Duratherm* EXL Series

FACT SHEET

High Temperature Operation and High Pressure Spiral Wound Membranes



The Duratherm EXL Series spiral wound membranes are specifically designed to maximize the benefits of continuous high temperature operation, high operating pressures, as well as being designed to withstand the high temperatures utilized in hot water sanitization in industries seeking to maximize energy recovery and use hot purified water. Hot water sanitization is common in industries that rely on chemical free sanitization for product quality and/or industry compliance standards. The Duratherm EXL Series includes reverse osmosis (RO) and nanofiltration (NF) spiral wound membranes.

The Duratherm EXL Series are suitable for separation systems purifying water at operating temperatures up to 70°C (158°F) or up to 1,200 psi (8,273 kPa) in a low crossflow environment and with no suspended solids.

Further, the Duratherm EXL Series is able to be used in a separation system where the sanitization protocol is performed via periodic exposure to temperature as high as 90°C (194°F) at minimum feed pressure. The high temperature during the sanitization protocol kills microorganisms by denaturation and coagulation of the proteins chains. This sanitization protocol reduces site chemical costs as well as allows sanitization on the permeate side of the spiral wound membrane while not damaging the spiral wound membrane.

All models are designed for durability and include a cage outer wrap, polysulfone anti-telescoping devices (ATDs), and a polysulfone central tube.

Typical Applications

- Food & Beverage
- Biopharmaceuticals
- Electronics
- Chemical

Table 1: Specifications

Membrane	Thin-film membrane (TFM)

Model	Maximum Crossflow gpm (m^3/hr)	Recommended Crossflow	Salt Rejection
Duratherm EXL RO2540HR	8 (1.8)		Figure 2
Duratherm EXL RO8040HR	100 (22.7)	Figure 7	Figure 2
Duratherm EXL NF2540HR	8 (1.8)		Figure 3, 4 & 5
Duratherm EXL NF4040HR	40 (9.1)	Figure 6	Figure 3, 4 & 5
Duratherm EXL NF8040HR	100 (22.7)	Figure 7	Figure 3, 4 & 5
Duratherm EXL NF4040	40 (9.1)	Figure 6	Figure 3, 4 & 5
Duratherm EXL NF8040	100 (22.7)	Figure 7	Figure 3, 4 & 5
Duratherm EXL UF2 4040	NA	NA	2,500 MWCO
Duratherm EXL UF2 8040	NA	NA	2,500 MWCO

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Table 2: Properties (1)

Model	Feed Spacer mil (mm)	Active Area ft^2 (m^2)	Part Number
Duratherm EXL RO2540HR	50 (1.27)	18 (1.7)	1228306
Duratherm EXL RO8040HR	50 (1.27)	275 (25.5)	1228840
Duratherm EXL NF2540HR	50 (1.27)	18 (1.7)	1206922
Duratherm EXL NF4040HR	50 (1.27)	65 (6.0)	1206950
Duratherm EXL NF4040	50 (1.27)	65 (6.0)	1207032
Duratherm EXL NF8040HR	50 (1.27)	280 (26.0)	1206982
Duratherm EXL NF8040	50 (1.27)	280 (26.0)	1207045
Duratherm EXL UF2 4040	50 (1.27)	65 (6.0)	3156050
Duratherm EXL UF2 8040	50 (1.27)	280 (26.0)	3002290

(1) Spiral wound membrane properties and parameters are indicative numbers. Specific values by spiral wound membrane may vary within normal manufacturing tolerances.

Table 3: Maximum Pressure Drops

Range	0°C-50°C psig (kPa)	51°C-70°C psig (kPa)
Over an element	15 (103)	7 (48)
Per housing	60 (414)	30 (207)

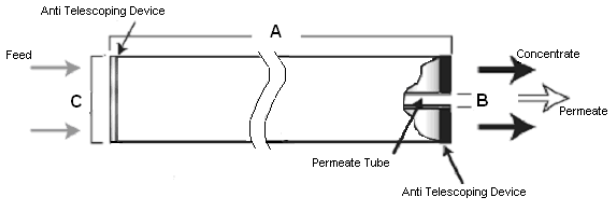

Figure 1: Dimensions Diagram for Duratherm EXL Series Models with 4040 and 8040 Designations

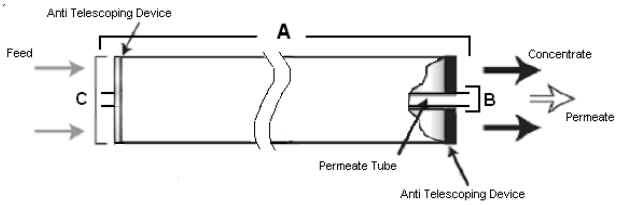

Figure 2: Dimensions Diagram for Duratherm EXL Series Models with 2540 Designation

Table 4: Dimensions and Weight (1)

Model		Dimensions, inches (cm)			Boxed Weight lbs (kg)
	Figure	A	B^2	C^3	
EXL 2540	2	40.0 (101.6)	0.75 (1.91)	2.43 (6.17)	4 (1.8)
EXL 4040	1	40.0 (101.6)	0.625 (1.59)	3.9 (9.9)	9 (4.1)
EXL 8040	1	40.0 (101.6)	1.125 (2.86)	7.9 (20.1)	29 (13.2)

(2) Internal diameter.
(3) The spiral wound membrane diameter (dimension C) is designed for optimum performance in Veolia pressure vessels. Others pressure vessel dimension and tolerance may result in excessive bypass and loss of capacity.

Table 5: Operating Pressure

Do not exceed 20 GFD (33 LMH) or 2,000 Wagner units under any circumstance.

Typical Operating Pressure	Figures 9 & 10	
Maximum Operating Pressure	1,200 psi (8,273 kPa)	32 – 77°F (0 – 25°C)
	600 psi (4,137 kPa)	78 – 122°F (26 – 50°C)
	400 psi (2,758 kPa)	123 – 158°F (51 – 70°C)
	Hot Water Sanitization	158 – 194°F (70 – 90°C)

Table 6: Operating and CIP Parameters (1)

Model	pH Range for Continuous Operation	Chlorine Tolerance	Feed Water
Duratherm EXL RO HR	2.0 - 11.0	1,000 ppm-hours (4)	NTU < 1 SDI < 5
Duratherm EXL NF HR	3.0 - 9.0	500 ppm-hours (4)	NTU < 1 SDI < 5
Duratherm EXL NF	3.0 - 9.0	500 ppm-hours (4)	NTU < 1 SDI < 5
Duratherm EXL UF2	2.0 - 11.0	5,000+ ppm-days	NTU < 1 SDI < 5

(4) Dechlorination recommended

Table 7a: Clean-In-Place Temperature and pH Range for Duratherm EXL Series RO and UF Models

Maximum Clean-In-Place Temperature	pH Minimum	pH Maximum
122°F (50°C)	2.0	11.5
113°F (45°C)	1.5	11.5
95°F (35°C)	1.5	11.5
77°F (25°C)	1.0	12.0

Table 7b: Clean-In-Place Temperature and pH Range for Duratherm EXL Series NF Models

Maximum Clean-In-Place Temperature	pH Minimum	pH Maximum
113°F (45°C)	3.0	9.0
95°F (35°C)	3.0	10.0
68°F (20°C)	3.0	11.0

Hot Water Sanitization Recommendations

Prior to first use, new spiral wound membranes must be flushed with clean water[1] to remove any residual chemicals for at least an hour, at a transmembrane pressure of not more than 45 psi (3 bar). The system must be started and in operation for minimum 24 hours prior to hot water sanitization.

If the new spiral wound membranes are to be hot water sanitized before first use, the system must be flushed at low transmembrane pressure (up to 45 psi (3 bar)), for minimum 24 hours prior to sanitization.

Transmembrane pressure during hot water sanitization should also be maintained as low as possible, not exceeding 45 psi (3 bar), while ensuring some permeate flow for effective sanitization on the permeate side.

The cross flow to the system should be monitored and adjusted so that the pressure drop is not more than 2 psi per spiral wound membrane or 10 psi per housing.

The following procedure should be followed step by step for the hot water sanitization of Duratherm EXL spiral wound membranes.

1. The spiral wound membranes that have been in operation should be cleaned with approved Clean In Place (CIP) procedure to remove any mineral scales or organic foulants, and then be thoroughly flushed for at least an hour before sanitization.
2. Increase the temperature in the system from room temperature to target sanitization temperature[2] (up to 90°C/194°F) at a rate not higher than 5°C/9°F per minute. Maintain the target temperature for 30 to 60 minutes.
3. Cool the system to room temperature at a rate not higher than 5°C/9°F per minute.

[1]RO permeate is strongly preferred when available. Feedwater which does not foul or form scale on membrane can also be used but only after appropriate filtration. Note that the solubility of some inorganics, for example calcium carbonate and at least above 45°C calcium sulfate, decreases with increasing temperature.

[2]The effectiveness of heat sanitization is a function of temperature and time. Duratherm EXL spiral wound membranes can withstand 90°C hot water sustained for over 60 minutes, but there is no gain by maintaining the high temperature for longer time than needed to deactivate the microbes that will be deactivated at the chosen temperature.

Loss of Permeate Flow After Repeated 90ºC (194ºF) Sanitization Cycles

It is almost impossible to exactly predict the percentage of permeate flow rate lost from the high temperature sanitations, which among other factors depends on:

- The rate of temperature increase and decrease.
- The presence of other species like organics, ionic and metallic compounds that could locally decrease or increase the temperature at the surface of the membrane.

- The feed flow rate and specifically the heat transfer rate to the membrane surface.
- The thickness and geometry of the feed spacer used.

At optimum conditions measured in controlled environment with deionized water, between 30% and 50% of the original permeate flow rate was lost before the spiral wound membrane performance had stabilized after repeated heat treatments (over 90% of this flow reduction occurred during the first heat treatment). With the loss of permeate flow rate, the salt rejection increases. The rate of cooling and heating was not more than 5°C (9ºF) per minute, and the differential pressure drop per spiral wound membrane did not exceed 2 psi.

Pilot testing based on the criteria noted above will give the best operating parameters for any specific application.

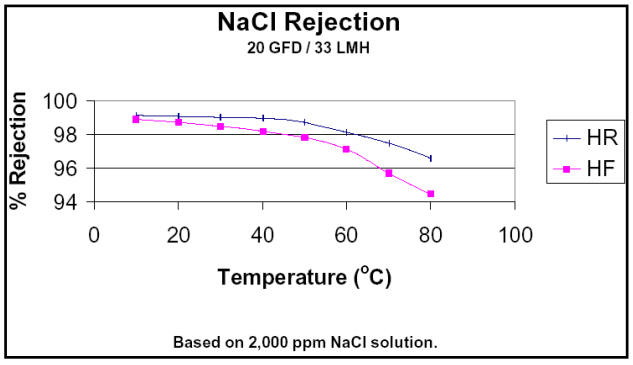

Figure 3: Typical NaCl Rejection dependence on Temperature of Duratherm EXL RO

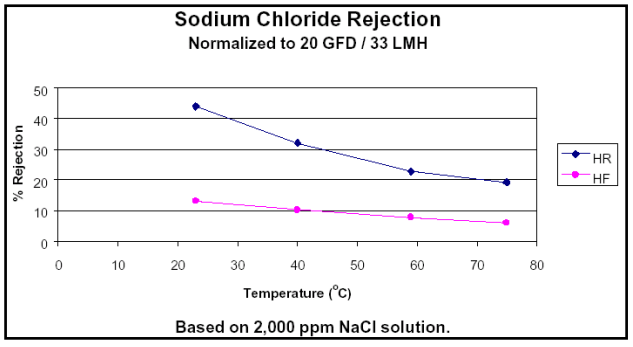

Figure 4: Typical NaCl Rejection dependence on Temperature of Duratherm EXL NF

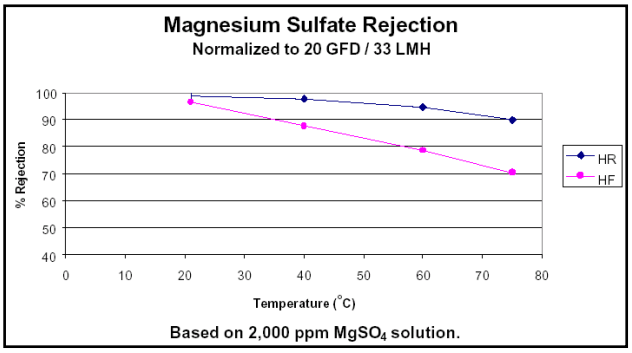

Figure 5: Typical $MgSO_4$ Rejection dependence on Temperature of Duratherm EXL NF

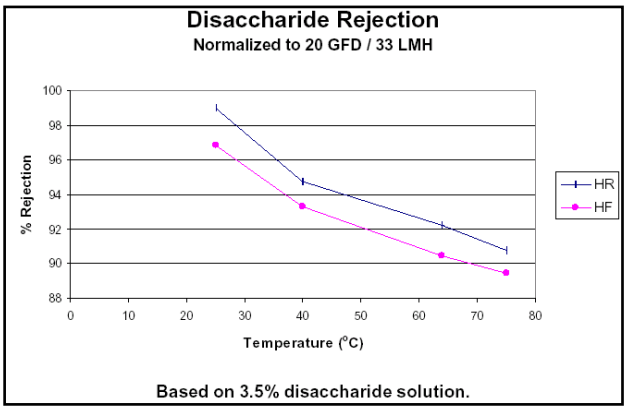

Figure 6: Typical Disaccharide Rejection dependence on Temperature of Duratherm EXL NF

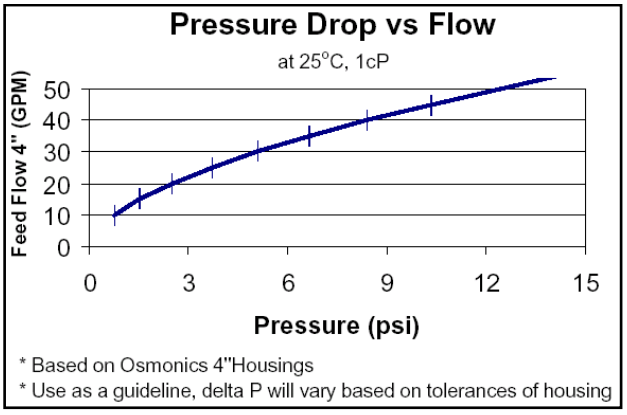

Figure 7: Pressure Drop for 4"

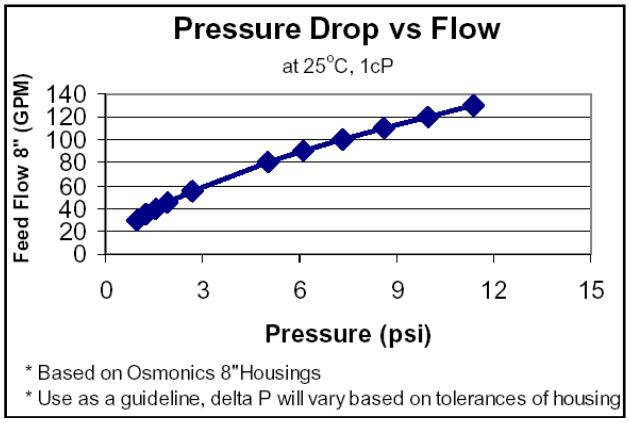

Figure 8: Pressure Drop for 8"

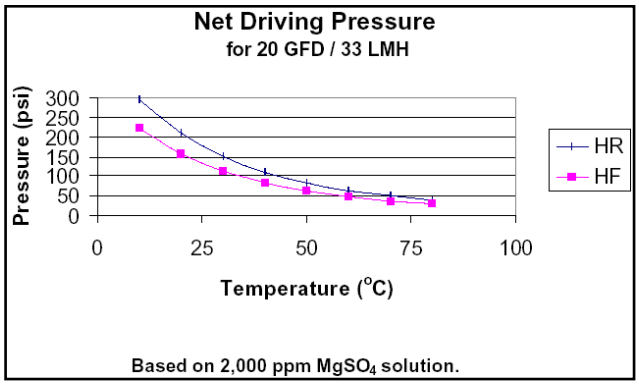

Figure 9: Net Driving Pressure for Duratherm EXL RO

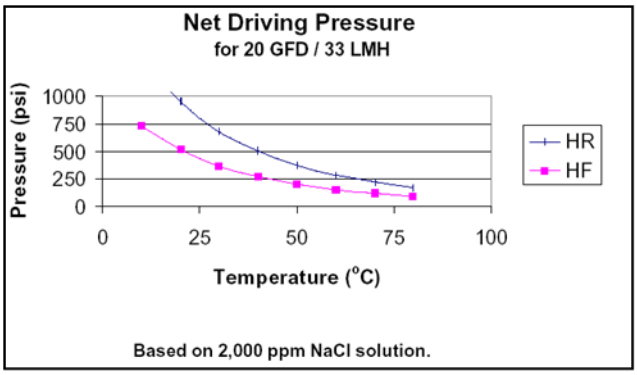

Figure 10: Net Driving Pressure for Duratherm EXL NF

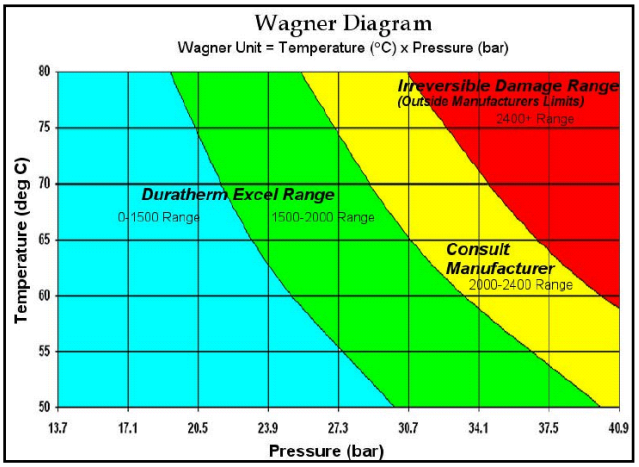

Figure 11: Wagner Diagram

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