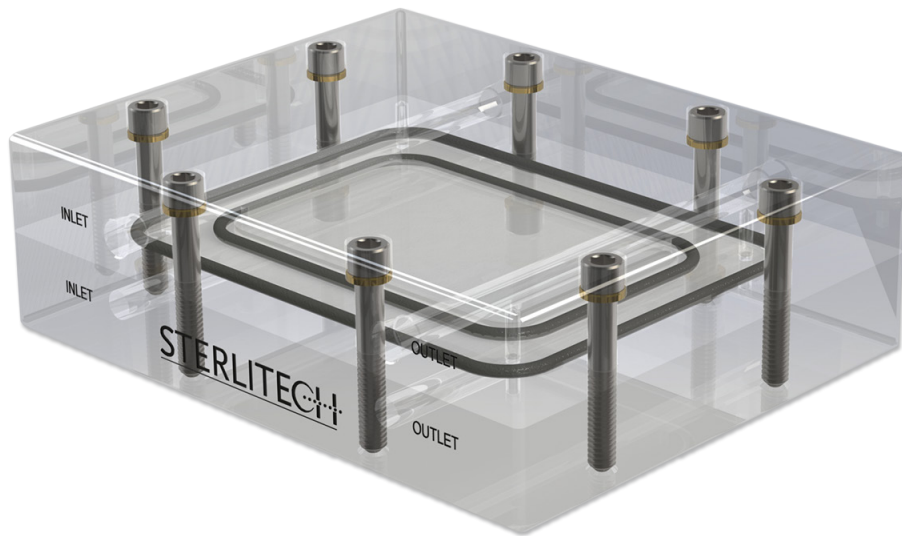


STERLITECH

C o r p o r a t i o n

AC SEPA FO CELL ASSEMBLY & OPERATION MANUAL



CONTENTS

1. INTRODUCTION	1
2. AC SEPA FO CELL ASSEMBLY	2
3. AC SEPA FO CELL CONNECTIONS AND PARTS	6
4. OPERATION OF THE AC SEPA FO CELL	9
5. SUPPLEMENTARY OPERATING INFORMATION	10
6. ACCESSORY AND SPARE PART ORDERING INFORMATION	11
7. RETURN MATERIAL AUTHORIZATION	12
8. WARRANTY	12
9. TECHNICAL ASSISTANCE	12
APPENDIX 1: AC SEPA FO CELL APPLICATIONS	13
APPENDIX 2: BENCH SCALE FILTRATION PRODUCTS.....	14

1. INTRODUCTION

The AC Sepa FO Cell is a laboratory-scale filtration unit that is designed to evaluate a variety of Osmotically Driven Membrane Processes (ODMP), including Forward Osmosis (FO) and Pressure Retarded Osmosis (PRO). It simulates the flow dynamics of larger, commercially available membrane elements such as industrial spiral wound membrane elements. By using a combination of Stainless Steel (SS) shims, feed 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 AC Sepa FO Cell. *Prior to operating or servicing this device, this manual must be read and understood.*

Table 1: AC Sepa FO Features and Technical Specification

Parameter	Description
Membrane Active Area	140 cm ² (22-inch ²)
Hold-Up Volume	70 ml (2.4 ounces)
Maximum Operating Pressure	15 bar (220 psig)
Maximum Temperature: Acrylic Cell Body	88 °C (190.4 °F)
Maximum Bolts Torque Setting	45 (in-lbs)
Maximum Fittings Torque Setting	25 (in-lbs)
O-rings	Viton (Other materials available)
pH Range	Membrane Dependent
Cross Flow Velocity	Variable
Dimensions	
Slot Depth	1.9 mm (0.075 inches)
Slot Width	95.3 mm (3.75 inches)

1.1 ADDITIONAL EQUIPMENT

The AC Sepa FO Cell also requires additional equipment to be operated, which are sold separately:

- Feed/Draw Pump
- Feed/Draw Tank
- Filtration membrane packs
- Assortments of shims and additional spacers
- Pressure control valve
- Pressure gauge
- Modified Osmosis Insert*

* *Modified Osmosis Insert is an accessory (sold separately) that is redesigned for experiments where a differential pressure is applied to the membrane sides, such as in a PRO process or an assisted FO process.*

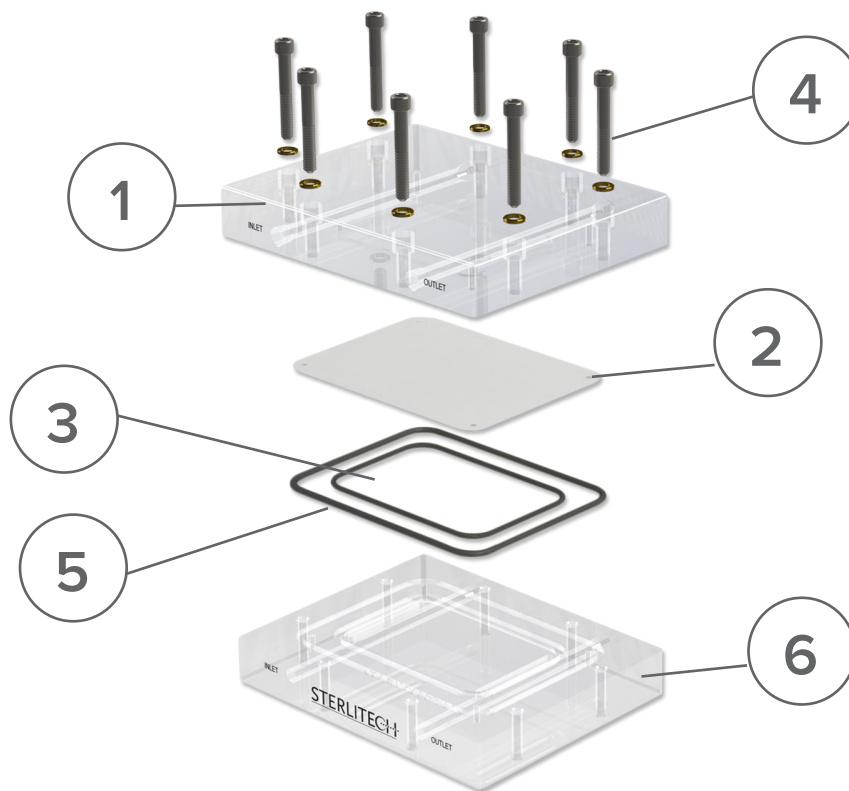
2. AC SEPA FO CELL ASSEMBLY

After verifying that all of the necessary components were shipped and present, you can begin the assembly of the AC Sepa FO Cell.

2.1 CELL BODY ASSEMBLY

The cell body consists of the cell top, membrane filter, feed spacer/ permeate carriers (optional), shims (optional), O-rings, and cell bottom. **Figure 1** illustrates a typical assembly of the cell body.

Figure 1: Typical AC Sepa FO Cell Body Assembly



LEGEND:

1. Cell Top
2. Membrane
3. Inner O-ring
4. Tightening Screws/Brass Washers
5. Outer O-ring
6. Cell Bottom

To assemble the AC Sepa FO Cell Body:

1. 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 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.

2. [Optional] Install the feed spacer into the central cavity, on top of the shims/Modified Osmosis Insert. The feed spacer must lie flat and be fully contained within the cavity.



Note: The feed spacer and the permeate carrier look similar and are cut in the same size. The permeate carrier is thinner and has a tight weave, while the feed spacer has large gridding.

3. Place a pre-cut membrane over the feed spacer using the four guideposts to hold the membrane in position. The membrane should be installed with the active side down toward the feed solution in an FO process and with the active side up toward the draw solution in a PRO process.



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.

4. [Optional] Wet the permeate carrier with water (or the fluid to be processed) and place it into the cavity in the cell top. The surface tension caused by wetting the carrier will keep it in place.



5. Complete the assembly of the cell body by placing the cell top onto the cell bottom. The alignment holes in the top should fit snugly over the alignment pins in the cell bottom.

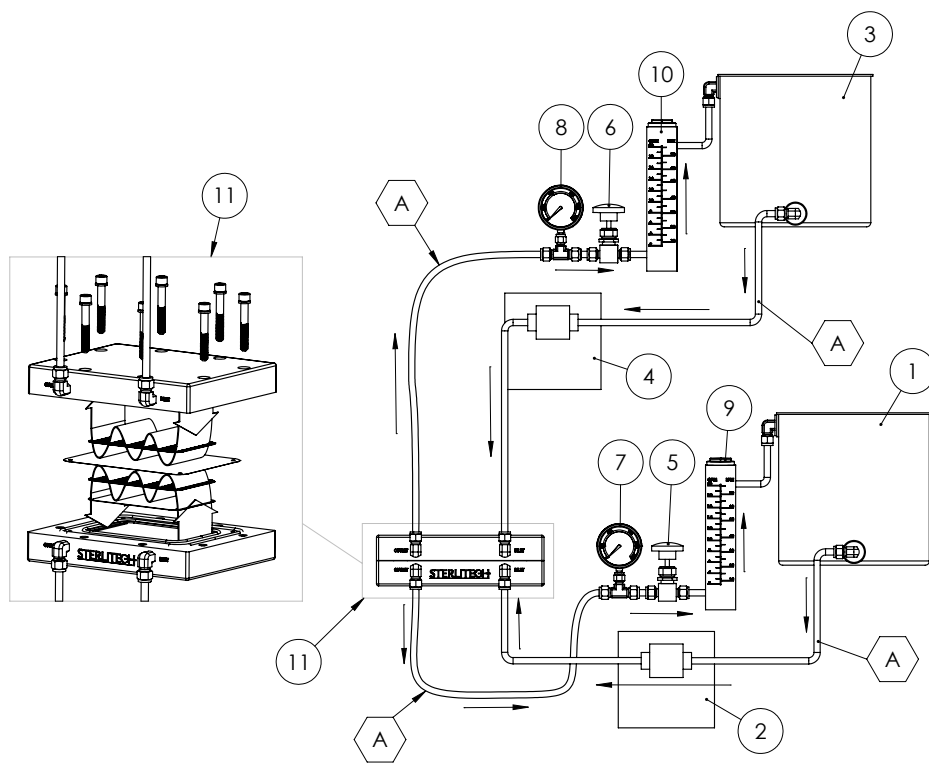


3. AC SEPA FO CELL CONNECTIONS AND PARTS

Figure 2 shows typical plumbing connections that need to be made for the operation of the AC SEPA FO Cell. The configuration can change slightly depending on the objectives of the user. 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 AC Sepa FO Flow Diagram



Acrylic Sepa FO Flow Diagram	
Item No.	Part Description
1	Feed Tank
2	Feed Pump
3	Draw Solution Tank
4	Draw Solution Pump
5	Concentrate Control Valve
6	Draw Solution Pressure Control Valve
7	Concentrate Pressure Gauge
8	Draw Solution Pressure Gauge
9	Concentrate Flow Meter
10	Draw Solution Flow Meter
11	Acrylic Sepa FO Cell Assembly
A	3/8" Low Pressure Tubing



Figure 2 also lists the additional components that are necessary to operate the AC Sepa FO cell. These components are sold separately and can be found in the Membrane/ Process Development section of the Sterlitech website (<http://www.sterlitech.com/membrane-process-development.html>). The final assembly of the forward osmosis system will vary with the feed vessels, pumps, and tubing used.

A. To connect the feed tank to the feed pump:

1. Attach a fitting for 3/8" nylon tubing to the feed pump.

***Caution:** Nylon tubing is rated for operations less than 250 psig (17.2 bar). High-pressure tubing must be used for the connection between the pump outlet and the feed inlet if the Sepa FO is being operated at higher pressures.*

2. Once the fitting is in place, insert the tubing firmly into the open end. The tubing should sit in the fitting and should be easily removable.
3. Connect the 3/8" nylon tubing from the outlet of the feed pump to the inlet of the feed tank.

B. To connect the feed pump to the feed inlet of the cell body:

1. Connect a length of 3/8" nylon tubing from the outlet of the pump to the feed inlet of the cell body. A flow meter (sold separately) can be installed between the outlet of the pump and the inlet of the cell body.

C. To connect the feed outlet of the cell body to the concentrate collection tank (or feed tank):

1. Connect a length of 3/8" nylon tubing from the feed outlet of the cell to a concentrate collection tank or back to the feed tank. A pressure control valve and a pressure gauge (sold separately) can be installed between the outlet of the cell and the inlet of the concentrate collection tank (or feed tank).

D. To connect the draw solution tank to the draw solution pump:

1. Attach a fitting for 3/8" nylon tubing to the draw solution pump.
2. Once the fitting is in place, insert the tubing firmly into the open end. The tubing should sit in the fitting and should be easily removable.
3. Connect the 3/8" nylon tubing from the outlet of the draw solution tank to the inlet of the pump.

- E.** To connect the draw solution pump to the draw solution inlet of the cell body:
 - 1. Connect a length of 3/8" nylon tubing from the outlet of the pump to the draw solution inlet of the cell body. A flow meter (sold separately) can be installed between the outlet of the pump and the inlet of the cell body.

- F.** To connect the draw solution outlet of the cell body to the draw solution collection tank:
 - 1. Connect a length of 3/8" nylon tubing from the draw solution outlet of the cell into a draw solution collection tank. A pressure control valve and a pressure gauge (sold separately) can be installed between the outlet of the cell and the inlet of the draw solution collection tank (or the draw solution tank).

4. OPERATION OF THE AC SEPA FO CELL

Once the AC Sepa FO Cell has been assembled and connected to a feed system, it can be used in variety of applications that includes forward osmosis and pressure retarded osmosis.

To operate the AC Sepa FO Cell:

1. Turn the feed and draw solution pump on.
2. Adjust the control valves (sold separately) to obtain the desired pressure and flow for feed and draw solution. 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 pumps OFF.
2. Separate the cell body top from the cell bottom.
3. Remove the membrane.
4. Install the new membrane (and, if necessary, spacers/permeate carrier).
5. Reassemble the cell top and bottom.
6. Tighten the screws.
7. Turn the flow pumps on.

5. SUPPLEMENTARY OPERATING INFORMATION

5.1 MEMBRANE PERFORMANCE

Other parameters such as viscosity, pressure, and suspended solids may also affect performance/operation. Experimentation with the AC Sepa FO 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.

5.2 TEMPERATURE LIMITS

The membranes, feed spacer, permeate, O-rings, and cell body materials construction dictates maximum operating temperatures.

Table 2: Upper Temperature Limits

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

6. ACCESSORY AND SPARE PART ORDERING INFORMATION

Accessories and spare parts for the AC Sepa FO Cell can be ordered by calling Sterlitech Corporation at 1-877-544-4420 or by visiting www.sterlitech.com.

Table 3: Accessory and Spare Part Ordering Information

Product	Shipping Weight	Ordering Number
Sepa Cell, Forward Osmosis, Acrylic	7 kg (3.1 lbs)	1160007
Feed/Draw Flow Pump	Contact Sterlitech	Contact Sterlitech
Accessories		
Permeate Carrier Pack (PP)	0.5 kg (1 lb)	1142817
34 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
65 mil Feed Spacer (PP, 5/pack)	0.5 kg (1 lb)	1142819
Feed Spacer Assortment Pack (PP): 17, 31, 47, and 65 mil¹	0.5 kg (1 lb)	1232558
Shims (12 total/pack):		
<ul style="list-style-type: none"> • 4 of 2 mil • 4 of 5 mil • 2 of 10 mil • 1 of 15 mil • 1 of 25 mil 	0.5 kg (1 lb)	1231104
Modified Osmosis Insert (SS316)		1230036
Spare Parts		
Viton O-rings	28g (1 oz)	1143205
Back Pressure Control Valve, 0-400 psi²	0.9 kg (2 lbs)	1149428

¹Other materials and sizes are available. Contact Sterlitech Corporation for more information.

²Other pressure ranges available.

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.

APPENDIX 1: SEPA FO CELL APPLICATIONS

The following studies utilized the cross flow FO Cell in their method and are listed here to illustrate the potential applications for the cross flow FO. These studies are good references for understanding the operation of the AC Sepa FO Cell.

APPLICATION	STUDY CITATION
Forward Osmosis and Low Pressure Reverse Osmosis	Yangali-Quintanilla, Victor, Zhenyu Li, et al. "Indirect desalination of Red Sea water with forward osmosis and low pressure reverse osmosis for water reuse." <i>Desalination</i> . 280. (2011): 160-166.
Forward Osmosis	Andrea Achillia, Tzahi Y. Cathb, Amy E. Childress Selection of inorganic-based draw solutions for forward osmosis applications, <i>Journal of Membrane Science</i> 364 (2010) 233–241.
Forward Osmosis	Cath, T. Y., Elimelech, M., McCutcheon, J. R., MCGinnis, R. L., Achilli, A., Anastasio, D., Brady, A. R., Childress, A. E., Farr, I. V., Hancock, N. T., Lampi, J., Nghiem, L. D., Xie, M. & Yip, N. Yin. (2013). Standard methodology for evaluating membrane performance in osmotically driven membrane processes. <i>Desalination</i> , 312 (N/A), 31-38.

APPENDIX 2: STERLITECH BENCH SCALE FILTRATION PRODUCTS

	Discoverer	Innovator	Explorer	Developer	Investigator
					
	HP4750(X)	CF016	CF042	Sepa	1812
Filter Holder					
Membrane Active Area	14.6 cm ² (2.26 in ²)	20.6 cm ² (3.2 in ²)	42 cm ² (6.5 in ²)	140 cm ² (24 in ²)	0.27-0.46 m ² (3-5 ft ²)
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) 1.8 GPM (1,100 psi)	6.8 LPM (76 bar) 1.8 GPM (1,100 psi)	6.8 LPM (76 bar) 1.8 GPM (1,100 psi)	6.8-38 LPM (76 bar) 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) HP4750X: 172 bar (2,500 psi)	PTFE/Acrylic: 276 bar (400 psi) Delrin/SS316/Hastelloy™: 69 bar (1,000 psi)	PTFE/Acrylic: 276 bar (400 psi) Delrin/SS316/Hastelloy™: 69 bar (1,000 psi)	Acrylic: 276 bar (400 psi) 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

Sales Inquiries
sales@sterlitech.com

Accounts Payable
AP@sterlitech.com

Accounts Receivable
AR@sterlitech.com

Press Inquiries
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