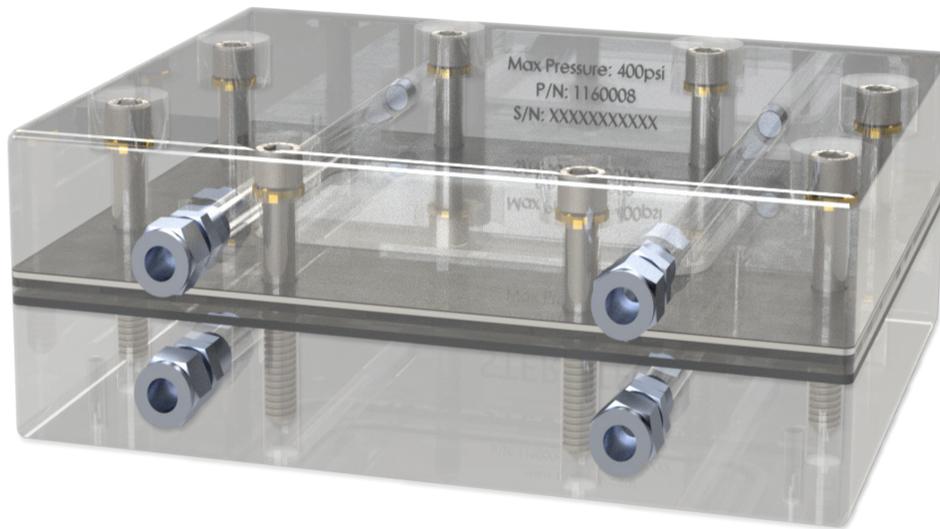


# STERLITECH

*C o r p o r a t i o n*

## **AIR GAP MEMBRANE DISTILLATION CELL ASSEMBLY & OPERATION MANUAL**





## CONTENTS

|   |    |
|---|----|
| 1. INTRODUCTION .....                                       | 1  |
| 2. MEMBRANE DISTILLATION CELL COMPONENTS.....               | 2  |
| 3. MEMBRANE DISTILLATION CELL ASSEMBLY .....                | 4  |
| 4. OPERATION OF THE MEMBRANE DISTILLATION CELL .....        | 9  |
| 5. SUPPLEMENTAL MEMBRANE INFORMATION .....                  | 10 |
| 6. ACCESSORY AND SPARE PART ORDERING INFORMATION .....      | 11 |
| 7. RETURN MATERIAL AUTHORIZATION .....                      | 12 |
| 8. WARRANTY .....   | 12 |
| 9. TECHNICAL ASSISTANCE .....                               | 12 |
| APPENDIX 1: MEMBRANE DISTILLATION CELL APPLICATIONS.....    | 13 |
| APPENDIX 2: STERLITECH BENCH SCALE FILTRATION PRODUCTS..... | 14 |

# 1. INTRODUCTION

The Air Gap Membrane Distillation Cell is a laboratory-scale crossflow filtration unit that is designed to evaluate the performance of flat sheet membranes in membrane distillation applications. It simulates the flow dynamics of larger, commercially available membrane systems. By using a combination of Stainless Steel (SS) shims, spacers, and membranes, users can vary the operating conditions and fluid dynamics over broad ranges.

**Table 1** outlines the operational parameters and technical specifications of the Air Gap Membrane Distillation Cell.

**Table 1: Air Gap Membrane Distillation Cell Features and Specifications**

| Parameter                  | Description                                 |
|----------------------------|---|
| Membrane Active Area       | 140 cm <sup>2</sup> (22-inch <sup>2</sup> ) |
| Maximum Operating Pressure | 15 bar (220 psig)                           |
| Maximum Temperature        | 88 °C (190.4 °F)                            |
| O-rings                    | Viton*                                      |
| Gaskets                    | Viton                                       |
| Spacer                     | Acrylic                                     |
| Condenser Plate            | Aluminium                                   |
| pH Range                   | Membrane Dependent                          |
| Cross Flow Velocity        | Variable                                    |
| <b>Dimensions</b>          |   |
| Air Gap Thickness          | 5.6 mm (7.32 inches)                        |
| Feed Channel Depth         | 1.9 mm (0.075 inches)                       |
| Feed Channel Width         | 146 mm (5.75 inches)                        |

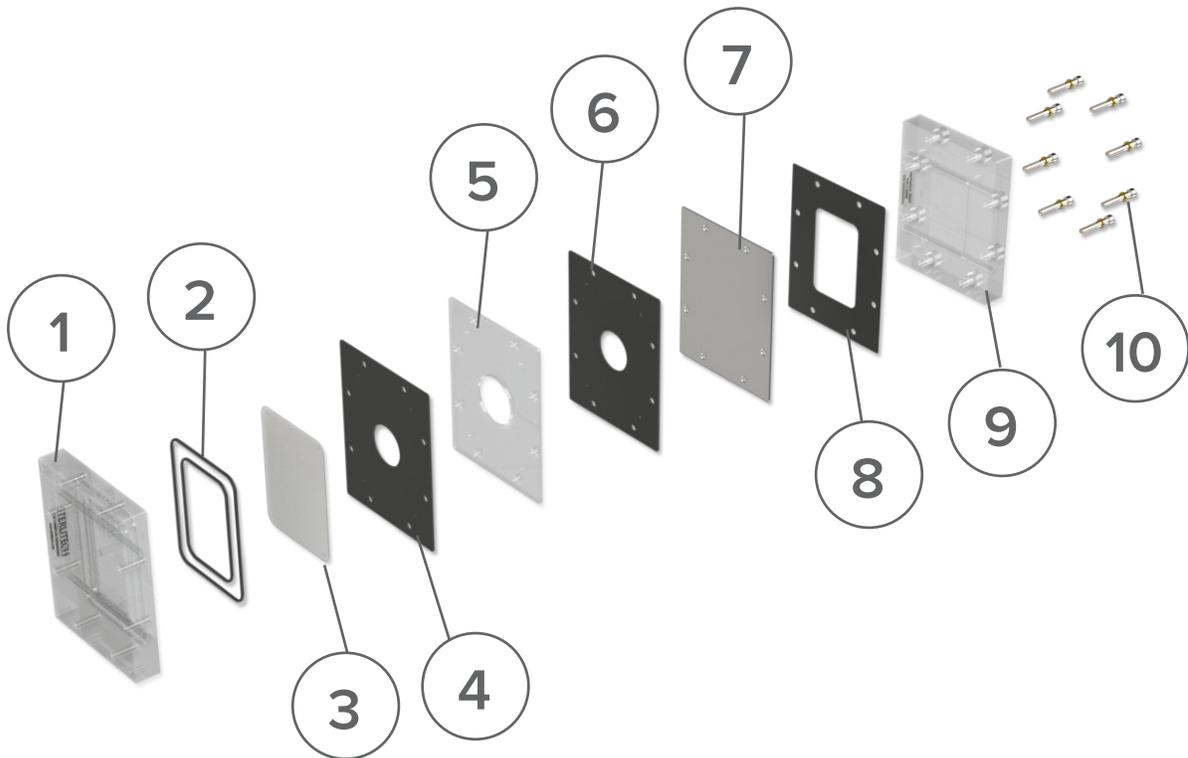
\*Other materials available

Prior to operating or servicing this device, this manual must be read and understood.

## 2. AIR GAP MEMBRANE DISTILLATION CELL COMPONENTS

Verify that the Air Gap Membrane Distillation Cell was shipped complete, intact, and undamaged.

Figure 1: Air Gap Membrane Distillation Cell Assembly



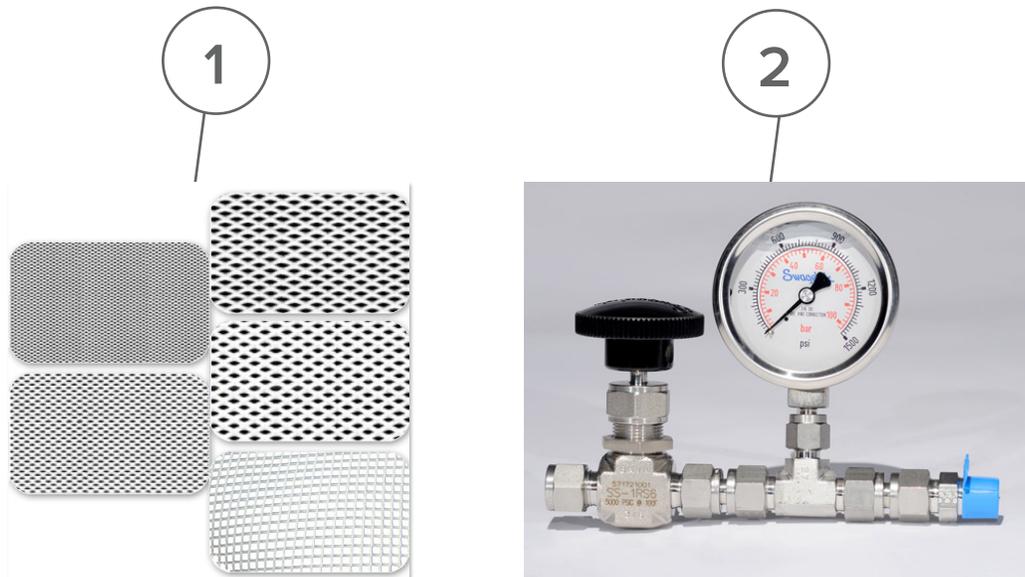
### LEGEND:

1. Acrylic Cell Bottom Plate
2. Inner and Outer O-rings
3. Membrane
4. Gasket
5. Spacer
6. Gasket
7. Condenser Plate
8. Gasket
9. Acrylic Cell Top Plate
10. Tightening Bolts

## 2.1 ADDITIONAL EQUIPMENT

The Air Gap Membrane Distillation Cell may also require additional equipment to be operated, which are sold separately:

1. Spacers
2. Concentrate/Back pressure control
3. Feed pump
4. Feed tank
5. Cooling solution pump
6. Cooling solution tank
7. Membrane filter packs
8. Assortment of shims and additional spacers
9. Temperature controller for feed and cooling solution
10. Scales for measuring weight change for feed or cooling solution
11. Flow Channel Inserts for Modified Osmosis\*



\*Flow Channel Inserts for Modified Osmosis are an accessory (sold separately) designed for experiments where a high pressure is applied to the membrane sides.

### 3. AIR GAP MEMBRANE DISTILLATION ASSEMBLY

After verifying that all of the necessary components are present, you can begin the assembly of the Air Gap Membrane Distillation Cell.

#### 3.1 CELL BODY ASSEMBLY

The cell body consists of the cell top, three Gaskets, one spacer, a condenser plate , inner and outer O-rings, cell bottom, and feed pressure control valve. Figure 1 illustrates a typical assembly of the cell body.

To assemble the Air Gap Membrane Distillation Cell Body:

1. Connect the pressure control valve to the cell bottom by wrapping PTFE tape around the valve's male NPT end and screwing it into the concentrate outlet port.

**Note:** The fittings should be tightened gently up to 15 Inch Pounds of torque. It should not exceed 15 Inch Pounds.

**Note:** The cell bottom is the half of the cell body that has the four alignment pins. The cell top has the holes to accept the alignment pins.

2. Install the O-rings into the grooves on the cell bottom and wet them with a small amount of water or the fluid to be processed.



**Caution:** Make sure that the O-rings lie flat in the grooves of the cell bottom. Leaking may occur if the O-rings do not lie flat in the grooves. The O-rings will be cut or crushed when the system is operating if the O-rings are not installed correctly.

3. Place a shim, if needed, in the cavity inside of the inner O-ring.



**Note:** Using Shims and Spacers enables to change the hydrodynamic conditions in the cell or to create a support for the membrane.

4. Install the feed spacer into the central cavity, on top of the shim, if needed. The spacer must lie flat and be fully contained within the cavity.

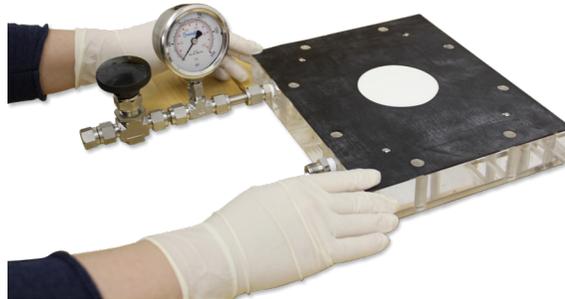


5. Place a piece of pre-cut membrane over the feed spacer using the four guideposts to hold the membrane in position. The membrane should be installed with the shiny or active side down toward the feed spacer.



**Note:** If you are cutting your own membranes, the membrane's outer edge should fit between the inner and outer O-rings in the cell body to prevent leakage.

6. Place the first gasket over the membrane.



7. Place the acrylic spacer on top of the Gasket.



**Note:** The aperture in the acrylic spacer is designed for permeate outlet. It should be placed toward the permeate collection vessel.

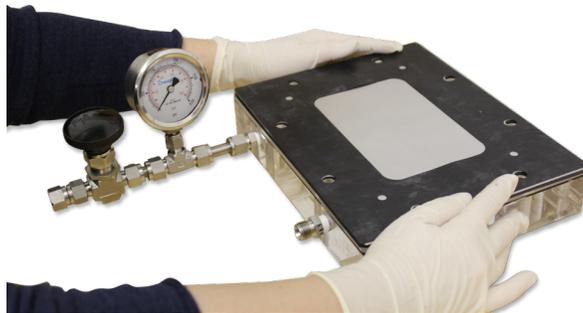
8. Place the second gasket over the acrylic spacer.



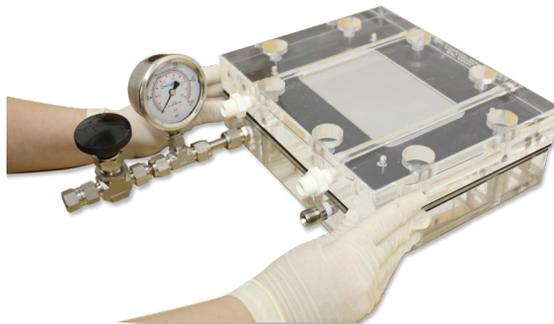
9. Place the Aluminum condenser plate over the gasket.



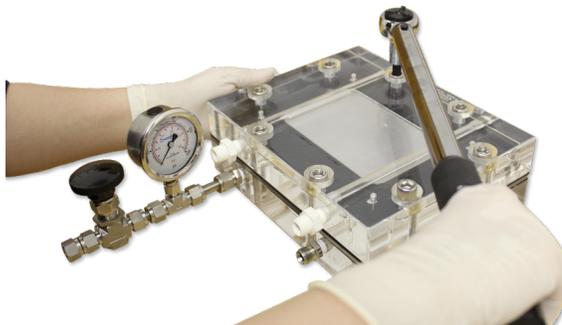
10. Place the third gasket over the condenser plate.



11. Complete the assembly of the cell body by placing the cell top onto the cell bottom.



12. Put the washers and bolts in and tighten the bolts using an Allen/Hex Key.



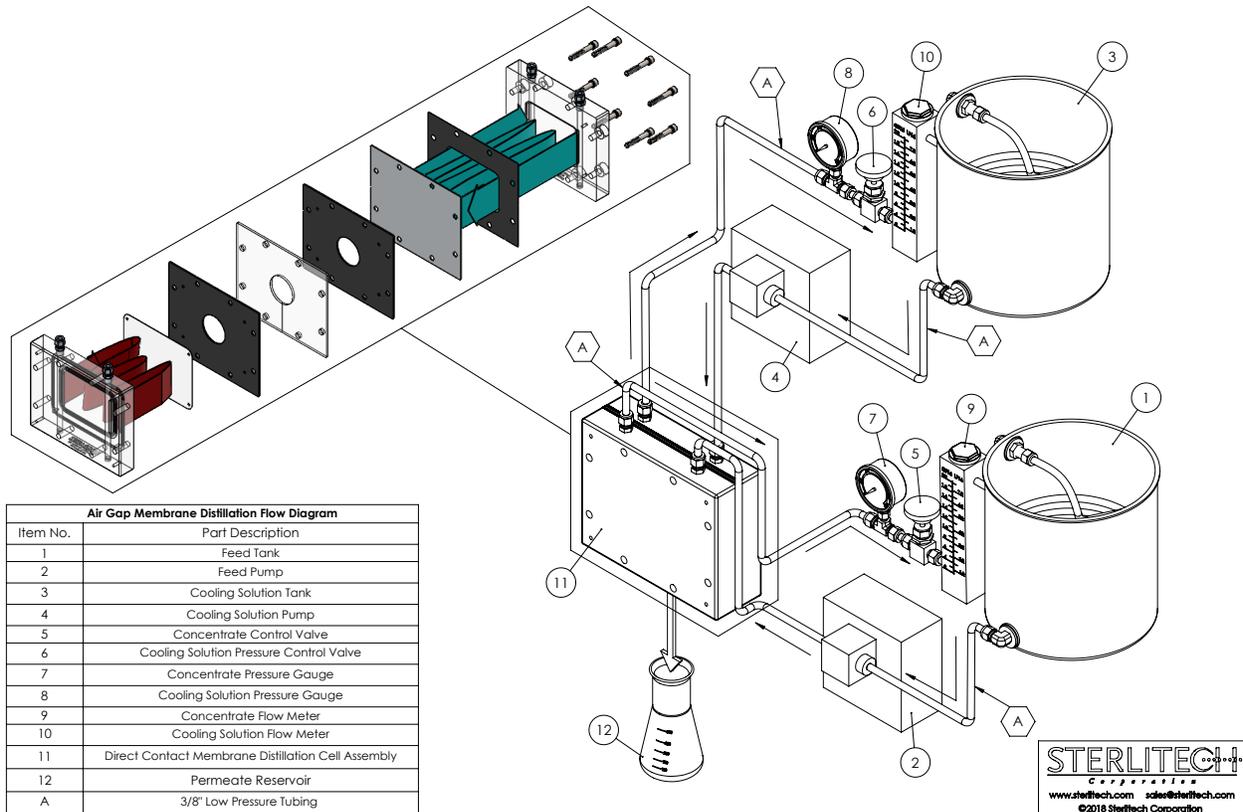
**Note:** The bolts should be tightened gently to 40 Inch Pounds of torque. Each bolt should be increased 2-5lbs at a time to evenly tighten down the surface.

### 3.2 AIR GAP MEMBRANE DISTILLATION CELL CONNECTIONS & PARTS

**Figure 2** shows typical plumbing connections that need to be made for the operation of the AGMD Cell. In general, the connections to be made are:

- A. Feed tank to the feed pump
- B. Pump outlet to the feed inlet of the cell body
- C. Feed outlet of the cell body to the concentrate collection tank (or the feed tank)
- D. Draw solution tank to the draw solution pump
- E. Draw solution pump outlet to the draw solution inlet of the cell body
- F. Draw solution outlet of the cell body to the draw solution collection tank

**Figure 2. Example Air Gap Membrane Distillation Cell Flow Diagram**



## 4. OPERATION OF THE AIR GAP MEMBRANE DISTILLATION CELL

Once the Air Gap Membrane Distillation Cell has been assembled and connected to a feed and cold stream, it will be ready to use.

### To operate the Membrane Distillation Cell:

1. Place the cell as is illustrated in the flow diagram to collect the permeate in a beaker.
2. Turn the feed/cooling solution flow pumps on.
3. Adjust the pressure on the feed or cooling solution side using the concentrate/back pressure control valve.

**Caution:** Do not exceed 400 psi (27.5 bar).

4. Adjust the concentrate/back pressure control valves and pump settings to obtain the desired pressure and flow. Experimentation enables you to determine the optimum settings for pressure, flow rate, and shim/spacer combination to use on the chosen membrane and the fluid being processed.

### To replace a membrane filter:

1. Turn the feed flow pump OFF.
2. Place the cell on a table, bottom half facing upward.
3. Separate the cell body bottom from the assembly.
4. Remove the membrane.
5. Remove the feed spacers, if necessary.

**Note:** Typically, the feed spacers do not have to be removed.

6. Install the new membrane (and, if necessary, a new feed spacer).
7. Reassemble the cell.
8. Install the cell in an appropriate place.
9. Turn the feed flow pump on.

## 5. SUPPLEMENTARY MEMBRANE INFORMATION

### 5.1 MEMBRANE PERFORMANCE RESULTS

Spiral wound membranes containing mesh spacers are usually operated with a fluid velocity across the membrane surface of 0.1–0.5 m/sec (0.3–1.6 ft/sec). Higher velocities in membranes may lead to excessive pressure differential across the membrane and possible damage. Hollow fiber membranes, tubular membranes, and membranes with tubular spacers may be operated at higher velocities, but this may not contribute to a more effective operation.

### 5.2 MEMBRANE PERFORMANCE

Other parameters such as viscosity, pressure, and suspended solids may also affect performance/operation. Experimentation with the Membrane Distillation Cell can help predict the best operating parameters. If your pump is delivering too much flow, a portion of the flow can be diverted back to the feed container before entering the feed inlet of the cell body. This requires installation of an optional bypass valve and fitting on the pump outlet which is not supplied with the system.

### 5.3 TEMPERATURE LIMITS

The membranes spacers, O-rings, and cell body materials dictate the maximum operating temperatures.

**Table 2: Upper Temperature Limits**

| Component         | Maximum Temperature |
|-------------------|---------------------|
| Acrylic Cell      | 88 °C (190.4 °F)    |
| Membrane Elements | Variable            |
| Mesh Feed Spacer  | 82 °C (180 °F)      |
| Gasket            | 200° C (400° F)     |
| Spacer Sheet      | 88 °C (190.4 °F)    |
| O-rings           |                     |
| Viton             | 200° C (400° F)     |
| EPDM              | 150° C (300° F)     |

### 5.3 MEMBRANE CLEANING

The Air Gap Membrane Distillation Cell can be cleaned easily after the membrane is removed. However, you may wish to simulate the actual cleaning conditions of Cleaning-In-Place (CIP) in larger systems with spiral-wound or tubular membranes. This can be done with CIP.

Clean-In-Place chemically cleans without removing the membrane to mechanically scrub the unit. During CIP, cleaning solutions are re-circulated and, in some cases, allowed to sit for a period of time within the cell body. In some cases, the feed pump can be used to re-circulate the cleaning solutions.

## 6. ACCESSORY AND SPARE PART ORDERING INFORMATION

Accessories and spare parts for the Air Gap Membrane Distillation Cell can be ordered by calling Sterlitech Corporation at 1-877-544-4420 or by visiting [www.sterlitech.com](http://www.sterlitech.com).

**Table 3: Accessory and Spare Part Ordering Information**

| Product  | Shipping Weight    | Ordering Number |
|--|--------------------|-----------------|
| Air Gap Membrane Distillation Cell, Acrylic              | 5.4 kg (11.85 lbs) | 1160071         |
| Air Gap Membrane Distillation Conversion Kit             |                    | 1160097         |
| Feed/Cooling Solution Flow Pump                          | Contact Sterlitech |                 |
| Modified Osmosis Insert (SS316)                          |                    | 1230036         |
| <b>Accessories</b>                                       |                    |                 |
| 17 mil Feed Spacer (PP, 5/pack)                          | 0.5 kg (1 lb)      | 1142816         |
| 31 mil Feed Spacer (PP, 5/pack)                          | 0.5 kg (1 lb)      | 1142818         |
| 47 mil Feed Spacer (PP, 5/pack)                          | 0.5 kg (1 lb)      | 1143763         |
| 47 mil Parallel Spacer (PP, 5/pack)                      | 0.5 kg (1 lb)      | 1142814         |
| 65 mil Feed Spacer (PP, 5/pack)                          | 0.5 kg (1 lb)      | 1142819         |
| Spacer Assortment Pack:<br>17, 31, 47, and 65 mil        | 0.5 kg (1 lb)      | 1232558         |
| Shims (12 total/pack):                                   |                    |                 |
| • 4 of 2 mil   |                    |                 |
| • 4 of 5 mil   |                    |                 |
| • 2 of 10 mil  | 0.5 kg (1 lb)      | 1231104         |
| • 1 of 15 mil  |                    |                 |
| • 1 of 25 mil  |                    |                 |
| <b>Spare Parts</b>                                       |                    |                 |
| Viton O-rings  | 28 g (1 oz)        | 1143205         |
| Back Pressure Control Valve, 0-400 psi                   | 0.9 kg (2 lbs)     | 1149428         |
| <b>Membrane Packs</b>                                    |                    |                 |
| • Novamem PEEK and PVDF                                  |                    |                 |
| • PTFE (Unlaminated, Laminated,<br>and Aspire Laminated) | Contact Sterlitech |                 |
| • Polypropylene  |                    |                 |

## 7. RETURN MATERIAL AUTHORIZATION

If materials are to be returned to Sterlitech for repair, evaluation, or warranty consideration, a Return Material Authorization (RMA) number and form must be obtained from Sterlitech prior to the return. Contact Sterlitech's Customer Service Department for these forms.

The form must be completed and returned with the material. Be sure to include a complete, detailed written reason for the return. Also, include serial numbers, installation and removal dates, and any other pertinent information that is available. AC Sepa FO Cells have a serial number imprinted on the cell bottom.

Indicate the proposed disposition of the material, and reference the RMA number on all packages or cartons. All material must be shipped to Sterlitech with freight prepared by the customer.

## 8. WARRANTY

The following is made in lieu of all other warranties expressed or implied. Sterlitech Corporation guarantees equipment to be free from defects in material and workmanship when operated in accordance with written instructions for a period of one year from receipt. Parts not manufactured by Sterlitech are covered by their manufacturer's warranties, which are normally for one year.

Manufacturers and Seller's only obligation shall be to issue credit against the purchase or replacement of equipment proved to be defective in material or workmanship. Neither manufacturer nor seller shall be liable for any injury, loss or damage, direct or indirect, special or consequential, arising out of the use of, misuse, or the inability to use such product.

The information contained herein is based on technical data and tests, which we believe to be reliable, and is intended for use by persons having technical skill at their discretion and risk. Since conditions of use are outside Sterlitech's control, we can assume no liability whatsoever for results obtained or damages incurred through the application of the data presented.

This information is not intended as a license to operate under, or a recommendation to infringe upon, any patent of Sterlitech or others covering any material or use.

The foregoing may not be altered except by a written agreement signed by officers of the manufacturer.

## 9. TECHNICAL ASSISTANCE

Please contact us if you have any questions or technical inquiries about our products by calling Sterlitech Corporation at 1-877-544-4420 or by visiting [www.sterlitech.com](http://www.sterlitech.com).

## APPENDIX 1: AIR GAP MEMBRANE DISTILLATION CELL APPLICATIONS

The following studies focused on Air Gap Membrane Distillation application are listed here to illustrate the potential applications for the Air Gap Membrane Distillation Cell. These studies are good references for understanding the operation of the Air Gap Membrane Distillation Cell.

| APPLICATION                          | STUDY CITATION   |
|--------------------------------------|--|
| <b>Air Gap Membrane Distillation</b> | C. Feng et al. "Production of drinking water from saline water by air-gap membrane distillation using polyvinylidene fluoride nanofiber membrane". Journal of membrane science. 311 (2008): 1-6. |
| <b>Air Gap Membrane Distillation</b> | M.C. Garcia-Payo et al. "Air gap membrane distillation of aqueous alcohol solutions". Journal of membrane science. 169 (2000): 61-80.  |
| <b>Air Gap Membrane Distillation</b> | A. Alkhudhiri et al. "Produced water treatment: application of air gap membrane distillation". Desalination. 309 (2013): 46-51.  |

## APPENDIX 2: STERLITECH BENCH SCALE FILTRATION PRODUCTS

|                                       | Discoverer   | Innovator  | Explorer  | Developer   | Investigator  |
|---------------------------------------|--|--|---|---|---|
| Filter Holder                         | <br>HP4750(X) | <br>CF016 | <br>CF042 | <br>Sepa | <br>1812 |
| Membrane Active Area                  | 14.6 cm <sup>2</sup> (2.26 in <sup>2</sup> )   | 20.6 cm <sup>2</sup> (3.2 in <sup>2</sup> )  | 42 cm <sup>2</sup> (6.5 in <sup>2</sup> )   | 140 cm <sup>2</sup> (24 in <sup>2</sup> )   | 0.27-0.46 m <sup>2</sup> (3-5 ft <sup>2</sup> )   |
| Typical Permeate Flow Rate (per Cell) | 1.5-15 mL/min  | 1-10 mL/min  | 2-20 mL/min   | 7-70 mL/min   | 350-2,300 mL/min  |
| System Capacity                       | 0.7-7 L/day (0.2-2 GPD)  | 1.5-15 L/day (0.4-4 GPD)   | 3-30 L/day (0.5-5 GPD)  | 10-100 L/day (2.6-26 GPD)   | 194-1,940 L/day (51-510 GPD)  |
| Min. Batch Volume (per Cell)          | 300 mL   | 3.7 L (1 gal)  | 3.7 L (1 gal)   | 3.7 L (1 gal)   | 15 L (4 gal)  |
| Max. Pump Capacity                    | N/A  | 6.8 LPM (76 bar)<br>1.8 GPM (1,100 psi)  | 6.8 LPM (76 bar)<br>1.8 GPM (1,100 psi)   | 6.8 LPM (76 bar)<br>1.8 GPM (1,100 psi)   | 6.8-38 LPM (76 bar)<br>1.8-10 GPM (1,100 psi)   |
| Cell Material                         | SS316, Hastelloy™  | PTFE, Delrin, Acrylic, SS316, Hastelloy™   | PTFE, Delrin, Acrylic, SS316, Hastelloy™  | Acrylic, SS316, Hastelloy™  | SS316   |
| Max. Operating Pressure               | HP4750: 69 bar (1,000 psi)<br>HP4750X: 172 bar (2,500 psi)                                       | PTFE/Acrylic: 276 bar (400 psi)<br>Delrin/SS316/Hastelloy™: 69 bar (1,000 psi)               | PTFE/Acrylic: 276 bar (400 psi)<br>Delrin/SS316/Hastelloy™: 69 bar (1,000 psi)              | Acrylic: 276 bar (400 psi)<br>SS316/Hastelloy™: 69 bar (1,000 psi)                        | 41.4 bar (600 psi)  |
| Filtration Mode(s)                    | Dead-End Stirred Cell  | Cross Flow, Forward Osmosis  | Cross Flow, Forward Osmosis   | Cross Flow, Forward Osmosis   | Cross Flow  |

## NOTES:

Founded in 2001 in Kent, WA, Sterlitech Corporation manufactures and markets filtration-focused laboratory products to a broad spectrum of scientific and industrial sectors. Its line of flat sheet membranes and tangential flow cells deliver industry-leading performance and reliable results. Configured for reverse osmosis, nanofiltration, ultrafiltration, and microfiltration applications, Sterlitech's bench scale test equipment provides the versatility required to innovate.

Sterlitech's comprehensive line of products is supported by the expertise of its technical specialists who can assist with application-specific product selection, and provide customized solutions where necessary. Unique problem-solving approaches, flexibility, and consistent quality have made Sterlitech Corporation a renowned global provider of filtration products and equipment.

#### General Corporate Information

Sterlitech Corporation

22027 70th Avenue S  
Kent, WA 98032-1911 USA  
Tel: 877-544-4420 or 1-253-437-0844  
Fax: 1-253-437-0845

[info@sterlitech.com](mailto:info@sterlitech.com)

Sales Inquiries  
[sales@sterlitech.com](mailto:sales@sterlitech.com)

Accounts Payable  
[AP@sterlitech.com](mailto:AP@sterlitech.com)

Accounts Receivable  
[AR@sterlitech.com](mailto:AR@sterlitech.com)

Press Inquiries  
[PR@sterlitech.com](mailto:PR@sterlitech.com)

---

© 2018 Sterlitech Corporation  
22027 70th Ave. S  
Kent, WA 98032-1911 USA  
Phone: (253) 437-0844  
Fax: (253) 437-0845  
Email: [sales@sterlitech.com](mailto:sales@sterlitech.com)