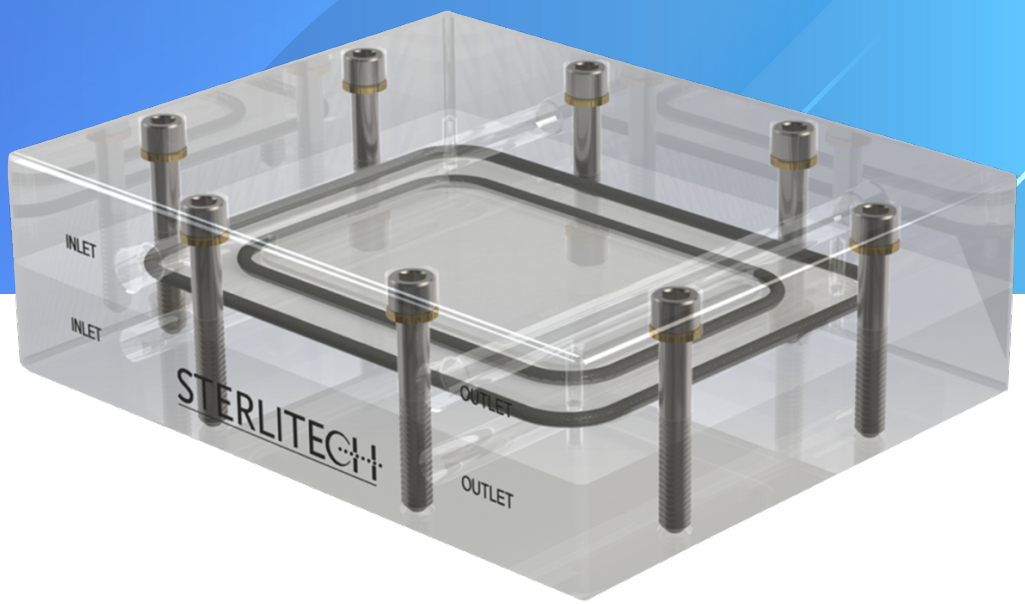
STERLITECH
Corporation

Membrane Distillation Cell
Assembly & Operation Manual



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1. Introduction

The 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, feed spacers, and membranes, users can vary the operating conditions and fluid dynamics over broad ranges.

Table 1 below outlines the operational parameters and technical specifications of the Membrane Distillation Cell.

Table 1: Membrane Distillation Cell Features and Specifications

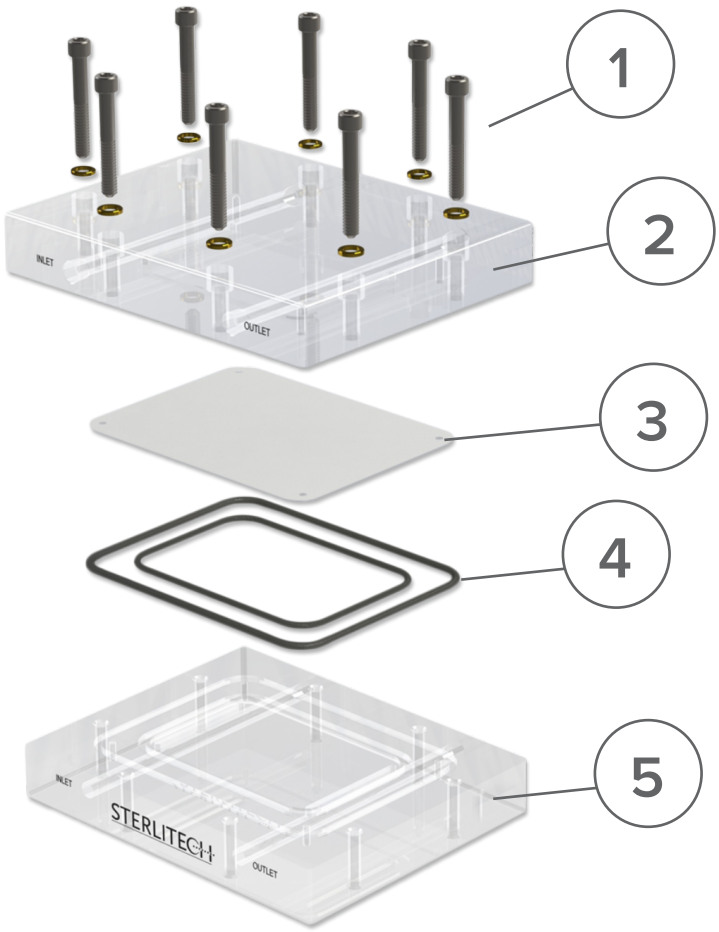
Parameter	Description
Membrane Active Area	140 cm^2 (22-$inch^2$)
Hold-Up Volume	70 ml (2.4 ounces)
Maximum Pressure	27 bar (400 psig)
Maximum Temperature	88 °C (190.4 °F)
Maximum Bolts Torque Setting	45 (in-lbs)
O-rings	Viton (Other materials available)
pH Range	Membrane Dependent
Cross Flow Velocity	Variable
Dimensions	Variable
Slot Depth	1.9 mm (0.075 inches)
Slot Width	146 mm (5.750 inches)

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

2. Membrane Distillation Cell Components

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

Figure 1: Membrane Distillation Cell



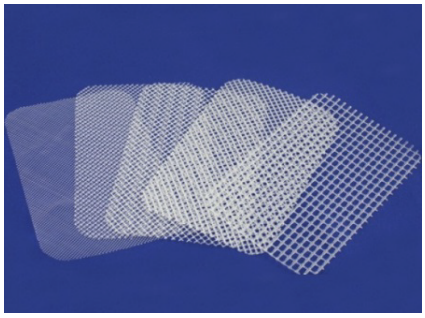
The complete Membrane Distillation Cell illustrated in **Figure 1** includes:

1. Fastening bolts and washers
2. Acrylic Cell Top Plate
3. Membrane
4. Inner and Outer O-rings
5. Acrylic Bottom Plate

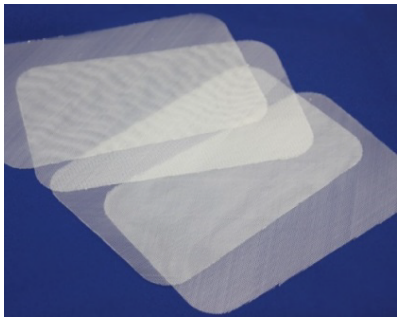
2.1. Additional Equipment

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

1. Feed Spacers



2. Permeate Carriers



3. Concentrate/Back pressure control valve with high pressure gauge

5. Feed pump
6. Feed tank
7. Cooling solution pump
8. Cooling solution tank
9. Membrane filter packs
10. Assortment of shims and additional spacers
11. Temperature controller for feed and cooling solution
12. Scales for measuring weight change for feed or cooling solution

3. Membrane Distillation Cell Assembly

After verifying that all of the necessary components were shipped and present, you can begin the assembly of the Membrane Distillation Cell.

3.1. Cell Body Assembly

The cell body consists of the cell top, permeate carrier, feed spacer, shims, O-rings, cell bottom,
and concentrate control valve. Figure 1 illustrates a typical assembly of the cell body.

To assemble the Membrane Distillation Cell Body:

1. Connect the concentrate/back 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 a maximum of 25 inch-pounds of torque.
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.

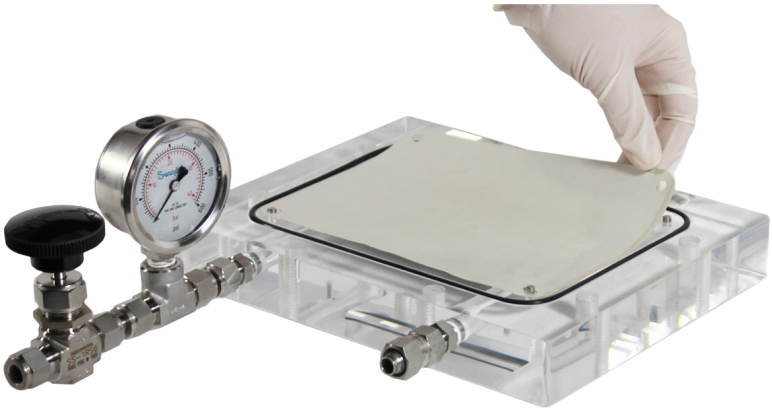
4. Install the feed spacer into the central cavity, on top of the shim. The feed spacer must lie flat and be fully contained within the cavity.

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.

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

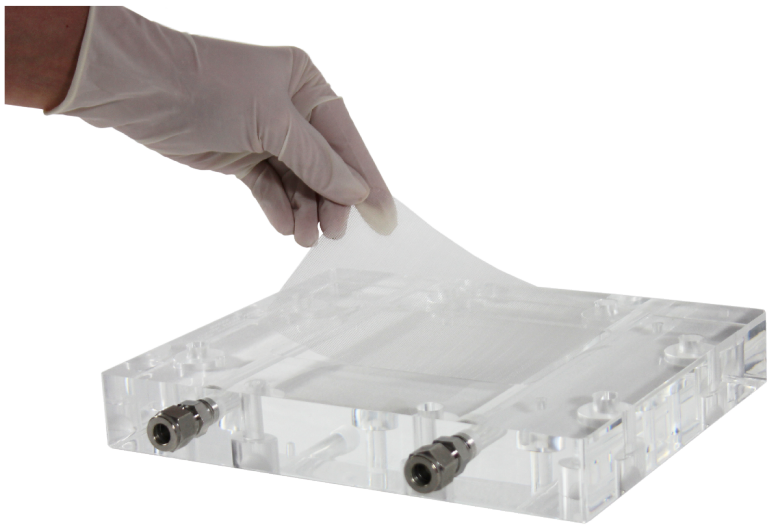
Note: The feed spacer and the permeate carrier look similar and are cut in the same size. The permeate carrier is thinner and has a tight weave while the feed spacer has large gridding.

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

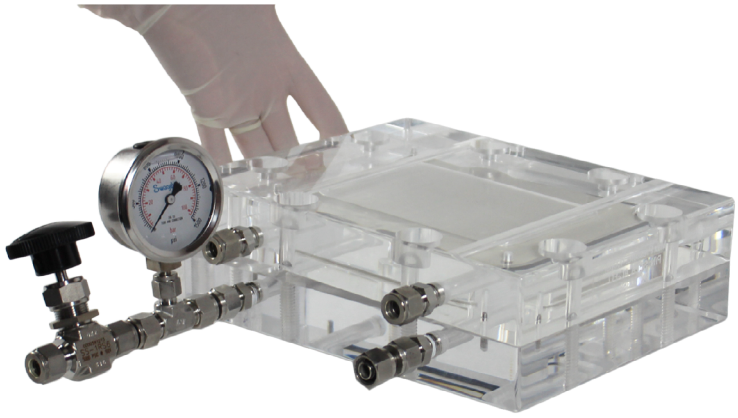


Note: The feed spacer and the permeate carrier look similar and are cut in the same size. The permeate carrier is thinner and has a tight weave while the feed spacer has large gridding.

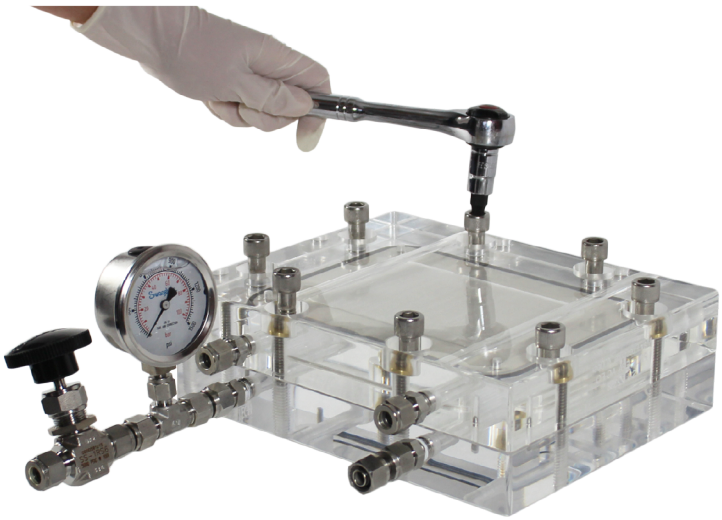
7. Wet a permeate carrier or a feed spacer with water or the fluid to be processed and place it into the cavity in the cell top. The surface tension caused by wetting the carrier will keep it in place.



8. 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.



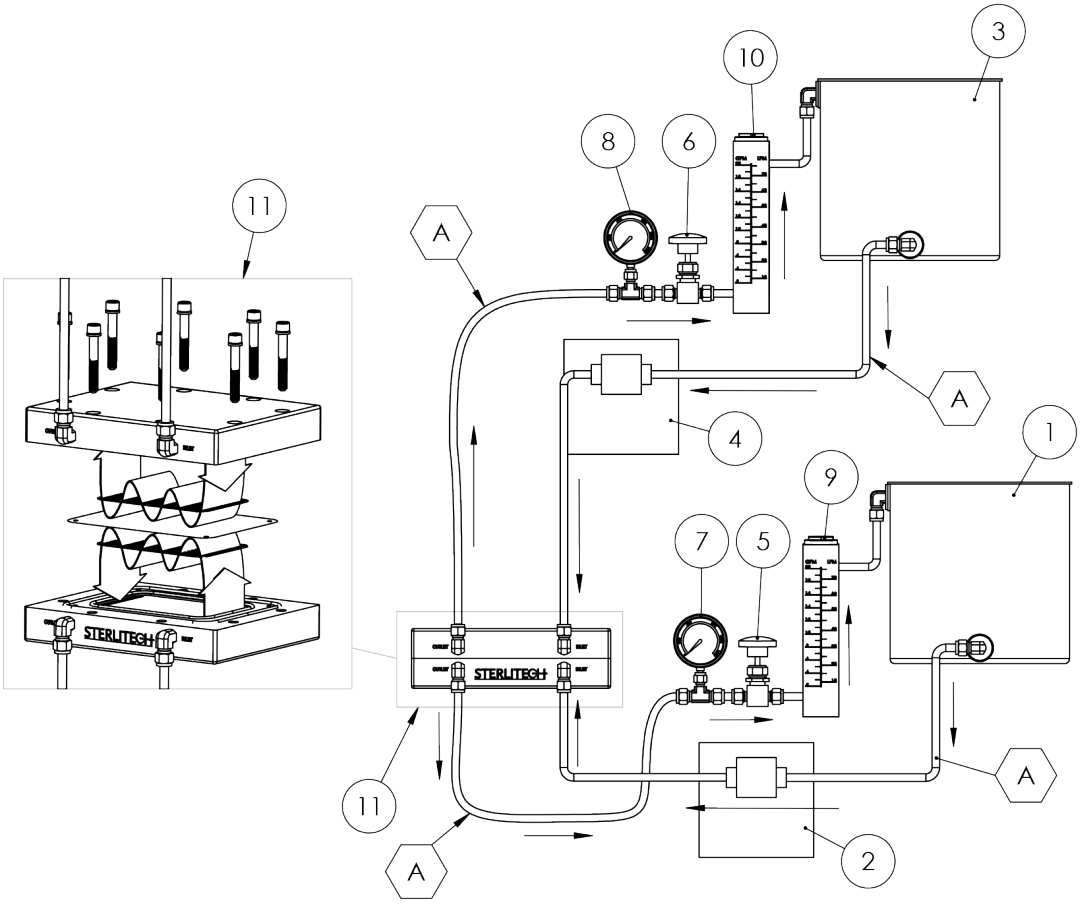
9. Put the washers and bolts in and tighten the bolts using an Allen/Hex Key.



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. Membrane Distillation Cell Connections and Parts

Figure 2: Example Membrane Distillation Cell Flow Diagram embrane Distillation Cell



Direct Contact Membrane Distillation Flow Diagram

Item No.	Part Description
1	Feed Tank
2	Feed Pump
3	Cooling Solution Tank
4	Cooling Solution Pump
5	Concentrate Control Valve
6	Cooling Solution Pressure Gauge
7	Concentrate Pressure Gauge
8	Cooling Solution Pressure Pump
9	Concentrate Flow Meter
10	Cooling Solution Flow Meter
11	Direct Contact Membrane Distillation Cell Assembly
A	3/8” Low Pressure Tubing

Figure 2 shows typical plumbing connections that need to be made for the operation of the Membrane Distillation Cell. The configuration can change slightly depending on the objectives of the user. In general, the connections to be made are:

1. Feed vessel to the pump inlet
2. Pump outlet to the feed inlet of the cell body
3. Concentrate flow control valve to the feed vessel
4. Cooling solution tank to the pump inlet
5. Pump outlet to the cooling solution inlet of the cell body
6. Cooling solution control valve to the cooling solution tank

Figure 2 also lists the additional components that are necessary to operate the Membrane Distillation 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) and are listed in Section 6. The final assembly of the membrane distillation system will vary with the feed vessels, pumps, and tubing used.

4. Operation of the Membrane Distillation Cell

Once the Membrane Distillation Cell has been assembled and connected to a feed system, it can be used in variety of applications that includes reverse osmosis, ultrafiltration, nanofiltration, and microfiltration.

To operate the Membrane Distillation Cell:

1. Turn the feed/cooling solution flow pump on.

2. 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).

3. 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. Separate the cell body top from the cell bottom.

3. Remove the membrane.

4. Remove the permeate carrier, if necessary.

Note: Typically the feed spacer/permeate carrier do not have to be removed.

5. Install the new membrane (and, if necessary, a new permeate carrier).

6. Reassemble the cell top and bottom.

7. Turn the feed flow pump on.

5. Supplemental 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, feed spacer, permeate, 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 Element:	Variable
Feed Spacer:	82 °C (180 °F)
O-rings	82 °C (180 °F)
Viton	200 °C (400 °F)
EPDM	150 °C (300 °F)

5.4. Temperature Limits

The 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 recirculate the cleaning solutions.

6. Accessory and Spare Part Ordering Information

Accessories and spare parts for the Membrane Distillation 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
Membrane Distillation Cell, for operation to 27 bar (400psig)	11.85 lbs (5.4 kg)	1160035
Feed/Cooling Solution Flow Pump	Contact Sterlitech	Contact Sterlitech
Accessories		
Permeate Carrier Pack	0.5 kg (1 lb)	1142817
17 mil Feed Spacer (5/pack)	0.5 kg (1 lb)	1142816
31 mil Feed Spacer (5/pack)	0.5 kg (1 lb)	1142818
47 mil Feed Spacer (5/pack)	0.5 kg (1 lb)	1143763
47 mil Parallel Feed Spacer (5/pack)	0.5 kg (1 lb)	1142814
65 mil Feed Spacer (5/pack)	0.5 kg (1 lb)	1142819
Feed Spacer Assortment Pack 17, 31, 47, and 65 mil	0.5 kg (1 lb)	1232558
Shims (12 total/pack):	0.5 kg (1 lb)	1231104
• 4 of 2 mil		
• 4 of 5 mil		
• 2 of 10 mil		
• 1 of 15 mil		
• 1 of 25 mil		
Spare Parts		
Viton O-rings	28kg (1 oz)	1143205
Concentrate/Back Pressure Control Valve (0-400 psi)	0.9 kg (2 lbs)	1149428
Membrane Packs		
Visit www.sterlitech.com for membrane ordering information.		

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. Membrane Distillation 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 inquires about our products by calling Sterlitech Corporation at 1-877-544-4420 or by visiting www.sterlitech.com.

Appendix 1: Membrane Distillation Cell Applications

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

Application	Study Citation
Direct Contact Membrane Distillation	Kezia, Kezia et al. "Direct contact membrane distillation for the concentration of saline dairy effluent ." Water Research. 81. (2015): 167-177.
Direct Contact Membrane Distillation	Manawi, Yehia M. et al. "Effect of operational parameters on distillate flux in direct contact membrane distillation (DCMD): Comparison between experimental and model predicted performance "Desalination. 336. (2014): 110-120.
Direct Contact Membrane Distillation	Alkhudhiri Abdullah et al. " Membrane distillation: A comprehensive review ."Desalination. 287 (2012): 2-18.

Notes:

Notes:

Founded in 2001 in Kent, WA, Sterlitech Corporation manufactures and markets filtrationfocused 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.

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