

# MANIFOLD ADAPTOR PLATE FOR FILTRATION APPARATUS

## Cross Reference to Related Applications

5           The present application claims the benefit of U.S. Provisional Patent Application No.: 60/927, 058, filed on May 1, 2007 and U.S. Provisional Patent Application No. 60/833,891 filed on July 28, 2006, and the entire text of both of these applications is incorporated by reference in the present application.

## BACKGROUND OF THE INVENTION

10           The present invention relates to a manifold adaptor plate that functions as a gasket (or packing) for the separation of filtrate from feed liquid and retentate in a tangential flow filtration apparatus. In further detail, the present invention relates to a unitary manifold adaptor plate, or similar plate having a plurality of layers, including one or two  
15 enclosure layers and an intermediate rigid support layer.

          By means of prior art, primarily liquids such as aqueous solutions, or the like have been filtered by a tangential flow module having a plurality of filters that are stacked between two manifolds, one of which is disposed at the base of the stack and the other of which is disposed at the top of the stack. The filtration module stack comprises an  
20 assembly of one or more filtration modules and related gaskets (or packings) between modules. The filters are separated by an appropriate diaphragm (or screen) and liquid-impervious layers in order to allow for the flow of liquid, as well as filtrate and retentate, to and from the stack. Moreover, the stack has through holes (or flow holes) that pass through the layers. These holes or openings are appropriately sealed by a separation  
25 sheet made of a gasket material in order to prevent mixing of the filtrate and the incoming feed liquid or retentate. The manifold of each compartment is disposed such that the filtrate is removed from the second manifold. This manifold structure requires an attachment device to both manifolds in order to feed liquid to the manifold (or remove liquid from the manifold) and feed liquid to the stack (or remove liquid from the stack).  
30 Consequently, there is a disadvantage in that additional operating steps are needed to remove and attach the attachment devices when it becomes necessary to replace a filtration element that forms the stack.

Typical tangential flow modules are disclosed in U.S. Patents 5,176,828 and 5,597,447 which use a single manifold at one end of each filters stack and wherein a plate is disposed at the end on the opposite side of each filter stack. The pathways for liquid flow are disposed such that the filtrate will not be contaminated by retentate or feed liquid.

By means of the above-mentioned tangential flow module, a separate sheet made of a gasket material is disposed between one or two manifolds and the filter stack in order to guarantee the desired liquid flow. Moreover, the gasket sheet used with the manifold adaptor plate is formed from a metal plate. A gasket sheet of an elastomer such as silicone can be disposed on both surfaces of the metal plate in order to impart the desired seal. Liquid flow pathways are disposed in the metal plate and elastomer gasket in order to guarantee the desired liquid flow to the tangential flow module, inside the tangential flow module, and from the tangential flow module.

Nevertheless, manifold adaptor plates having separation elastomer sheets are problematic in that because of their pliability, it is difficult to adequately align the liquid flow pathways through the elastomer layer with the manifold liquid inlets and liquid outlets. Moreover, depending on the case, there is a possibility that the gasket sheet will deform, leading to inappropriate mixing of fluids, during use. Furthermore, the elastomer layer can adhere to the manifold and form creases that have a detrimental effect on the uniform and complete contact at the manifold surface. There is the possibility that this state will lead to nonalignment of the liquid flow paths and as a result, external leakage and contamination among liquids. Furthermore, when the elastomer gasket comes under pressure during module use, there is a possibility that the elastomer gasket will move, leading to obvious distortion of the liquid inlets and liquid outlets.

Moreover, the separation sheet is often formed from silicone, which has a relatively high extractability, and there is therefore the possibility of addition or extraction into the fluid flowing through the silicone. It is necessary to either remove these extractables from the fluid prior to use, or to perform tests in order to confirm that these extractables will not contaminate the fluid. If this is not done there is a chance that the final product will be detrimentally affected, particularly when it is a drug or therapeutic protein. Furthermore, the gasket sheet is relatively delicate and has an unsupported structure formed from silicone or rubber of relatively low hardness; therefore inconveniences occur in that the gasket sheet tends to rupture during the procedure and during storage and becomes distorted to the extent that external leakage occurs.

Consequently, there is a need to provide a manifold adaptor plate that imparts sufficient sealing performance without any problems in terms of alignment of the liquid flow pathways or handling of the plate.

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## SUMMARY OF THE INVENTION

The present invention provides a manifold adaptor plate comprising a rigid plate layer, a polymer sheet layer and one or two elastomer layers. Each layer has openings that allow for the passage of feed liquid, filtrate and retentate through the layer without allowing the filtrate to mix with the retentate or feed liquid. When a single elastomer layer is used, the elastomer layer passes through all of the openings in each of the layers and is on the first surface of the rigid plate layer such that it connects with the region where the openings in the polymer sheet are enclosed via the polymer sheet that contacts the opposite side or the second surface of the rigid plate. When the polymer sheet connects with the elastomer layer, the rigid plate layer provides rigid support to the elastomer layer and the elastomer layer will not move relative to the rigid plate layer. Moreover, by providing rigid support to the elastomer layer, the elastomer layer can be appropriately and easily disposed in a state contacting the manifold and impart the desired seal. Two elastomer layers are used in another example of the present invention. One of the elastomer layers contacts the first surface of the rigid plate layer and the second elastomer layer contacts the polymer sheet contacting the surface on the second opposite side of the rigid plate layer. The elastomer layers are joined together through the openings formed in the rigid plate layer and polymer sheet. By means of this example, two sealing layers can be used in order to seal the filtration module and prevent mixing of the filtrate and the feed liquid or retentate. Moreover, a plate can be used between two devices.

By means of an alternative example of the present invention, the elastomer layer is silicone-based and the polymer layer is optional. By means of one example, when the rigid layer is formed from steel, preferably stainless steel, or a plastic to which silicone will adhere, such as polysulfone or polyethersulfone, at least a portion of one surface of the rigid plate is covered by silicone, and the silicone extends up to the surface on the opposite side through the holes formed in the rigid

plate. Alternately, one or both surfaces of the rigid plate (which can be made from steel, a plastic to which silicone will adhere, or another material suitable for rigid plates) are covered by silicone without requiring a polymer layer, and the silicone layers are connected to one another via the openings formed in the rigid plate layer. Nevertheless, a polymer sheet can be used as needed.

By means of yet another example, one or more of the openings in the plate are filled by an elastomer material in order to act as a shunt.

The elastomer sheet of the present invention has sufficiently pliability to serve as a seal for the manifold or filtration module contacting the elastomer sheet and prevent mixing of filtrate and feed liquid or retentate flowing through the inside of the manifold of the filtration module. Preferably, the elastomer sheet is made from a thermoplastic elastomer having low level extractability.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an isometric view of the manifold apparatus of the present invention when used.

Fig. 2 is an exploded view of the manifold adaptor plate of the present invention.

Fig. 3 is a partial cross section of the manifold adaptor plate in Fig. 2.

Fig. 4 is an exploded view of an alternative manifold adaptor plate of the present invention.

Fig. 5 is a partial cross section of the manifold adaptor plate in Fig. 4.

Fig. 6 is an exploded view of a filtration module manifold and the manifold adaptor plate of the present invention.

Fig. 7 shows the function of a filtration module appropriate for use in the present invention.

Fig. 8 is an exploded view of the manifold adaptor plate and two filtration modules of the present invention.

Fig. 9 is a partial cross section of an alternative example of the manifold adaptor plate of the present invention.

Fig. 10 is a partial cross section of an alternative example of the manifold adaptor plate of the present invention.

Fig. 11 is a partial cross section of an alternative example of the manifold adaptor plate of the present invention.

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## DESCRIPTION OF SPECIFIC EMBODIMENTS

Referring to Fig. 1, a manifold apparatus 1 capable of incorporation of the manifold adaptor plate of the present invention comprises a first set of manifold compartments 2 and 4, which are connected to one another and are attached to a manifold frame 12; a feed liquid manifold compartment 6; and a second set of manifold compartments 8 and 10, which are connected to one another. The first set of manifold compartments 2 and 4 has a filtrate outlet 14 and a retentate vent 16. The second set of manifold compartments 8 and 10 has a filtrate outlet 18 and a retentate drain 20. Retentate drain 20 and retentate vent 16 are capped (or closed) during filtration. Retentate vent 16 makes it possible to fill the retentate flow paths with liquid and retentate drain 20 makes it possible to drain retentate from the apparatus once filtration is completed. Feed liquid compartment 6 has a feed liquid inlet 22 and a retentate outlet 25. Incoming feed liquid is distributed to the first set of manifold compartments 2 and 4 and the second set of manifold compartments 8 and 10; therefore, the feed liquid inlet can have a diameter greater than those of the internal feed liquid conduits of the manifold compartments. A plurality of filtration modules 24 can be anchored to manifold compartments 2, 4, 8 and 10 by means such as a plate 26 and a plurality of compression assemblies 28, for instance, bolts. Alternatively, threaded rods having nuts at the ends can be used in place of the bolts. Manifold adaptor plate 11 of the present invention (Fig. 6) is disposed between filtration modules 24 and the manifold compartments 2, 4, 8 and 10.

Referring to Figs. 2 and 3 manifold adaptor plate 11 of the present invention comprises of polymer sheet 13, an elastomer layer 17, and a rigid plate 19, which can be formed from a thermosetting resin, a reinforced composition such as a graphite or carbon composition, or a metal such as stainless steel, Hastolloy metal or aluminum. Rigid plate 19 has two primary surfaces 7A and 7B. The polymer sheet is disposed such that it contacts one of the primary surfaces (first primary surface 7A in Figs. 2 and 3) of the rigid plate, and elastomer layer 17 is disposed such that it contacts the other primary surface (second primary surface 7B on the opposite side of the first surface in Figs. 2 and 3).

Each layer 13, 17 and 19 has openings for the desired liquid flow passing through plate 11. The openings in each layer 13, 17, 19 are aligned in order to guarantee the appropriate flow and fluid pathway seal, and to guarantee the appropriate connection of the elastomer layer with the polymer layer. Each layer 13, 17 and 19 has one edge with alternating openings 50 for filtrate and openings 56 for retentate. The opposite edge has openings 48 for feed liquid disposed in alternating manner with openings 50 for filtrate. As shown in Fig. 3, which is an enlarged view of assembled plate 11 shown through one opening (which is opening 50 in Figs. 3), elastomer layer 17 extends through each opening 48, 50 and 56 in order to form protrusions 15. Protrusions 15 are distributed over polymer sheet 13 and connect with polymer sheet 13. Preferably, manifold adaptor plate Nevertheless, this is not necessary and other means can be used. Plate 11 can also have tabs 23 for facilitating the attachment of plate 11 to bolts 28 and removal of the plate from bolts 28.

Elastomer layer 17 and polymer sheet 13 are aligned (or matched) such that the two layers connect with one another when elastomer layer 17 is formed. Optionally, the elastomer layer can be joined to the surface of the rigid plate on the side where the elastomer layer is applied. Moreover, optimally, the polymer sheet can be formed by being cast (or by another method) over the surface of the rigid plate on the side where the polymer sheet is applied rather than being a separate layer. The apparatus can be sealed by a variety of elastomer materials. The elastomer material is not necessarily an extremely elastic material, but it must be capable of maintaining a seal relative to the adjacent layers under bending or compression. Preferably, the elastomer has a Shore A hardness of approximately 60 to 100.

(Although not exclusively,) the appropriate materials include thermoplastics resins such as polyethylene, polypropylene, EVA copolymers,  $\alpha$ -olefins and metallocene copolymers; PFA; MFA; polycarbonates; and vinyl copolymers such as PVC; polyamides such as nylon; polyesters, acrylonitrile-butadienestyrene (ABS), polysulfone, polyethersulfone, polyarylsulfone, polyphenylsulfone, polyacrylonitrile, polyvinylidene fluoride (PVDF), and blends thereof; styrene block copolymers,

EPDM and polypropylene blends, or the like; substances marketed under the brand names of Santoprene® polymer, Kraton® thermoplastic elastomer and Dynaflex® elastomer, EPDM rubber; thermosetting substances such as closed cell foamed urethanes; and  
5 natural and synthetic rubbers.

Thermoplastic or thermoplastic elastomers are preferred because they allow for use by injection molding, which is the preferred method of the present invention. Also, thermoplastics and thermoplastic elastomers have a low levels of extractability and make the filtered product cleaner. Examples are SANTOPRENE® polymer having a hardness  
10 of approximately 80 obtained from Advanced Elastomer Systems, and the thermoplastic elastomer Kraton® elastomer G27052 having a Shore A hardness of 56 obtained from Advanced Elastomer Systems. Preferred thermoplastics include low density, linear low density, medium density and high density polyethylene, polypropylene and EVA copolymers.

15 Examples of appropriate polymer sheets are polypropylene, polyethylene, polyester, polysulfone, polyamide, acetal, acrylic resin, polystyrene, PTFE, silicone, vinyl or the like. Examples of preferred rigid layers are stainless steel, steel, aluminum, phenol-formaldehyde, urea-formaldehyde, carbon/epoxy compositions, graphite/epoxy compositions, rigid molded plastic, glass or fiber-reinforced plastics or the like.

20 Referring to Figs. 4 and 5, alternative manifold adaptor plate 9 of the present invention comprises two elastomer layers 17 and 41, polymer sheet 13 and rigid plate 19. Elastomer layers 17 and 41 are connected to one another via openings 48, 50 and 56; therefore, polymer sheet 13 is optional. The optional polymer sheet can be disposed on both surfaces 7A and 7B of rigid plate 19, or it can be disposed on only one surface 7A of  
25 plate 19, as shown in Fig. 4. In Figs. 4 and 5, the same reference numbers are used for the same elements as in Figs. 2 and 3. As shown in Fig. 5, elastomer layer 41 covers polymer sheet 13 and elastomer layer 17 covers polymer sheet 13. Furthermore, elastomer layers 17 and 41 are connected to one another inside openings 50, as well as inside openings 48 and 56. This example of the present invention provides two gasket sealing surfaces. The  
30 sealing surfaces on the

elastomer surfaces can be smooth (layer 41 in Fig. 4) or can have protrusions (protrusions 15 in Figs. 2 and 3).

Fig. 6 shows a filtration module that is capable of being used together with the manifold adaptor plate of the present invention. A filtration element 70 is disposed  
5 between manifold compartment 51 and plate 55. Manifold compartment 51 has a liquid inlet 73, filtrate outlets 77 and 79, and retentate outlet 81. Manifold compartment 51 has a plurality of feed liquid introduction means 33 and a plurality of retentate evacuation means 26. A first set of filtrate evacuation means 28 is disposed at one end of manifold  
10 compartment 51, while a second set of filtrate evacuation means 28 is disposed at the end on the opposite side of manifold compartment 51. Filtrate evacuation means 28 are connected to filtrate outlets 77 and 79 by filtrate conduit pathways (grooves) 46 and filtrate evacuation means 29. Pathways 46 have dimensions that permit the flow of filtrate through the pathways while preventing sagging of the filtrate diaphragm (or filtrate screen;  
15 not illustrated) into pathways 46, and their width is usually approximately 1.5 to 3.0 mm. Filtration module 70 has openings 48, which reach feed liquid inlets 33, and openings 50, which reach filtrate evacuation means 28. Manifold adaptor plate 11 (Fig. 2) is disposed so that the elastomer layer 17 contacts manifold compartment 51 and an appropriate seal for preventing the mixing of filtrate and feed liquid or retentate is realized. As shown in  
20 Fig. 7, filtrate side 52 of filter layer 53 has mesh spacer 54 that contacts the layer and is exposed. Filtration compartment 70 further has openings 56 that reach retentate evacuation means 26. Plate 55 is used in order to seal the top surface of filtration module 70.

Referring to Fig. 7, filtration module 70 has a filtrate spacer 54, a filter layer 52, a  
25 retentate spacer 60, a second filtrate spacer 54 (not illustrated), and a filter layer 62. Second filtrate spacer 54 (not illustrated) can contact pathways 46. As shown by arrow 58, feed liquid flows through openings 48 of layer 62 into spacer 60. A portion of this liquid flows through spacer 60, as shown by arrow 64 and passes through filter 52, as shown by arrow 68. The remaining portion of the incoming liquid flows up through openings 48 of  
30 filtrate spacer 54, as represented by arrow 68, and into the adjacent next filtration module (not illustrated) proceeding as described above for filtration module 70. The filtrate

flows into openings 50 and toward filtrate evacuation means 28 (Fig. 6) in the direction shown by arrows 71 and 72. The retentate flows through retentate spacer 60, as shown by arrows 64 and 65, and flows through openings 56 in the direction shown by arrow 78 to retentate evacuation means 26 (Fig. 6). The filtrate flows toward filtrate outlets 77 and 79 to openings 28, grooves 46, and evacuation means 29 (Fig. 6). The retentate flows through openings 26 to retentate outlet 81.

As shown in Fig. 8, adaptor plate 9 (Fig. 4) is disposed between two filtration modules (Fig. 6) so that elastomer layer 41 and 17 act as seals.

Manifold apparatus 1 that uses manifold adaptor plate 11 of the present invention will now be described while referring to Figs. 1, 6, and 7. The feed liquid to be filtered flows from feed liquid inlet 22 (Fig. 1), liquid inlet 73 (Fig. 6) and passes through feed liquid introduction means 33, feed liquid inlets 48, and filtration module 70 in order to separate the feed liquid into filtrate and retentate. The retentate is removed from filtration modules 70 via openings 56 and 26 and outlet 81. The filtrate is removed from filtration modules 70 through openings 50 along pathways 46 and via outlets 77 and 79.

By means of an alternative example of the present invention, the elastomer layer is silicone-based, and the polymer layer is optionally omitted. By means of one such example shown in Fig 9, at least a portion of one surface 102 of a rigid plate 100 is covered by a silicone layer 104, and silicone layer 104 extends through openings 106 formed in rigid plate 100 up to surface 108 on the opposite side of rigid plate 100 in order to form a seal on both surfaces of rigid plate 100. Alternatively, when necessary, one surface, both surfaces, or the entire plate 100 can be covered.

Silicone adheres to steel and certain plastics such as polysulfone and polyethersulfone, and therefore, the polymer sheet is not necessary in the present example. Nevertheless, the polymer sheet can also be used as needed in the present example. Moreover, by means of these examples, silicone adheres to the plate surface and enclosure of the entire surface therefore is not necessary; it is possible to enclose only the portions where the seal is formed, or the portions exposed to the treatment flow. Nevertheless, the entire surface can be enclosed as needed.

When silicone does not adhere to the plate surface, it is possible to simply enclose the entire plate in silicone and to support the silicone elastomer layer on the plate by this enclosure itself. Alternatively, it is possible to treat the plate surface with plasma by oxidation, using a binder or the like, in order to improve adhesion of the silicone on the plate, or to use the above-described polymer layer.

In particular, when stainless steel such as 316L stainless steel or other stainless steel grades are used, or when the above-mentioned plastics acceptable for contact with fluids are used, it is not necessary to cover or enclose the entire surface of the rigid plate. In essence, it is possible to simply cover with silicone only the regions where the seal is formed in the system, as well as the openings and the area on the plate around the openings.

Alternatively, both surfaces of the rigid plate are covered by silicone and as a result, the need to connect the polymer layer and the silicone layer via openings formed in the rigid plate layer can be eliminated. This means can use the above-mentioned (stainless or other) steel, plastic or composite rigid plates. The coating can be applied to only the two primary surfaces, or all surfaces of the rigid plate can be enclosed as needed.

By means of these examples, a polymer layer is not always needed for the adhesion of the silicone to the material selected for the rigid plate, or for enclosure of the plate, but it is possible to use a polymer layer as needed, or when the rigid plate is not steel, or selected from the above-mentioned plastics.

(Although not exclusively,) examples of the appropriate silicones are silicones capable of being cured at room temperature, platinum-cured silicones, photo-cured silicones, moisture-cured silicones, and heat-cured silicones. Examples of silicones that can be used in the present invention are platinum-cured silicone obtained from suppliers, including Dow Corning Corporation (such as Silastic® silicone).

By means of yet another example of the present invention, it is possible to block or close off one or more openings in the plate using an elastomer material in order to form a shunt. In general, all of at least one type of opening (for feed liquid, retentate or permeating liquid) or all openings (for feed liquid, permeating liquid and retentate (when used)) are

closed off. It is further preferred that the openings are closed off by being filled with an elastomer or silicone material in an amount sufficient for preventing the passage of liquid through the openings.

5           By means of one example of this design, it is possible to use a polymer sheet 112 for the first primary surface 111 of a rigid plate 110 and to use elastomer material 114 for the other primary surface 113, as shown in Fig. 10. Elastomer material 114 extends through openings 116 in order to cover the portion of sheet 112 adjacent to openings 116. The amount of elastomer material used is an amount sufficient for filling openings 116  
10       and preventing fluid from being able to pass from one primary surface 111 to the other primary surface.

          Similarly, by means of the same type of design, it is possible to close off the openings using the silicone when a polymer sheet is not employed (not illustrated).

          Yet another example is shown in Fig. 11, where plate 120 is designed as a simple  
15       shunt, and there are no openings, at least where the flow is to be diverted. Polymer sheet 122 (when used) does not having openings 124, and is bonded to shunt plate 120 by using elastomer material 126 in and around openings 124 of sheet 122. A sealing layer 128 is formed as described above on the surface on the opposite side of plate 120.

          Similarly, by means of an example wherein the polymer sheet is not used, silicone  
20       can be used in a similar manner to cover the regions of the plate that correspond to where openings should have been disposed, or to cover the entire plate, as needed (not illustrated).

## CLAIMS

What is claimed:

- 5           1.    A manifold adaptor plate having a plurality of liquid pathways that pass  
              through the plate and allow for the passage of feed liquid, filtrate and  
              retentate, wherein the manifold adaptor plate comprises an elastomer layer, an  
              intermediate rigid layer formed from stainless steel, and a polymer sheet, and  
              the elastomer layer connects with the polymer sheet via the liquid pathways.  
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2.    A manifold adaptor plate having a plurality of liquid pathways that pass  
              through the plate and allow for the passage of feed liquid, filtrate, and  
              retentate, wherein the manifold adaptor plate comprises a first elastomer layer,  
              an intermediate rigid layer, which contacts at least a portion of the first  
15           elastomer layer and is formed from stainless steel; optionally a first polymer  
              sheet between the first elastomer layer and the rigid layer; a second elastomer  
              layer that connects with the first elastomer layer via the liquid pathways; and  
              optionally a second polymer sheet disposed between the second elastomer  
              layer and the rigid layer.  
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3.    The manifold adaptor plate according to Claim 1, wherein the elastomer layer  
              is formed from a thermoplastic elastomer.
4.    The manifold adaptor plate according to Claim 1, wherein the polymer sheet  
25           is formed from polypropylene.
5.    A manifold adaptor plate having a plurality of liquid pathways that pass  
              through the plate and allow for the passage of feed liquid, filtrate, and  
              retentate, wherein the manifold adaptor plate comprises an elastomer layer, an  
30           intermediate rigid layer, which has a first and second primary surface formed  
              on its two sides and is formed from stainless steel; and a polymer sheet; and  
              the elastomer layer contacts the first primary surface of the rigid layer the  
              polymer sheet, contacts the second primary surface of the rigid layer, and the  
              elastomer layer connects with the polymer sheet via the liquid pathways.

elastomer layer connects with the polymer sheet via the liquid pathways.

6. The manifold adaptor plate according to Claim 2, wherein the elastomer layer is formed from a thermoplastic elastomer.
7. The manifold adaptor plate according to Claim 2, wherein the polymer sheet is formed from polypropylene.
8. The manifold adapter plate according to claim 1, wherein the elastomer sheet is silicone.
9. The manifold adapter plate according to claim 2, wherein the first and second elastomer layers are silicone.
10. A manifold adaptor plate having a plurality of liquid pathways that pass through the plate and allow for the passage of feed liquid, filtrate, and retentate, wherein the manifold adaptor plate comprises a silicone layer and an intermediate rigid layer made from a material selected from the group consisting of steel, polysulfone, and polyethersulfone, the silicone layer is formed on at least one side of the intermediate rigid layer, and the silicone layer connects with the intermediate rigid layer and extends through said liquid pathways.
11. A manifold adaptor plate having a a plurality of liquid pathways that pass through the plate and allow for the passage of feed liquid, filtrate, and retentate, wherein the manifold adaptor plate comprises a silicone layer and an intermediate rigid layer made from stainless steel, the silicone layer is formed on at least one surface of the intermediate rigid layer, and the silicone layer connects with the intermediate rigid layer and extends through the liquid pathways.
12. A manifold adaptor plate having a plurality of liquid pathways that pass through the plate and allow for the passage of feed liquid, filtrate, and retentate, wherein the manifold adaptor plate comprises a silicone layer and

an intermediate rigid layer made from polysulfone, the silicone layer is formed on at least one surface of the intermediate rigid layer, and the silicone layer connects with the intermediate rigid layer and extends through the liquid pathways.

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13. A manifold adaptor plate having a plurality of liquid pathways that pass through the plate and allow for the passage of feed liquid, filtrate, and retentate, wherein the manifold adaptor plate comprises a silicone layer and an intermediate rigid layer made from polyethersulfone, the silicone layer is formed on at least one surface of the intermediate rigid layer, and the silicone layer connects with the intermediate rigid layer and extends through the liquid pathways.

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14. The manifold adaptor plate according to any of claims 10 through 13, further comprising a silicone layer formed on the second side of the intermediate rigid layer.

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15. The manifold adaptor plate according to any of claims 10 through 13, further comprising a silicone layer formed on the second side of the intermediate rigid layer in order to enclose the intermediate rigid plate.

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16. The manifold adaptor plate according to any of claims 10 through 13, wherein the amount of silicone is an amount sufficient for closing off one or more of the liquid pathways.

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17. The manifold adaptor plate according to claim 1, wherein the amount of elastomer is an amount sufficient for closing off one or more of the liquid pathways.

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18. The manifold adaptor plate according to claim 2, wherein at least one of the first and second elastomer layers is an amount sufficient for closing off one or more of the liquid pathways.