioned adjacent to the lip.

In some embodiments, the endblock comprises a contour dimensioned to accept a
portion of the lip.

25 In some embodiments, the contour of the endblock is dimensioned to accept the
portion of the lip and the o-ring when the o-ring is compressed.

In some embodiments, the gasket and o-ring are rated in operation to withstand a
static pressure of at least up to 100 psi.

In some embodiments, the o-ring has a compression between 15% and 40% when the
gasket and o-ring are positioned within the housing.

30 In some embodiments, the endblock comprises a contour dimensioned to correspond
with a distal end of the lip.

In some embodiments, at least a portion of an edge side of the endblock is tapered.

In accordance with another aspect, there is provided a system for water treatment. The
system may comprise a housing. The system may comprise at least one endblock

dimensioned to be positioned within the housing. The system may comprise a gasket having a face and a lip extending from the face, the face dimensioned to be positioned between an internal side of the endblock and an active area of the water treatment, and the lip dimensioned to be positioned over an outer edge of the endblock. The system may comprise an o-ring dimensioned to be positioned between the lip and an internal side of the housing. The gasket and o-ring may be rated in operation to withstand a static pressure of at least up to 100 psi.

In some embodiments, the o-ring is integrated with the gasket.

In some embodiments, the o-ring is independent from the gasket.

In some embodiments, the endblock comprises a contour dimensioned to accept a portion of the lip and the o-ring when the o-ring is compressed.

In some embodiments, the gasket and o-ring are rated in operation to withstand a static pressure of at least up to 180 psi.

In accordance with another aspect, there is provided a sealing assembly for a water treatment system. The sealing assembly may comprise a gasket having a face and a lip extending from the face, the face dimensioned to be positioned in contact with an endblock and the lip dimensioned to be positioned over an outer edge of the endblock.

In some embodiments, the sealing assembly may further comprise an o-ring dimensioned to be positioned adjacent to the lip.

In some embodiments, a portion of the lip is dimensioned to correspond with a contour of the endblock.

In some embodiments, the portion of the lip is dimensioned to accept the o-ring when the o-ring is compressed.

In some embodiments, the o-ring is formed of an elastomeric material.

In some embodiments, the gasket is formed of an elastomeric material.

In some embodiments, the gasket comprises an o-ring integrated with the lip.

In some embodiments, a distal end of the lip is dimensioned to correspond with a contour of the endblock.

In accordance with another aspect, there is provided a method of retrofitting an electrochemical separation device having an endblock and a housing. The method may comprise providing a sealing assembly. The method may comprise providing instructions to install the sealing assembly in a system for water treatment. The method may comprise providing instructions to install the face of the gasket in contact with the endblock and position the lip over the outer edge of the endblock.

In some embodiments, the method may further comprise providing the endblock comprising a contour dimensioned to correspond with a portion of the lip.

The disclosure contemplates all combinations of any one or more of the foregoing aspects and/or embodiments, as well as combinations with any one or more of the
5 embodiments set forth in the detailed description and any examples.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are not intended to be drawn to scale. In the drawings, each identical or nearly identical component that is illustrated in various figures is
10 represented by a like numeral. For purposes of clarity, not every component may be labeled in every drawing. In the drawings:

FIG. 1A is a perspective view of an endblock, according to one embodiment;

FIG. 1B is a perspective view of a gasket, according to one embodiment;

FIG. 1C is a perspective view of an o-ring, according to one embodiment;

15 FIG. 1D includes photographs showing a side view and a side perspective view of a gasket comprising an o-ring portion, according to one embodiment;

FIGS. 2A-2B are exploded views of a sealing assembly including an endblock, a gasket, and an o-ring, according to one embodiment;

20 FIGS. 3A-3B are perspective views of a sealing assembly including an endblock, a gasket, and an o-ring, according to one embodiment;

FIG. 4A is a back view of an endblock having a sealing assembly including a gasket and an o-ring, according to one embodiment;

FIG. 4B is a side view of the endblock and sealing assembly of FIG. 4A, according to one embodiment;

25 FIG. 4C is a partial scale view of the endblock and sealing assembly of FIGS. 4A-4B, according to one embodiment;

FIG. 4D is a partial scale view of an endblock and sealing assembly, according to one embodiment;

30 FIG. 5A is a side sectional view of a sealing assembly on a water treatment system, according to one embodiment;

FIG. 5B is a partial scale sectional view of the sealing assembly of FIG. 5A, according to one embodiment;

FIG. 6 is a side sectional view of a water treatment system, according to one embodiment;

FIGS. 7A-7C are photographs showing an electrochemical cell stack (10 cell pairs) with endblocks and sealing assemblies, according to one embodiment;

FIGS. 8A-8C are photographs showing an electrochemical cell stack (50 cell pairs) with endblocks and sealing assemblies, according to one embodiment;

5 FIGS. 9A-9C are photographs showing the electrochemical cell system setup for a static pressure test, according to one embodiment;

FIGS. 10A-10B are photographs showing an electrochemical cell stack after a static pressure test, according to one embodiment;

10 FIGS. 11A-11C are photographs showing an electrochemical cell stack with endblocks and sealing assemblies, pictured during a repeated installation test, according to one embodiment;

FIGS. 12A-12B are schematic diagrams of a simulated endblock and sealing assembly during installation into a housing, according to one embodiment;

15 FIG. 13A is a heat map showing maximum pressure against an o-ring after installation into a housing, according to one embodiment;

FIG. 13B is a heat map showing maximum pressure against a gasket after installation into a housing, according to one embodiment;

FIG. 13C is a heat map showing maximum strain of an o-ring after installation into a housing, according to one embodiment;

20 FIG. 13D is a heat map showing maximum strain of a gasket after installation into a housing, according to one embodiment;

FIG. 14A is a schematic diagram of a comparative endblock and sealing assembly before installation into a housing, according to one embodiment;

25 FIG. 14B is a heat map showing maximum pressure against a comparative o-ring after installation into a housing, according to one embodiment; and

FIG. 14C is a heat map showing maximum strain of a comparative o-ring after installation into a housing, according to one embodiment.

DETAILED DESCRIPTION

30 The disclosure relates to gasket and endblock assemblies for separation modules. The gasket and endblock assemblies disclosed herein may be used in any system that directs a fluid into and/or out of a housing. In certain embodiments, the gasket and endblock assemblies disclosed herein may be used in systems that operate at an elevated pressure, such as pressurized vessels or devices. In certain embodiments, the gasket and endblock

assemblies disclosed herein may be used in systems that operate with electrical and/or corrosion hazards. Exemplary systems include electrochemical separation devices, reverse osmosis, membrane filtration, ultrafiltration, nanofiltration, activated carbon, cartridge filter, sand filter, diatomaceous earth filter, or other fluid treatment systems.

5 The systems disclosed herein may include an active area of water treatment. First and second endblocks may be positioned at opposite ends of the active area of water treatment. A gasket may be positioned between each endblock and the stack. The entire assembly, from the first endblock to the second endblock, may be positioned within a housing. The systems may further include one or more feed lines fluidly connected to the active area
10 of water treatment.

 In one exemplary embodiment, the active area of an electrochemical separation device may include a stack, formed of dilution and concentration compartments and ion exchange membrane. An electric field may be applied to the compartments from a source of voltage and electric current applied to first and second electrodes. The system may further include a
15 first feed stream or first feed line fluidly connected to the dilution compartment and a second feed stream or second feed line fluidly connected to the concentration compartment.

 As used herein, "electrochemical separation device" refers to a device for purifying fluids using an electrical field. Electrochemical separation devices may be commonly used to treat water and other liquids containing dissolved ionic species. Generally, electrochemical
20 separation devices may employ an electric potential to influence ion transport and remove or reduce a concentration of one or more ionized or ionizable species from a fluid. In certain embodiments, electrochemical devices may comprise electrically active membranes, such as semi-permeable or selectively permeable ion exchange or bipolar membranes.

 Electrodeionization (EDI) systems may employ electrically active media to separate
25 the one or more ionized or ionizable species from the fluid. The electrically active media typically serves to alternately collect and discharge ionic and/or ionizable species and, in some cases, to facilitate the transport of ions. The transport of ions may occur continuously, for instance by ionic or electronic substitution mechanisms. EDI devices may comprise electrochemically active media of permanent or temporary charge, and may be operated
30 batch-wise, intermittently, continuously, and/or even in reversing polarity modes.

 One embodiment of EDI is continuous electrodeionization (CEDI). CEDI devices are EDI devices known to those skilled in the art that operate in a manner in which water purification can proceed continuously, while ion exchange material is continuously recharged. CEDI techniques may include processes such as continuous deionization, filled

cell electrodialysis, or electrodiagnosis. An example of such a CEDI device is the IONPURE® VNX CEDI module from Evoqua Water Technologies LLC, Pittsburgh, PA.

Electrodialysis (ED) devices operate similarly to EDI devices (i.e., alternately collecting and discharging species in batch-wise processes, intermittently, continuously, or in reversing polarity modes). However, ED devices typically do not contain electroactive media between the membranes.

The separation systems disclosed herein may comprise a housing. In certain embodiments, the housing may be cylindrical or have an oval or “racetrack” cross-sectional area. The housing may be constructed of a material capable of withstanding elevated pressures. In some embodiments, the housing may be constructed of an electrically inert material. Exemplary housing materials include polysulfone, polyvinylchloride, polycarbonate, and epoxy impregnated fiberglass. In certain embodiments, adhesive may be applied to seal at least a portion of the periphery of the cell stack to the inside wall of the housing.

The endblocks may be drawn together with rods, e.g., threaded rods. The rods may be isolated from the fluid streams, for example, by positioning within sleeves. In certain embodiments, the sleeves may be non-metallic sleeves. A gasket may be positioned between each endblock and the cell stack. The gasket may be configured to substantially prevent contact between the fluid passing through the module and the endblocks, in particular, to prevent fluid leaks from the system.

The endblocks may be formed of a durable material capable of withstanding elevated pressures. In at least certain embodiments, the durable material of the endblock is a conductive material (e.g., aluminum). In such embodiments, the gaskets may also be configured to substantially prevent contact between a fluid carrying an electrical current and the endblocks. In one exemplary embodiment, the endblock may be formed of cast aluminum plates.

Conventional gaskets provide a face seal between the endblocks and the cell stack. While such gaskets are excellent at preventing water leaks, it has been discovered that conventional gaskets may not be specifically configured to contain water leaks from certain structural challenges, such as, for example, a cracked spacer within an electrochemical device. In such instances, it is believed that water leaking from within the module can potentially pass around the gasket and come into contact with an endblock. The undesirable water leak can be particularly damaging if the device contains electrically-conductive endblocks. Accordingly, there is a need for an improved gasket design, or an improved gasket

and endblock assembly design, to better isolate the endblock from fluid within the module and prevent water leaks.

Additionally, elevated operational pressures, such as elevated static pressures within the system, may also increase the risk of water leaks. The gasket and endblock assemblies disclosed herein may be employed in systems that operate at elevated pressures. The systems may operate at elevated pressures caused by intrinsic factors, extrinsic factors, or both. Intrinsic factors may include, for example, swelling of ion exchange membranes. Ion exchange membranes may swell up to 20% during operation of an electrochemical separation system. Swelling of the ion exchange membrane generally increases static pressure of the system, which may increase the risk of a water leakage. In certain embodiments, the active area may include one or more filtration membranes. In such embodiments, static pressure may gradually increase during operation as a result of membrane resistance of fluid in the active area of water treatment. The gasket and endblock assemblies disclosed herein may prevent water leaks in systems operating at elevated pressures.

In accordance with certain embodiments, there is provided a sealing assembly, as shown in FIGS. 1A-1C and FIGS. 2A-2B. The sealing assembly may include a gasket 120. The gasket 120 may have a face 122 dimensioned to be positioned in contact with an endblock 110, for example, in contact with a face side 112 of the endblock 110. The face side 112 of the endblock 110 may refer to a side of the endblock 110 adjacent to the active area of water treatment 160 within a system for water treatment 1000 (FIG. 6). The face side 112 of the endblock 110 may have a substantially flat surface. The face 122 of the gasket 120 may have a diameter that is substantially equivalent to a diameter of the face side 112 of the endblock 110.

The gasket 120 may have a lip 124 extending from the face 122. The lip 124 may be dimensioned to be positioned over an outer edge of the endblock 110, for example, over an edge side 114 of the endblock 110. The edge side 114 of the endblock 110 may refer to a side of the endblock 110 adjacent to the housing 100 of a water treatment system 1000 (FIG. 6). The edge side 114 of the endblock 110 may have a curved surface. The lip 124 may be dimensioned to extend a predetermined width, or depth, along the edge side 114 of the endblock 110. The width of the lip 124 may be defined as a dimension designed to extend from the face side 112 of the endblock 110 towards the back side 113 of the endblock 110 opposite the face side 112. In some embodiments, the lip 124 may have a width selected to extend 10-25%, 25-35%, 35-45%, 45-55%, 55-65%, 65-75%, 75-90%, or 100% along the

edge side 114 of the endblock 110, as measured from the face side 112 toward the back side 113.

The gasket 120 may include through-holes. For instance, the gasket 120 may comprise through-holes on the face 122 and/or on the lip 124. In some embodiments, the through-holes may be dimensioned and positioned to correspond with through-holes of the endblock 110, for example, as shown in FIGS. 2A-2B. Specifically, as shown in FIGS. 2A-2B, in some embodiments, the gasket 120 may include rod holes 142 and fluid holes 144. The gasket 120 rod holes 142 and fluid holes 144 may be generally dimensioned and positioned to correspond with rod holes 152 and fluid holes 154 of the endblock 110, respectively. In some embodiments, the through-holes of the gasket 120 may comprise an edge, or a lip, surrounding or substantially surrounding the through-hole.

Thus, the gasket 120 may be designed or formed, for example, dimensioned, to correspond with an endblock 110 of a water treatment system, such as system 1000 shown in FIG. 6. In operation, when assembled over the endblock 110, the gasket 120 may form a seal between the endblock 110 and a housing 100 of the system 1000. The face 122 may be configured to be positioned between a face side 112 of the endblock 110 and an active area of water treatment 160 within the system 1000. The lip 124, which may extend over the edge side 114 of the endblock 110, may be configured to be positioned between the edge side 114 of the endblock 110 and an internal side of the housing 100, forming the seal and isolating the endblock 110 from the active area 160.

The gasket 120 may be formed of an elastomeric material. For instance, the gasket 120 may be formed of a molded elastomer. The material of the gasket 120 may be selected to provide electrical isolation of the endblock 110. Additionally, the material of the gasket 120 may be selected to provide a desired temperature stability and/or chemical stability.

In certain embodiments, the dimensions and/or material of the gasket 120 may be selected to provide target or desired properties, including, for example, flexibility, elasticity, resilience, compression, density, specific gravity, elongation, tensile strength, tear strength (crescent or angle), and others. For instance, the thickness or material of the gasket 120 may be selected to provide target or desired properties. Additionally, the thickness or material of the gasket 120 or a portion of the gasket 120 may be selected to maintain a target compression when assembled over the endblock 110 and/or when installed in the housing 100.

In some embodiments, the thickness of a lip 124 of the gasket or a portion of the lip 124 of the gasket (for example, a groove 126) may be selected to provide target or desired

properties, such as, to maintain a target compression when assembled over the endblock 110 and/or when installed in the housing 100. The thickness of the gasket 120, for example, the lip 124, or a groove 126, may be between 0.02-0.1 in, for example, 0.02-0.04 in, 0.04-0.06 in, 0.06-0.08 in, or 0.08-0.1 in.

5 Exemplary elastomeric materials include natural rubbers, styrene-butadiene block copolymers, polyisoprene, polybutadiene, ethylene propylene rubber, ethylene propylene diene rubber, silicones, fluoroelastomers, polyurethane elastomers, nitriles, others, and combinations thereof. In one exemplary embodiment, the elastomeric material is a silicone. The elastomeric material may be a semi-rigid material. For instance, the elastomeric material
10 may be a 60-80 shore A durometer material or a 65-75 shore A durometer material, for example, a 60 shore A durometer, a 65 shore A durometer, a 70 shore A durometer, a 75 shore A durometer, or an 80 shore A durometer material. The elastomeric material may have a specific gravity of 1-1.5 g/cm³, for example, 1.15-1.25 g/cm³. The elastomeric material may have an elongation of 300-400%, for example, 300-325%, 325-350%, 350-375%, or 375-
15 400%. The elastomeric material may have a tensile strength of 5-15 MPa, for example, 8-12 MPa, or 9.5-10.5 MPa. The elastomeric material may have a tear strength of 12-24 KN/m, for example, 16-20 KN/m or 17-19 KN/m.

In certain embodiments, the gasket 120 may comprise an o-ring integrated with the lip 124. The o-ring may be molded with the lip 124. Thus, in some embodiments, the lip 124
20 may comprise an o-ring portion 132, as shown in the photographs of FIG. 1D. The o-ring portion 132 may be positioned on an exterior surface of the lip 124 or on an interior surface of the lip 124. In some embodiments, an o-ring portion 132 may be positioned on both surfaces of the lip 124. The o-ring portion 132 may extend around the length of the lip 124. In other embodiments, the o-ring portion 132 may extend around part of the length of the lip
25 124. The gasket 120 may comprise more than one integrated o-ring, or o-ring portion 132, extending around the length of the lip 124. The length of the lip 124 may be defined as a dimension designed to extend around a circumference of the edge side 114 of endblock 110.

In some embodiments, the sealing assembly may further comprise an o-ring 130 which is independent from the gasket 120, as shown in FIGS. 1C and FIGS. 2A-2B.
30 Providing the o-ring 130 independent from the gasket 120 may facilitate repairs and replacement of the sealing assembly should one of the components need to be replaced. For instance, the o-ring 130 or the gasket 120 may be repaired or replaced independently, as needed.

The o-ring 130 may be dimensioned to be positioned adjacent to the lip 124. For instance, the o-ring 130 may be dimensioned to be positioned on an outer surface of the lip 124. Thus, in operation, when the gasket 120 is assembled over the endblock 110, the o-ring 130 may be positioned over the lip 124, such that the lip 124 is positioned between the edge side 114 of the endblock 110 and the o-ring 130, as shown in FIGS. 3A-3B. When not assembled, the o-ring 130 may have a central diameter that is slightly smaller, substantially equivalent, or slightly larger than a diameter of the endblock 110. For instance, the central diameter of the o-ring 130 may be 1-10%, for example 1-5% or 5-10% less than the diameter of the endblock 110 or 1-10%, for example, 1-5% or 5-10% more than the diameter of the endblock 110.

The dimensions and/or material of the o-ring 130 may be selected based on target or desired properties of the o-ring 130, such as flexibility, elasticity, resilience, compression, density, specific gravity, elongation, tensile strength, tear strength (crescent or angle), and others. The dimensions of the o-ring 130 that may be selected include central diameter (for example, a measurement spanning the central opening of the o-ring 130) and tubular diameter of the o-ring 130 (for example, a measurement of thickness of the tubular body of the o-ring 130). The tubular diameter of the o-ring 130 may be between 0.01-0.2 in, for example, 0.01-0.02 in, 0.02-0.04 in, 0.04-0.06 in, 0.06-0.08 in, 0.08-0.1 in, 0.1-0.15 in, or 0.15-0.2 in. In some embodiments, the dimensions and/or material of the o-ring 130 may be selected to provide a target or desired compression of the o-ring 130 against the gasket 120, for example, when the gasket 120 and the o-ring 130 are positioned within the housing. The target or desired compression of the o-ring 130 against the gasket 120 may be between 15-40%, for example, between 15-30%, between 16-32%, or between 18-26%.

The o-ring 130 may be formed of an elastomeric material. The o-ring may be formed of a molded elastomer. The o-ring elastomeric material may be the same or different than the gasket elastomeric material. In addition to meeting target properties, the material of the o-ring may be selected to provide a desired temperature stability and/or chemical stability. The material of the o-ring may be selected to provide electrical isolation.

Exemplary elastomeric materials include natural rubbers, styrene-butadiene block copolymers, polyisoprene, polybutadiene, ethylene propylene rubber, ethylene propylene diene rubber, silicones, fluoroelastomers, polyurethane elastomers, nitriles, others, and combinations thereof. In one exemplary embodiment, the elastomeric material is a silicone. The elastomeric material may be a semi-rigid material. For instance, the elastomeric material may be a 60-80 shore A durometer material or a 65-75 shore A durometer material, for

example, a 60 shore A durometer, a 65 shore A durometer, a 70 shore A durometer, a 75 shore A durometer, or an 80 shore A durometer material. The elastomeric material may have a specific gravity of 1-1.5 g/cm³, for example, 1.15-1.25 g/cm³. The elastomeric material may have an elongation of 300-400%, for example, 300-325%, 325-350%, 350-375%, or 375-
5 400%. The elastomeric material may have a tensile strength of 5-15 MPa, for example, 8-12 MPa, or 9.5-10.5 MPa. The elastomeric material may have a tear strength of 12-24 KN/m, for example, 16-20 KN/m or 17-19 KN/m.

The seal for the assembly may generally be provided by compression of the o-ring 130 against the interior surface of the housing 100 on one side and the gasket 120 on the
10 opposite side, or compression of the o-ring portion 132 between the housing 100 and the endblock 110. In certain embodiments, the seal for the assembly may be provided by the combined compression of the o-ring 130 and the gasket 120, for example, the lip 124, between the interior surface of the housing 100 and the edge side 114 of the endblock 110. The properties of the o-ring 130 and/or gasket 120 may be selected to provide a desired or
15 target sealing force between the o-ring 130 and the gasket 120. For instance, the compression of the o-ring 130 and/or the gasket 120 may be between 15-40%, for example, between 15-30%, between 16-32%, or between 18-26%. The thickness of the gasket 120, for example, the lip 124, or a groove 126, may be between 0.02-0.1 in, for example, 0.02-0.04 in, 0.04-0.06 in, 0.06-0.08 in, or 0.08-0.1 in. A tubular diameter of the o-ring 130 may be between 50-200% of
20 the thickness of the groove 126, for example, 50-75%, 75-100%, 100-150%, or 150-200% of the thickness of the groove 126. Thus, the tubular diameter of the o-ring 130 may be between 0.01-0.2 in, for example, 0.01-0.02 in, 0.02-0.04 in, 0.04-0.06 in, 0.06-0.08 in, 0.08-0.1 in, 0.1-0.15 in, or 0.15-0.2 in.

The gasket 120 and optional integrated or independent o-ring 130 may form a sealing
25 assembly mountable to an endblock 110, as shown in FIGS. 3A-3B. The endblock 110 may be configured for use in a water treatment system 1000. Thus, the exemplary system 1000, as shown in FIG. 6, may include at least one endblock 110 dimensioned to be positioned within the housing 100. For instance, the face side 112 of the endblock 110 may have an area dimensioned to fit within a cross-sectional area of the housing 100. In certain embodiments,
30 the system 1000 may include a first endblock 110a and a second endblock 110b. Each endblock 110a, 110b may be positioned adjacent a corresponding gasket 120a, 120b. Each gasket 120a, 120b may form an assembly with a corresponding o-ring 130a, 130b.

The opposite endblocks 110a, 110b may be positioned on opposite ends of the active area of water treatment 160. In some embodiments, such as the exemplary embodiment of

FIG. 6, the active area of water treatment 160 may comprise a stack formed of membranes 162 and compartments 164. The gaskets 120a, 120b may be positioned between the corresponding endblock 110a, 110b and the active area of water treatment 160. The o-rings 130a, 130b may be positioned between the lip 124 of the corresponding gasket 120a, 120b and the housing 100, for example, an interior surface of the housing 100, to form the sealing assembly.

The endblocks 110a, 110b may be drawn together with rods 102, e.g., threaded rods. The rods 102 may be held over the endblock 110 with bolts 106 and isolated from the fluid streams, for example, by positioning within non-metallic sleeves 108. The non-metallic sleeves 108 may direct the rods 102 through rod holes 152 of the endblock 110a, 110b and corresponding rod holes 142 of the gasket 120a, 120b.

The system 1000 may further include fluid pipes 104 for fluid communication with the active area of the water treatment system 160. The fluid pipes 104 may pass through pipe holes 154 of the endblock 110a, 110b and corresponding pipe holes 144 of the gasket 120a, 120b. The fluid pipes 104 may direct fluid, such as a feed stream, product stream, and one or more reject streams, into or out of the system 1000.

The endblock 110 may be dimensioned to correspond with the gasket 120. For instance, the endblock 110 may comprise a contour dimensioned to correspond with the gasket 120. In some embodiments, the endblock 110 may comprise a contour on the edge side 114 dimensioned to correspond with the gasket 120. The contour of the endblock 110 may be dimensioned to correspond with the lip 124 or a portion of the lip 124 when the gasket 120 is assembled over the endblock 110. In some embodiments, the contour of the endblock 110 may comprise one or more channel or slot dimensioned to receive a corresponding feature of the gasket, such as a groove, a tab, or an o-ring portion. The corresponding features may form mating elements. The mating elements may couple the sealing assembly, for example, the gasket 120, to the endblock 110. In general, the mating elements may be reversibly or temporarily coupled. However, in certain embodiments, the mating elements may be permanently coupled.

Thus, in some embodiments, a portion of the gasket 120, for example, the lip 124, may be dimensioned to correspond with a contour of the endblock 110. In some embodiments, the lip 124 may comprise a groove 126 dimensioned to correspond with a channel 116 of the endblock 110, as shown in FIGS. 4B-4C and FIGS. 5A-5B. In some embodiments, an o-ring portion 132 positioned on the lip 124 may correspond with channel 116 of the endblock 110, as shown in FIG. 4D. In some embodiments, channel 116 may

extend around a length of edge side 114 or a portion of the length of edge side 114. The length of edge side 114 may be defined as a measurement around the perimeter or circumference of endblock 110, formed by the curved surface. O-ring portion 132 or groove 126 may extend around a length of lip 124 or a portion of the length of lip 124. The length of lip 124 may be defined as a measurement around a perimeter or circumference of gasket 120 when assembled over endblock 110.

A portion of the gasket 120 may be dimensioned to accept o-ring 130. The gasket 120 may comprise a channel dimensioned to accept o-ring 130. In some embodiments, groove 126, which is positioned and dimensioned to mate with channel 116 of endblock 110, may also be dimensioned to accept the o-ring 130 (FIGS. 5A-5B). Thus, in some embodiments, groove 126 may form a channel to accept o-ring 130. In such embodiments, groove 126 may extend around the length of lip 124.

FIG. 4A is a back view of an endblock 110 having a sealing assembly including a gasket 120 and an o-ring 130 assembled over the endblock 110. FIG. 4B is a side view of the endblock 110 and sealing assembly of FIG. 4A. The view of FIG. 4B shows channel 116 on edge side 114 and corresponding groove 126 on lip 124. FIG. 4C is a partial scale view of the endblock 110 and sealing assembly of FIG. 4B. FIG. 4C shows an enlarged view of channel 116 and corresponding groove 126. FIG. 4D is a similar partial scale view of endblock 110 and an exemplary sealing assembly. However, in the embodiment of FIG. 4D, the gasket 120 includes an o-ring portion 132 integrated in lip 124. The integrated o-ring portion 132 forms a groove that corresponds with channel 116. FIG. 5A is a side view of endblock 110 and a sealing assembly formed of gasket 120 and o-ring 130 within housing 100. FIG. 5B is a partial scale view of the endblock 110 and sealing assembly of FIG. 5A.

As shown in FIGS. 4B-4C and FIGS. 5A-5B, the contour of the endblock 110, for example, channel 116, may be dimensioned to also accept the o-ring 130 with groove 126. As shown in FIG. 4D, the contour of endblock 110, for example, channel 116, may be dimensioned to accept o-ring portion 132. O-ring portion 132 or o-ring 130 and groove 126 positioned in corresponding channel 116 may form a seal when the sealing assembly and endblock 110 are positioned within the housing 100, compressing o-ring portion 132 or o-ring 130 and groove 126 into channel 116.

In some embodiments, the sealing assembly may comprise more than one o-ring 130. Each o-ring 130 may be positioned sequentially over lip 124 of gasket 120 to seal gasket 120 against endblock 110. In such embodiments, the gasket 120 may comprise more than one channel dimensioned to accept an o-ring 130. For instance, gasket 120 may comprise more

than one groove 126. The gasket 120 may comprise more than one channel, groove 126, or combination thereof, each positioned to accept a corresponding o-ring 130. Additionally, in such embodiments, the endblock 110 may comprise one or more channel 116. For instance, the endblock 110 may comprise one or more channel 116, each channel 116 positioned and
5 dimensioned to mate with a corresponding groove 126 and o-ring 130. In other embodiments, the gasket channel or groove 126 may be dimensioned to accept the more than one o-ring 130. Similarly, the endblock 110 channel 116 may be dimensioned to accept one or more groove 126 and the more than one o-ring 130.

The dimension of the gasket channel or groove 126 may be selected to accept o-ring
10 130 when o-ring 130 is compressed, for example, when the sealing assembly and endblock 110 are positioned within the housing 100. In some embodiments, the cross-sectional area of the gasket channel or groove 126 may be slightly larger than the tubular diameter of the o-ring 130 when not compressed (FIG. 4C). In some embodiments, the depth or width of the channel or groove 126 is 1-100% greater than a tubular diameter of the o-ring 130, for
15 example, 1-10%, 10-25%, 25-50%, 50-75%, or 75-100% greater. Thus, in some embodiments, a gap is formed between an interior cross-sectional area of the channel or groove 126 and the o-ring 130, when not compressed.

In some embodiments, the tubular diameter of the o-ring 130 may be slightly larger than a depth of the gasket channel or groove 126. A portion of the o-ring 130 may extend out
20 of the gasket channel or groove 126 when the o-ring 130 is not compressed, for example, when the sealing assembly and endblock 110 are not positioned within the housing 100. In some embodiments, the tubular diameter of the o-ring 130 may be 1-50% greater than the depth of the channel or groove 126, for example, 1-5%, 5-10%, 10-15%, 15-20%, 20-30%, 30-40%, or 40-50% greater. An interference may be formed between a portion of the o-ring
25 130 that extends from the gasket channel or groove 126 and the interior surface of the housing 100 during installation, for example, as shown in FIG. 5B. The interference formed between the tubular diameter of the o-ring 130 and the interior surface of the housing 100 may be 0.01-0.1 in, for example, 0.01-0.02 in, 0.02-0.04 in, 0.04-0.05 in, 0.05-0.06 in, 0.06-0.07 in, 0.07-0.08 in, or 0.08-0.1 in.

30 In some embodiments, the edge of the housing 100 may be tapered to enable the o-ring 130 to stay within the gasket channel or groove 126 during installation of the housing 100. For instance, the tapered edge of the housing 100 may also avoid rolling of the o-ring 130 out of the gasket channel or groove 126 during installation of the housing 100.

Upon compression, for example, upon installation of the sealing assembly and endblock 110 into the housing 100, the o-ring 130 may be compressed into the volume of the gasket channel or groove 126 without substantially spilling over the channel or groove 126. In some embodiments, a subsequent compression of the o-ring 130 may substantially fill the cross-sectional area of the gasket channel or groove 126. However, compression of the o-ring 130 need not fill the cross-sectional area of the gasket channel or groove 126.

The dimension of channel 116 may be selected to accept o-ring portion 132 or groove 126 and o-ring 130 when the sealing assembly is compressed, for example, when the sealing assembly and endblock 110 are positioned within the housing 100. In some embodiments, the cross-sectional area of the channel 116, or the depth of the channel 116, may be slightly larger than the contour formed by the o-ring portion 132 or the groove 126 when not compressed (FIG. 4C). In some embodiments, the depth of the channel 116 is 1-100% greater than a depth of the o-ring portion 132 or groove 126, for example, 1-10%, 10-25%, 25-50%, 50-75%, or 75-100% greater. Thus, in some embodiments, a gap is formed between a cross-sectional area of the channel 116 and the o-ring portion 132 or groove 126, when not compressed. The gap formed between the cross-sectional area of the channel 116 and the o-ring portion 132 or groove 126 may be 0.01-0.1 in, for example, 0.01-0.02 in, 0.02-0.04 in, 0.04-0.06 in, 0.06-0.08 in, or 0.08-0.1 in.

In some embodiments, a dimension of the o-ring portion 132 may be selected to extend beyond the channel 116 when the sealing assembly is not compressed, for example, when the sealing assembly and endblock 110 are not positioned within the housing 100. The dimension of the o-ring portion 132 may extend 1-50% out of the channel 116, for example, 1-5%, 5-10%, 10-15%, 15-20%, 20-30%, 30-40%, or 40-50%. An interference may be formed between a dimension of the o-ring portion 132 that extends from the channel 116 and the interior surface of the housing 100 during installation. The interference formed between the dimension of the o-ring portion 132 and the interior surface of the housing 100 may be 0.01-0.1 in, for example, 0.01-0.02 in, 0.02-0.04 in, 0.04-0.05 in, 0.05-0.06 in, 0.06-0.07 in, 0.07-0.08 in, or 0.08-0.1 in.

In some embodiments, the edge of the housing 100 may be tapered to enable the o-ring portion 132 to stay coupled to the channel 116 during installation of the housing 100. For instance, the tapered edge of the housing 100 may also avoid curling of the gasket 120 out of the channel 116 during installation of the housing 100.

Upon compression, for example, upon installation of the sealing assembly and endblock 110 into the housing 100, the o-ring portion 132 or the o-ring 130 and groove 126

may be compressed into the volume of channel 116 without substantially spilling over the channel 116. In some embodiments, a subsequent compression of the o-ring portion 132 or the o-ring 130 and groove 126 may substantially fill the cross-sectional area of channel 116. However, compression of the o-ring portion 132 or the o-ring 130 and groove 126 need not
5 fill the cross-sectional area of the channel 116.

The endblock 110 may additionally or alternatively comprise a contour dimensioned to correspond with a distal end of the lip 124. In some embodiments, the lip 124 may comprise a tab 128 at a distal end, dimensioned to correspond with a slot 118 of the endblock 110, as shown in FIGS. 4B-4C and FIGS. 5A-5B. Tab 128 may be a substantially solid
10 fastener configured to mate with slot 118. In some embodiments, slot 118 may extend around a length of edge side 114 or a portion of the length of edge side 114. Tab 128 may extend around a length of lip 124 or a portion of the length of lip 124. While tab 128 is shown positioned at a distal end of lip 124, in certain embodiments, the gasket 120 may comprise a tab 128 positioned at a point along a length of lip 124 that is not the distal end. Slot 118 may
15 be positioned to mate with tab 128.

In some embodiments, gasket 120 may comprise more than one tab 128 positioned along lip 124. Endblock 110 may comprise more than one slot 118. For example, endblock 110 may comprise a slot 118 positioned to mate with each tab 128. In other embodiments, endblock 110 may comprise a slot 118 positioned and dimensioned to accept the more than
20 one tab 128.

In some embodiments, tab 128 may substantially fill a volume of slot 118. For instance, tab 128 may have a cross-sectional area that is substantially equivalent to a cross-sectional area of slot 118 (FIG. 5B). In other embodiments, the dimension of slot 118 may be selected to accept tab 128 when gasket 120 is compressed, for example, when the sealing
25 assembly and endblock 110 are positioned within the housing. In some embodiments, the cross-sectional area of slot 118 may be slightly larger than the cross-sectional area of tab 128 when not compressed. A subsequent compression of the gasket 120 may substantially fill the cross-sectional area of slot 118. In particular, upon compression, the tab 128 may be compressed into the volume of slot 118 without substantially spilling over the slot 118.

In some embodiments, tab 128 may be dimensioned to snap into slot 118. For example, tab 128 may require the use of force to be coupled to slot 118. In some
30 embodiments, a proximal end of tab 128, adjacent to the body of lip 124, may be slightly narrower than a distal end of tab 128 (FIG. 5B). Additionally or alternatively, an edge of slot 118, adjacent to the opening, may be slightly narrower than a bottom of slot 118 (FIG. 5B).

Thus, in some embodiments, tab 128 may require the use of force to be uncoupled from slot 118. In other embodiments, tab 128 may be permanently coupled to slot 118.

In some embodiments, at least a portion of the edge side 114 of the endblock 110 may be tapered, as shown in FIGS. 4B-4C and FIGS. 5A-5B. The portion of the edge side 114
5 may be tapered toward a back side 113 of the endblock 110. For instance, the portion of the endblock 110 may become narrower towards the back side 113. Thus, in some embodiments, the portion of the edge side 114 may be tapered away from the face side 112. In some embodiments, the tapered portion of edge side 114 may be positioned beyond channel 116, for instance, between channel 116 and back side 113 of the endblock 110, as shown in FIG.
10 5B. Thus, in some embodiments, channel 116 may be positioned on a straight or non-tapered portion of edge side 114. In some embodiments, slot 118 may be positioned on a tapered portion of edge side 114 of endblock 110.

The tapered portion of the edge side 114 of the endblock 110 may enable the sealing assembly to stay coupled to the endblock 110 during installation of the housing 100. For
15 instance, the tapered portion of the edge side 114 may avoid curling of the gasket 120 off the endblock 110 or catching of the gasket 120 on the housing 100 during installation of the housing 100. The tapered portion of edge side 114 may also avoid rolling of the o-ring 130 out of the gasket channel or groove 126 during installation of the housing 100.

The tapered portion of edge side 114 may also be dimensioned to maintain tension of
20 the gasket 120 when coupled to the endblock 110. For example, the tapered portion may cause a portion of lip 124 of gasket 120 to be angled toward face 122 of gasket 120 when the gasket 120 is assembled over endblock 110, as shown in the views of FIGS. 5A-5B. The tapered portion of edge side 114 may be angled 5-10°, 10-20°, 15-25°, 15-30°, 25-40°, 30-45°, 35-45°, 40-50°, or any range therebetween.

25 The systems disclosed herein may typically operate at elevated pressures and/or elevated flowrates. Thus, in some embodiments, the components of the system 1000, for example, the sealing assembly and endblock 110, may be rated in operation to withstand elevated static pressure. In some embodiments, the sealing assembly and endblock 110 may be rated in operation to withstand an elevated internal pressure drop, an elevated sustained
30 inlet pressure, and/or an elevated maximum inlet pressure. The components of the system 1000, for example, the sealing assembly and endblock 110, may be rated to withstand elevated flowrates, for example, an elevated inlet flowrate. The dimensions of the components of the system 1000 may be selected to withstand the elevated pressures and/or elevated flowrates. The materials and construction of the components of the system 1000 may

be selected to withstand the elevated pressures and/or elevated flowrates. In particular, the dimensions, materials, and construction of the components of the system 1000 may be selected to withstand the elevated pressures and/or elevated flowrates when assembled.

In some embodiments, the components of the system 1000, for example, dimensions,
5 materials, and construction of the components of the sealing assembly, for example, the gasket 120 (e.g., the face 122 and/or the lip 124), the o-ring 130, and/or the endblock 110, may be rated in operation to withstand a static pressure of 80-200 psi, for example, 100-180 psi, 140-180 psi, at least up to 80 psi, at least up to 100 psi, at least up to 140 psi, at least up to 180 psi, up to 180 psi, or up to 200 psi.

10 In some embodiments, the components of the system 1000, for example, dimensions, materials, and construction of the components of the sealing assembly, for example, the gasket 120 (e.g., the face 122 and/or the lip 124), the o-ring 130, and/or the endblock 110, may be rated in operation to withstand flowrate of at least 25 gpm (5.68 m³/h), at least 30 gpm (6.81 m³/h), at least 50 gpm (11.36 m³/h), at least 65 gpm (14.76 m³/h), at least 80 gpm
15 (18.17 m³/h), at least 100 gpm (22.71 m³/h), for example 25 gpm (5.68 m³/h) to 80 gpm (18.17 m³/h) or 30 gpm (6.81 m³/h) to 100 gpm (22.71 m³/h), or any range therebetween.

Methods of retrofitting a water treatment system are disclosed herein. Existing water treatment systems, for example, systems including a pressurized vessel, such as electrochemical water treatment systems, may be retrofit by providing one or more
20 components disclosed herein. The methods may comprise providing a sealing assembly. For example, the methods may comprise providing a sealing assembly including a gasket 120, such as a gasket 120 having a face 122 and a lip 124. In some embodiments, the methods may comprise providing an o-ring 130. In some embodiments, the methods may comprise providing an endblock 110, such as an endblock 110 having a contour dimensioned to accept
25 a portion of the gasket 120, e.g., a portion of the lip 124.

The methods may further comprise providing instructions to install the sealing assembly adjacent to and/or over the endblock 110. For instance, the methods may comprise providing instructions to install the face 122 of gasket 120 in contact with the endblock 110, for example, a face side 112 of endblock 110. The methods may comprise providing
30 instructions to position the lip 124 over the outer edge of endblock 110. Additionally, the methods may comprise providing instructions to couple a portion of the lip 124 to endblock 110, for example, couple a groove 126 and/or tab 128 of lip 124 to a channel 116 and/or slot 118 of endblock 110, respectively. The methods may comprise providing instructions to install an o-ring 130 adjacent lip 124, for example, in a channel or groove 126 of lip 124. The

methods may comprise providing instructions to couple the endblock 110 having a sealing assembly to an active area of water treatment 160 and install a housing 100 over the assembled components.

5 Examples

The function and advantages of these and other embodiments can be better understood from the following examples. These examples are intended to be illustrative in nature and are not considered to be limiting the scope of the invention.

10 Example 1: Test Assembly Procedure

Two endblocks were secured to a stack of alternating membranes and compartments with rods and bolts. In a first test, the stack included 10 cell pairs (FIGS. 7A-7C). In a second test, the stack included 50 cell pairs (FIGS. 8A-8C). A sealing assembly, including a gasket and o-ring, was mounted over each endblock.

15 The exemplary sealing assembly was formed of a Xiameter™ RBB-2003-70 silicone rubber (distributed by Dow® Chemical Company, Midland, MI). Silicone rubbers are typically finished by vulcanization with a rubber additive. One exemplary rubber additive is SILASTIC™ RC-4 50P FD Rubber Additive (distributed by Dow® Chemical Company, Midland, MI), which may be combined with the silicone rubber at a ratio, e.g., 1:100, to form
20 the finished material prior to molding or extruding. The silicone rubber may be pigmented. The finished silicone rubber had a specific gravity of 1.21 g/cm³ (using ASTM standard D792), shore A durometer of 70-74 (using ASTM standard D2240), elongation of 380% (using ASTM standard D412), tear strength of 18.0 KN/m (using ASTM standard D624 DIE B), tensile strength of 10.0 MPa (using ASTM standard D412), and compression of 25% at
25 177°C (351° F)/22 hrs (using ASTM standard D395). The above properties were obtained using 1.0 phr SILASTIC™ RC-4 50P FD Rubber Additive on 2 mm thick slabs, press cured 10 minutes at 170° C, and post cured 4 hours at 200° C.

The gasket was then molded from the finished silicone rubber. The gasket was designed to have a groove dimensioned to leave a gap of 0.05 in between the groove and a
30 channel of the endblock. The o-ring was designed to provide a 0.056-0.065 in interference between the housing and the o-ring.

In a vertical position, the 10-cell pair stack having endblocks and sealing assemblies was pressed at a pressure of 3900 psi (FIG. 7A), then positioned horizontally (FIG. 7B) and

pushed into the housing (FIG. 7C). Similarly, the 50-cell pair stack having endblocks and sealing assemblies was pressed at a pressure of 3900 psi in a vertical position (FIG. 8A), then positioned horizontally (FIG. 8B) and pushed into the housing (FIG. 8C). No damage occurred to the gasket during installation. All procedures were performed at room (ambient) temperature, for example, 20-25 °C.

Accordingly, varying cell stack configurations can be accurately and efficiently assembled into an electrochemical cell having endblocks and sealing assemblies.

Example 2: Static Pressure Test

Static pressure tests of the electrochemical cells of example 1 were performed. The 10-cell stack and 50-cell stack were set up as shown in FIGS. 7A-7C and 8A-8C, respectively, with endblocks and sealing assemblies. Fluid pipes were connected to the electrochemical cell through a first endblock, as shown in FIG. 9A. Pressure gauges were mounted on the back side of the opposite endblock, as shown in FIGS. 9B-9C. The test procedures were performed at room (ambient) temperature, for example, 20-25 °C.

The 10-cell stack system was operated at 50 psi for 5 minutes, 100 psi for 20 minutes, and 140 psi for 5 minutes. At each pressure, the system passed the static pressure test, and no leaks were detected. The pressure was then increased to 180 psi and no leak was detected. The test was then stopped and the cell stack with endblocks and sealing assemblies was removed from the housing. A 360° inspection of the sealing assembly was performed. The sealing assembly after the static pressure test is shown in FIGS. 10A-10B. As shown in the photographs, some damage occurred to the o-ring and gasket. However, no leaks were detected during the test, and the system was considered to have passed the test.

The 50-cell stack system was operated at 100 psi for 15 minutes. No leaks were detected, and the system was considered to have passed the test.

Accordingly, the sealing assembly was shown to maintain sealing integrity at elevated pressures, such as pressures greater than 100 psi, for example, 140 psi and 180 psi.

Example 3: Fatigue Life Cycle Test

A fatigue life cycle test of the 50-cell stack electrochemical cell system of example 1 was performed. The 50-cell stack was set up as shown in FIGS. 8A-8C with endblocks and sealing assemblies. Fluid pipes were connected to the electrochemical cell through a first endblock, as shown in FIG. 9A. Pressure gauges were mounted on the back side of the

opposite endblock, as shown in FIGS. 9B-9C. The test procedures were performed at room (ambient) temperature, for example, 20-25 °C.

The electrochemical cell system was operated for increasing number of cycles, as shown in Table 1. No leaks were detected, and the system was considered to have passed the

5 test.

Table 1: Fatigue Life Cycle Test

Test Run	No. of Cycles	Outcome
1	3,797	Pass (no leaks)
2	17,564	Pass (no leaks)
3	21,685	Pass (no leaks)
4	41,241	Pass (no leaks)
5	65,000+	Pass (no leaks)

Accordingly, the sealing assembly was shown to maintain sealing integrity during the
10 lifespan of the system, for example, at least 50,000 cycles, from 50,000 – 65,000 cycles, and at least 65,000 cycles.

Example 4: Repeated Installation Test

Two endblocks were secured to a stack of alternating membranes and compartments
15 with rods and bolts. A sealing assembly, including a gasket and o-ring, was mounted over each endblock. The assembly was installed into a housing and removed from the housing in three repeated installations and removals. For installation, the assembly was pushed in a first direction through a circular opening into the cylindrical housing. For removal, the assembly
20 was pulled in a second direction, opposite the first direction, through the circular opening out of the cylindrical housing. The test procedures were performed at room (ambient) temperature, for example, 20-25 °C. Photographs of the repeated installation test are shown in FIGS. 11A-11C.

During the first installation and removal (FIG. 11A), the o-ring was found to be damaged with no damage to the gasket. The o-ring was then replaced. During the second and
25 third installations and removals (FIGS. 11B-11C), there was no damage to the o-ring or gasket. Accordingly, the sealing assembly was found to pass the repeated installation test.

Furthermore, the sealing assembly was shown to have components that are easily replaceable should any damage occur to one or more component during installation or removal.

Example 5: Simulated Total Deformation, Contact Pressure, and Equivalent Elastic

5 Strain

Installation of the electrochemical cell into the housing was simulated. The simulated system included an endblock and a sealing assembly (gasket and o-ring). The endblock from the simulation had a channel dimensioned to receive a groove of the gasket and the o-ring and a tapered edge side.

10 During the simulation, a surface representing the housing was moved over the endblock and sealing assembly to simulate installation into the housing. The simulated sealing assembly is shown before installation in FIG. 12A and after installation in FIG. 12B. As shown in FIG. 12B, the channel is dimensioned to accept the groove of the gasket and the o-ring when the o-ring is compressed by the housing. As also shown in FIG. 12B, the tapered
15 edge side of the endblock allows the sealing assembly to remain coupled to the endblock during installation into the housing.

Additionally, o-ring maximum pressure at the housing contact location (top) and gasket contact location (bottom) and gasket maximum pressure at the o-ring contact location (top) and endblock contact location (bottom) after installation were determined (Table 2,
20 FIGS. 13A-13B). Maximum strain of the o-ring after installation (FIG. 13C) was determined to be 0.15 in/in and maximum strain of the gasket after installation (FIG. 13D) was determined to be 0.51 in/in.

Table 2: Maximum Pressure After Simulated Installation

Contact Location	O-ring maximum pressure	Gasket maximum pressure
Top	594 to 500 psi	400 to 300 psi
Bottom	300 to 250 psi	400 to 300 psi

25

As shown in Table 2, the o-ring maximum pressure at the top (against the housing) is greater than the o-ring maximum pressure at the bottom (against the gasket).

The results were compared to the maximum pressure and maximum strain experienced by an o-ring installed in a conventional system. In the simulated conventional
30 system, the gasket includes a face but no lip. As a result, the gasket does not become

compressed by the housing, and the o-ring does not contact the gasket at any point. Instead, in the conventional system, the top of the o-ring contacts the housing while the bottom of the o-ring contacts the endblock (FIG. 14A). The o-ring maximum pressures in the comparative conventional system are shown in Table 3 and FIG. 14B. The maximum strain of the comparative o-ring after installation (FIG. 14C) was determined to be 0.17 in/in.

Table 3: Maximum Pressure After Simulated Installation of a Conventional Sealing Assembly

Contact Location	O-ring maximum pressure
Top	490 to 436 psi
Bottom	490 to 436 psi

Accordingly, installation of the sealing assembly including a gasket having a lip and an o-ring results in a greater o-ring maximum pressure against the housing and a greater o-ring maximum pressure against the endblock than the sealing assembly including a gasket having no lip. Furthermore, the maximum strain of the o-ring is less in the sealing assembly including a gasket having a lip than in the sealing assembly including a gasket having no lip. The maximum pressure of the o-ring is distributed more favorably after installation of the sealing assembly including a gasket having a lip. Thus, the sealing assembly including a gasket having a lip and an o-ring provides a greater seal, which results in a reduced risk of leakage in the electrochemical separation module and may result in a greater operating efficiency for the electrochemical separation module.

The phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. As used herein, the term “plurality” refers to two or more items or components. The terms “comprising,” “including,” “carrying,” “having,” “containing,” and “involving,” whether in the written description or the claims and the like, are open-ended terms, i.e., to mean “including but not limited to.” Thus, the use of such terms is meant to encompass the items listed thereafter, and equivalents thereof, as well as additional items. Only the transitional phrases “consisting of” and “consisting essentially of,” are closed or semi-closed transitional phrases, respectively, with respect to the claims. Use of ordinal terms such as “first,” “second,” “third,” and the like in the claims to modify a claim element does not by itself connote any priority, precedence, or order of one claim element

over another or the temporal order in which acts of a method are performed, but are used merely as labels to distinguish one claim element having a certain name from another element having a same name (but for use of the ordinal term) to distinguish the claim elements.

Having thus described several aspects of at least one embodiment, it is to be appreciated that various alterations, modifications, and improvements will readily occur to those skilled in the art. Any feature described in any embodiment may be included in or substituted for any feature of any other embodiment. Such alterations, modifications, and improvements are intended to be part of this disclosure and are intended to be within the scope of the invention. Accordingly, the foregoing description and drawings are by way of example only.

Those skilled in the art should appreciate that the parameters and configurations described herein are exemplary and that actual parameters and/or configurations will depend on the specific application in which the disclosed methods and materials are used. Those skilled in the art should also recognize or be able to ascertain, using no more than routine experimentation, equivalents to the specific embodiments disclosed.

CLAIMS

1. A system for water treatment, comprising:
a housing;
5 at least one endblock dimensioned to be positioned within the housing; and
a gasket having a face and a lip extending from the face, the face dimensioned to be positioned between the endblock and an active area of the water treatment, and the lip dimensioned to be positioned over an outer edge of the endblock adjacent to the housing to form a seal.
- 10 2. The system of claim 1, further comprising an o-ring dimensioned to be positioned adjacent to the lip.
3. The system of claim 2, wherein the endblock comprises a contour dimensioned to accept a portion of the lip.
- 15 4. The system of claim 3, wherein the contour of the endblock is dimensioned to accept the portion of the lip and the o-ring when the o-ring is compressed.
- 20 5. The system of claim 2, wherein the gasket and o-ring are rated in operation to withstand a static pressure of at least up to 100 psi.
6. The system of claim 5, wherein the o-ring has a compression between 15% and 40% when the gasket and o-ring are positioned within the housing.
- 25 7. The system of claim 1, wherein the endblock comprises a contour dimensioned to correspond with a distal end of the lip.
8. The system of claim 7, wherein at least a portion of an edge side of the endblock is tapered.
- 30 9. A system for water treatment, comprising:
a housing;
at least one endblock dimensioned to be positioned within the housing;

- a gasket having a face and a lip extending from the face, the face dimensioned to be positioned between an internal side of the endblock and an active area of the water treatment, and the lip dimensioned to be positioned over an outer edge of the endblock; and
an o-ring dimensioned to be positioned between the lip and an internal side of the
5 housing,
the gasket and o-ring being rated in operation to withstand a static pressure of at least up to 100 psi.
10. The system of claim 9, wherein the o-ring is integrated with the gasket.
- 10 11. The system of claim 9, wherein the o-ring is independent from the gasket.
12. The system of claim 11, wherein the endblock comprises a contour dimensioned to accept a portion of the lip and the o-ring when the o-ring is compressed.
- 15 13. The system of claim 9, wherein the gasket and o-ring are rated in operation to withstand a static pressure of at least up to 180 psi.
14. A sealing assembly for a water treatment system, comprising a gasket having a face and a
20 lip extending from the face, the face dimensioned to be positioned in contact with an endblock and the lip dimensioned to be positioned over an outer edge of the endblock.
15. The sealing assembly of claim 14, further comprising an o-ring dimensioned to be positioned adjacent to the lip.
- 25 16. The sealing assembly of claim 15, wherein a portion of the lip is dimensioned to correspond with a contour of the endblock.
17. The sealing assembly of claim 16, wherein the portion of the lip is dimensioned to accept
30 the o-ring when the o-ring is compressed.
18. The sealing assembly of claim 15, wherein the o-ring is formed of an elastomeric material.

19. The sealing assembly of claim 14, wherein the gasket is formed of an elastomeric material.
20. The sealing assembly of claim 19, wherein the gasket comprises an o-ring integrated with the lip.
21. The sealing assembly of claim 14, wherein a distal end of the lip is dimensioned to correspond with a contour of the endblock.
22. A method of retrofitting an electrochemical separation device having an endblock and a housing, the method comprising:
- providing the sealing assembly of any of claims 14-21; and
 - providing instructions to install the face of the gasket in contact with the endblock and position the lip over the outer edge of the endblock.
23. The method of claim 22, further comprising providing the endblock comprising a contour dimensioned to correspond with a portion of the lip.