Dow
Water Solutions

FILMTEC™ Membranes

Product Information Catalog

Form No. 609-00204-1108

FILMTEC™ Membranes

FILMTEC™ Membranes

1. Product Overview

- Brackish Water Product Portfolio
- Seawater Product Portfolio

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FILMTEC™ Membranes
Brackish Water Product Portfolio

The Highest Quality Water at the Lowest Total Cost

FILMTEC™ reverse osmosis membrane elements from Dow are engineered to meet the varying needs of a wide range of industrial, municipal, commercial and drinking water applications. Our advanced manufacturing technologies ensure that FILMTEC membranes always deliver unmatched performance and productivity as well as the highest quality and consistency available.

Whatever your water treatment system requirements, FILMTEC elements can help you deliver the highest quality water at the lowest total cost. Based on extensive research and testing of FILMTEC and competitive membranes, we've engineered our brackish product line to meet precise cost and performance targets while optimizing both capital and operating costs.

FILMTEC™ Brackish Water Elements – Performance Data

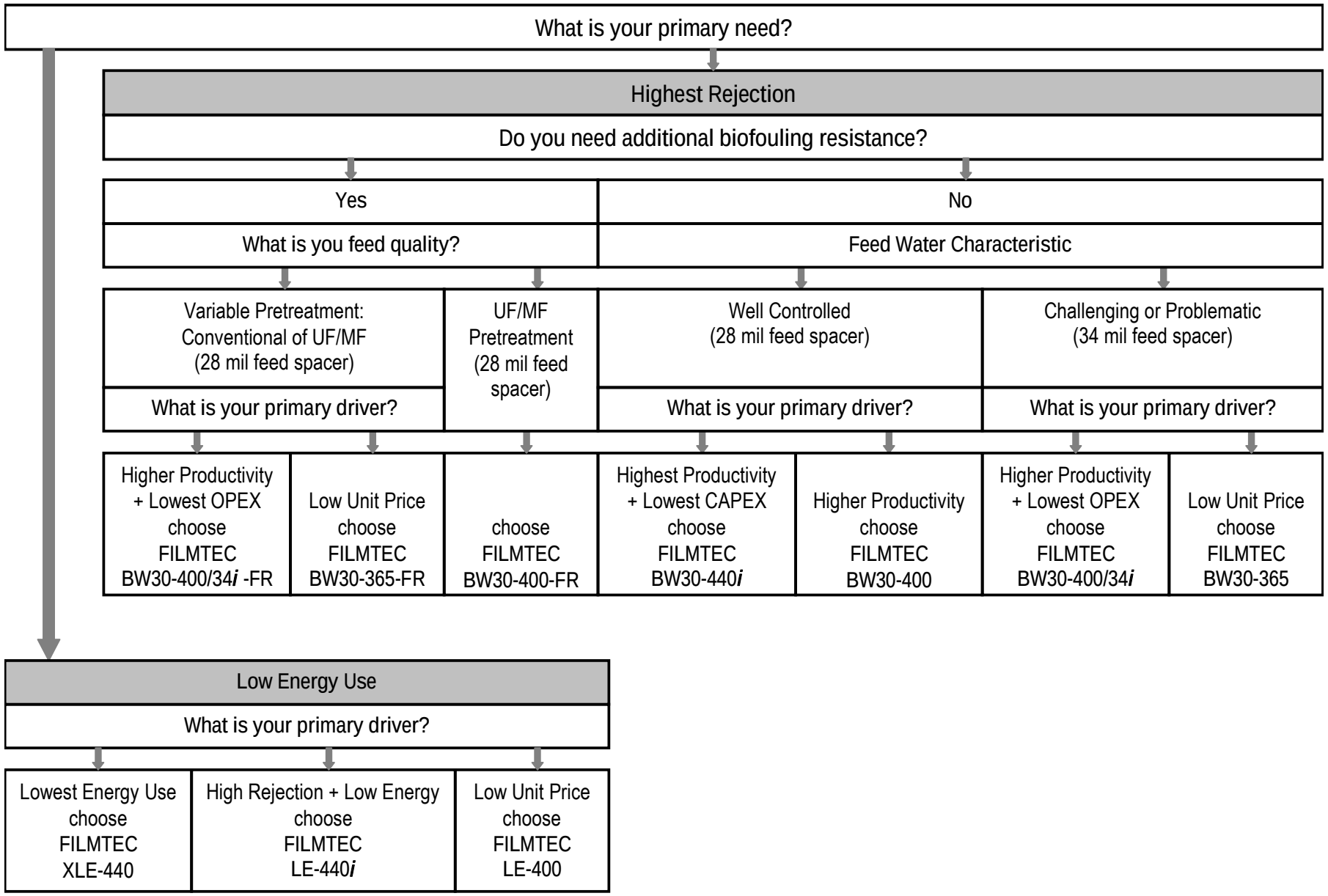
		Performance Attributes					Construction Features					Reliability Features			
		Feed Pressure (psi)	Flow Rate (gpd)	Stabilized Rejection (%)	Highest Cleanability	Fouling Resistant Membrane	*i*LEC ™ Interlocking Endcaps	34 mil Feed Spacer	28 mil Feed Spacer	Active Area (ft²)	Permeate Tube I.D. (in.)	Durable FT30 Membrane	pH 1-13 Cleaning Range	Automated Construction	Guaranteed Active Area
Highest Rejection	BW30-440*i*	225	11,500	99.5			■		■	440	1.125	■	■	■	■
	BW30-400/34*i*	225	10,500	99.5	■		■	■		400	1.125	■	■	■	■
	BW30-400	225	10,500	99.5					■	400	1.125	■	■	■	■
	BW30-365	225	9,500	99.5	■			■		365	1.125	■	■	■	■
Low Energy	LE-440*i*	150	12,650	99.3			■		■	440	1.125	■	■	■	■
	LE-400	150	11,500	99.3					■	400	1.125	■	■	■	■
	XLE-440	100	12,700	99.0					■	440	1.5	■	■	■	■
Fouling Resistant	BW30-400/34*i* -FR	225	10,500	99.5	■	■	■	■		400	1.125	■	■	■	■
	BW30-400-FR	225	10,500	99.5	■	■			■	400	1.125	■	■	■	■
	BW30-365-FR	225	9,500	99.5	■	■		■		365	1.125	■	■	■	■

BW30-Permeate flow and salt rejection for BW30 elements based on the following standard conditions: 2,000 ppm NaCl, 225 psi (15.5 bar), 77◦F (25◦C), pH 8 and 15% recovery.

LE-Permeate flow and salt rejection for LE elements based on the following standard conditions: 2,000 ppm NaCl, 150 psi (10.3 bar), 77◦F (25◦C), pH 8 and 15% recovery.

XLE-Permeate flow and salt rejection for XLE elements based on the following standard conditions: 500 ppm NaCl, 100 psi (6.9 bar), 77◦F (25◦C), pH 8 and 15% recovery.

FILMTEC™ Brackish Water Product Selection Guide



Benefits of FILMTEC™ Brackish Membrane Elements

Each and every FILMTEC™ element uses precision engineered FILMTEC membrane combined with our exclusive automated element fabrication method resulting in the most consistent product performance available. Automated fabrication allows us to deliver the highest active area without compromising feed spacer thickness or outer hard-shell thickness. FILMTEC elements are constructed with a greater number of shorter membrane leaves compared with competitive elements, thereby reducing the overall effect of fouling, maximizing membrane efficiency and lowering the cost of operation. In addition, FILMTEC elements deliver high performance over their operating lifetimes without the use of oxidative post-treatments like many competitive products, offering greater durability and more effective cleaning over a wider pH range (1-13) than other elements.

Our precision engineered products deliver these additional, specialized benefits:

Highest Rejection RO Elements

FILMTEC BW30-440*i* element

The FILMTEC BW30-440***i*** element is a high-productivity element combining the highest active membrane area in the industry with the high rejection BW30 membrane. It is designed to minimize capital expenses in high-purity industrial water applications without increasing operating flux.

- Produces 10% more water compared to the FILMTEC BW30-400 element at the same operating pressure and high rejection, enabling lower capital expense for new systems, or increased water production in an existing system.
- Includes ***i****LEC*™ interlocking endcaps, which reduce system operating costs and the risk of o-ring leaks that can cause poor water quality.
- Designed using an industry standard 1.125 inch ID permeate tube for interchangeability with other brackish water elements.

FILMTEC BW30-400/34*i* element

The FILMTEC BW30-400/34***i*** element is the ultimate element for durable, high-rejection, high-productivity performance in high fouling or challenging feed conditions, enabling trouble-free operation and a low cost of water.

- Features a 34 mil feed spacer to lessen the impact of fouling on pressure drop across a vessel and enhance cleaning effectiveness.
- Offers the proven performance and high productivity of the FILMTEC BW30 membrane
- Delivers a lower total cost of water by enabling lower capital and/or operating expenses compared to 365 sq. ft. elements.
- Includes ***i****LEC* interlocking endcaps, which reduce system operating costs and the risk of o-ring leaks that can cause poor water quality.

Benefits of FILMTEC™ Brackish Membrane Elements (cont.)

FILMTEC™ BW30-400 element

This proven, industry-recognized element delivers high-rejection performance value, enabling capital savings when used in new equipment or increased productivity when used as a replacement element.

Compared to 365 sq. ft. elements:

- Lower capital expense when used in new equipment.
- 10% higher flow when used as replacement elements.

FILMTEC BW30-365 element

This element offers proven performance, high rejection and outstanding robustness and durability across a wide range of feed conditions where unit price is a key driver.

- Features a 34 mil feed spacer that resists fouling and enables more effective cleaning.
- Decades of success in industrial water applications.

Low-Energy RO Elements

FILMTEC LE-440*i* element

The FILMTEC LE-440***i*** element is a low-energy element featuring the highest active membrane area in the industry. It enables high productivity and low energy operation, while maintaining high-rejection performance, minimizing operating expense and lowering the total cost of water for industrial and municipal applications.

- Delivers the same permeate flow at an equivalent operating flux at 40% lower feed pressure, compared to the FILMTEC BW30-440***i*** element.
- Offers permeate flow rate 10 percent higher while producing similar permeate quality than that of the FILMTEC LE-400 element, enabling the lowest total cost of water in high-purity industrial applications.
- Includes ***i****LEC*™ interlocking endcaps, which reduce system operating costs and the risk of o-ring leaks that cause poor water quality.
- Designed using an industry standard 1.125 inch ID permeate tube for interchangeability with other brackish water elements.

FILMTEC LE-400 element

The FILMTEC LE-400 element is a low-energy element for industrial and municipal applications that operates at low pressure to deliver energy savings in new equipment or replacement situations where energy cost is an important factor and unit price is a key driver.

- Delivers equivalent permeate flow at 40% lower feed pressure, compared to the FILMTEC BW30-400.
- Offers the proven performance and high productivity of the FILMTEC BW30-400 element construction, with lower energy use and operating expense.
- The new FILMTEC LE-400 has an industry standard 1.125 inch ID permeate tube to facilitate element replacement.

Benefits of FILMTEC™ Brackish Membrane Elements (cont.)

FILMTEC™ XLE-440 element

The lowest-energy, highest active membrane area element available today for municipal or second pass seawater applications.

- Enables lowest total cost of water (where permeate TDS requirements are less stringent) through lowest capital and operating expenses.
- Delivers equivalent permeate flow at less than half the feed pressure of FILMTEC BW30-440***i*** elements.

Fouling Resistant Elements

All FILMTEC Fouling resistant elements feature FilmTec's proprietary surface modification of the FT30 membrane that lowers membrane fouling, reduces average system operating pressure and extends membrane life in high biofouling feed waters.

FILMTEC BW30-400/34***i***-FR

An optimized element for durable, high integrity, high productivity performance to purify water with high biological or organic fouling tendency. Offers the best long-term economics and most trouble-free operation for systems with variable feed or pretreatment. Delivers a lower total cost of water by enabling lower capital and/or operating expenses compared to 365 sq. ft. elements. Features:

- A wide 34 mil feed spacer to lessen the impact of fouling and enhance cleaning effectiveness.
- 400 square feet active area for more productivity without increasing the operating flux.
- ***i****LEC*™ interlocking endcaps, which reduce system operating costs and the risk of o-ring leaks that compromise system integrity and cause poor water quality.

FILMTEC BW30-400-FR element

This industry-recognized element delivers proven fouling-resistant performance in large systems. Offers the best long-term economics and most trouble-free operation in systems with high biological or organic fouling potential and well-controlled pretreatment such as UF/MF.

- Features 400 square feet active area for more productivity without increasing the operating flux.

FILMTEC BW30-365-FR element

The industry standard for fouling-resistant performance in water reuse and industrial water applications, offering robustness for systems with variable feed or pretreatment.

- Features a 34 mil feed spacer to lessen the impact of fouling and enhance cleaning effectiveness.

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FILMTEC Membranes

Seawater Product Comparison Chart

The Highest Quality Desalination at the Lowest Total Cost

FILMTEC™ reverse osmosis membrane elements from Dow are engineered to precisely meet the varying needs of a wide range of industrial, municipal, commercial and drinking water applications. Our advanced manufacturing technologies ensure that FILMTEC membranes always deliver unmatched performance and productivity as well as the highest quality and consistency available.

Whatever your water treatment system requirements, FILMTEC elements can help you deliver the highest quality water at the lowest total cost. Based on extensive research and testing of FILMTEC and competitive membranes, we've re-engineered our seawater product line to meet precise cost and performance targets while optimizing both capital and operating costs.

FILMTEC™ Seawater Elements – Performance Data

	Performance Attributes						Construction Features				Reliability Features				
	Feed Pressure (psi)	Flow Rate (gpd)	Stabilized Salt Rejection (%)	Stabilized Boron Rejection (%)	Maximum Pressure (psi)	Highest Cleanability	*i*LEC™ Interlocking Endcaps	34 mil Feed Spacer	28 mil Feed Spacer	Active Area (ft^2)	1200 psi Feed Pressure	Durable FT30 Membrane	pH 1-12 Cleaning Range	Automated Construction	Guaranteed Active Area
SW30XLE-400*i* NEW	800	9,000	99.70	88	1,200		■		■	400	■	■	■	■	■
SW30HR LE-400*i* NEW	800	7,500	99.75	91	1,200		■		■	400	■	■	■	■	■
SW30HR LE-400	800	7,500	99.75	91	1,200				■	400	■	■	■	■	■
SW30HR-380	800	6,000	99.70	90	1,000				■	380		■	■	■	■
SW30HR-320	800	6,000	99.75	91	1,200	■		■		320	■	■	■	■	■

The above values are normalized to the following conditions: 32,000 ppm NaCl, 5 ppm boron, 800 psi (5.5 MPa), 77˚F (25˚C), pH 8 and 8% recovery.

Are you working with high fouling feedwater?

Yes

Choose
FILMTEC SW30HR-320

No

What is your primary driver?

Low Energy

Lowest Energy Use
Choose
FILMTEC SW30XLE-400*i*

Low Energy Use + High Rejection
Choose
FILMTEC SW30HR LE-400*i*

Highest Rejection

One Pass System
Choose
FILMTEC SW30HR-380

Two Pass System
Choose
FILMTEC SW30XLE-400*i*
(Combined with brackish water second pass)

Drop-in membrane replacement for existing 4,000-6,000 gpd elements

Competitive Replacement Guide

Use: **FILMTEC SW30XLE-400*i***	No equivalent
Use: **FILMTEC SW30HR LE-400*i***	To replace: TMA820-400 SU820BCM
Use: **FILMTEC SW30HR-380**	To replace: SWC3+ SWC4+ TMA820-370
Use: **FILMTEC SW30HR-320**	To replace: SWC3 SWC4 SU820 SU820L SU820FA

Benefits of FILMTEC Seawater Membrane Elements

Each and every FILMTEC element produced uses precision engineered FILMTEC membrane combined with our exclusive automated element fabrication method resulting in the most consistent product performance available. Automated fabrication allows us to deliver the highest active area without compromising feed spacer thickness and to construct FILMTEC elements with a greater number of shorter membrane leaves compared with competitive elements, thereby reducing the overall effect of fouling, maximizing membrane efficiency, and lowering the cost of operation. In addition, FILMTEC elements deliver high performance over their operating lifetimes without the use of oxidative post-treatments like many competitive products, offering greater durability and more effective cleaning over a wider pH range (1-12) than other elements.

Our precision engineered products deliver these additional, specialized benefits:

FILMTEC SW30XLE-400*i* element

- Delivers lowest total cost of water through an unequalled combination of productivity and rejection.
- Lowest energy seawater element available on the market, enabling lowest operation cost.
- Reduces operating costs through lowest energy consumption, or reduces capital costs through higher productivity and recovery
- Highest active area without compromising feed spacer or outer shell thickness.
- Ideal for two-pass seawater designs and high total dissolved solids (TDS) brackish water applications.
- Can be used in permeate staged seawater desalination systems without impairing the performance of the downstream stage.
- Includes *iLEC* interlocking endcaps, which reduce system operating costs and the risk of o-ring leaks that cause poor water quality.

FILMTEC SW30HR LE-400*i* element

- Offers combination of higher productivity and very high rejection to enable lower total costs with high salinity feedwater.
- Delivers highest NaCl and high boron rejection to help meet World Health Organization and other drinking water standards.
- Reduces capital costs through higher productivity and recovery, *or* reduces operating costs through lower energy consumption.
- Highest active area without compromising feed spacer or outer shell thickness.
- Can be used in permeate-staged seawater desalination systems without impairing the performance of the downstream stages.
- Includes *iLEC* interlocking endcaps, which reduce system operating costs and the risk of o-ring leaks that cause poor water quality.

FILMTEC SW30HR-380

- High productivity and high rejection with high active area.
- Years of proven performance as the industry standard seawater element.
- Delivers the highest boron rejection to help meet World Health Organization and other drinking water standards and is ideally suited for single pass systems.

Benefits of FILMTEC Seawater Membrane Elements (cont.)

FILMTEC SW30HR-320

- High productivity, very high rejection.
- Designed to lower component economics.
- Effectively treats feedwater that has high fouling potential.
- Features a 34 mil feed spacer to lessen the impact of fouling and enhance cleaning capability.
- Can be used in permeate-staged seawater desalination systems without impairing the performance of the downstream stage.

FILMTEC™ Membranes

2. Tapwater Elements

- FILMTEC Home Drinking Water Elements
- FILMTEC High Flow 100 Gallons Per Day Drinking Water Element
- FILMTEC Small Commercial Elements
- FILMTEC Tape-Wrapped 2540 Elements for Commercial Applications
- FILMTEC Tape-Wrapped 4040 Elements for Commercial Applications
- FILMTEC Extra Low Energy (XLE) Elements for Commercial Systems

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FILMTEC™ Membranes

FILMTEC Home Drinking Water RO Elements

Features

FILMTEC™ reverse osmosis (RO) membrane elements for home drinking water are the industry's most reliable. Advanced membrane technology and automated fabrication allow these elements to deliver consistent performance that equipment suppliers, water treatment dealers and residential customers can rely on. FILMTEC elements are shipped dry for convenient handling and long shelf-life. These elements are NSF/ANSI Standard 58 listed. Equipment suppliers can take advantage of FilmTec's Standard 58 listing and participation in the NSF Data Transfer Protocol to reduce costs for reduction claims for their systems.

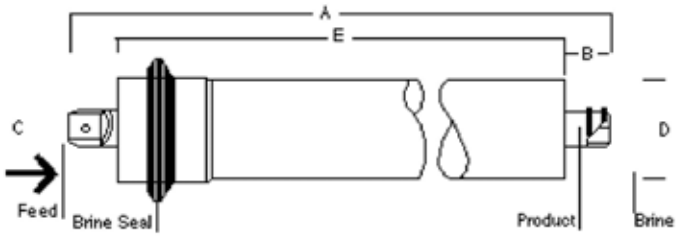
FILMTEC home drinking water elements are rated a 50 psi and will purify about 20% more water than competitive elements rated at 60 psi (please see reference charts on page two for more information).

Product Specifications

Product	Part Number	Applied Pressure psig (bar)	Permeate Flow Rate gpd (l/h)	Stabilized Salt Rejection (%)
TW30-1812-24	93430	50 (3.4)	24 (3.8)	98
TW30-1812-36	80719	50 (3.4)	36 (5.7)	98
TW30-1812-50	80722	50 (3.4)	50 (7.9)	98
TW30-1812-75	114731	50 (3.4)	75 (12)	98

1. Permeate flow and salt rejection based on the following test conditions: 250 ppm softened tapwater, 77°F (25°C), 15% recovery and the specified applied pressure.
2. Minimum salt rejection is 96.0%.
3. Permeate flows for individual elements may vary +/-20%.
4. For ease of installation, element o-rings have been pre-lubricated with glycerin.

Figure 1



COMPONENT
Tested and Certified to
ANSI/NSF Standard 58

Product	Dimensions – Inches (mm) A	B	C	D	E
TW30-1812	11.74 (298)	0.87 (22)	0.68 (17)	1.75 (44.5)	10.0 (254)

1. TW30-1812 Home Drinking Water Elements fit nominal 2-inch I.D. pressure vessels.

1 inch = 25.4 mm

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature	113°F (45°C)
• Maximum Operating Pressure	300 psig (21 bar)
• Maximum Feed Flow Rate	2.0 gpm (7.6 lpm)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Silt Density Index (SDI)	5
• Free Chlorine Tolerance[c]	< 0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Figure 2. Impact of Pressure on Permeate Flow (constant temperature, recovery)

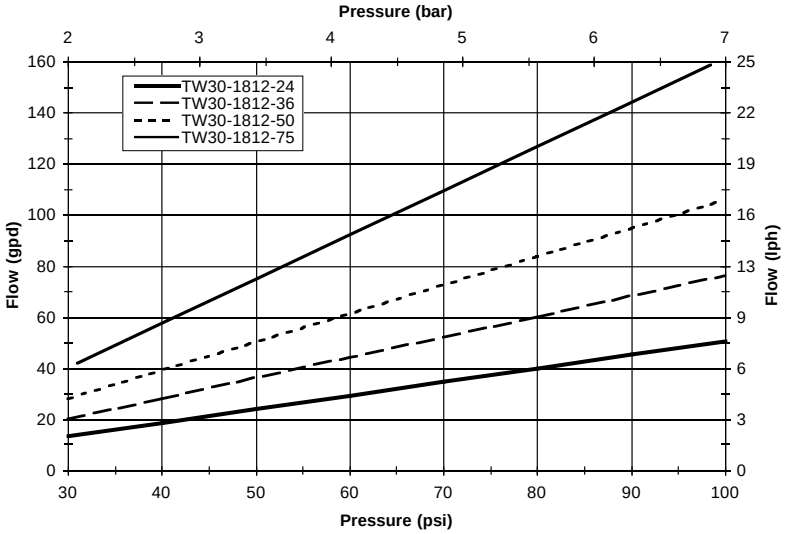
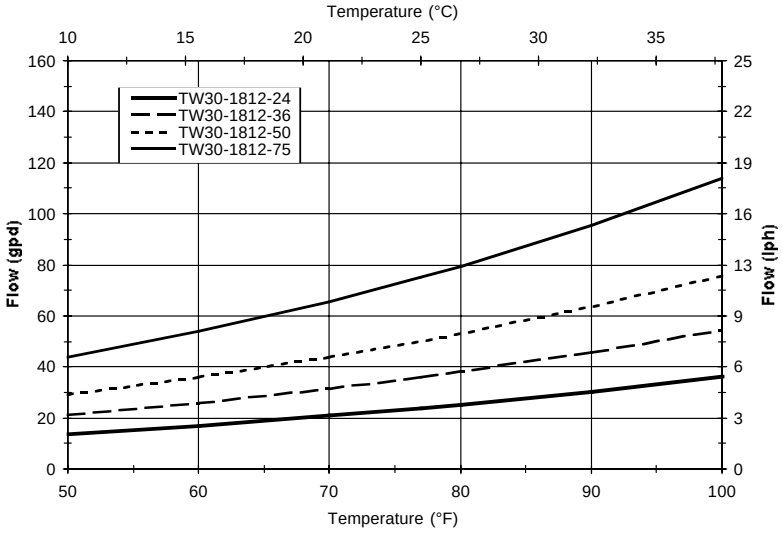


Figure 3. Impact of Temperature on Permeate Flow (constant pressure, recovery)



General Information

- The first full tank of permeate should be discarded. Do not use this initial permeate for drinking water or food preparation.
- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The membrane shows some resistance to short-term attack by chlorine (hypochlorite). Continuous exposure, however, may damage the membrane and should be avoided.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements. Their use will void the element limited warranty.

Note: These elements have not been through the French approval process for use in potable water.

Notice: The use of this product in and of itself does not necessarily guarantee the removal of cysts and pathogens from water. Effective cyst and pathogen reduction is dependent on the complete system design and on the operation and maintenance of the system.

Notice: No freedom from any patent owned by Seller or others is to be inferred. Because use conditions and applicable laws may differ from one location to another and may change with time, Customer is responsible for determining whether products and the information in this document are appropriate for Customer's use and for ensuring that Customer's workplace and disposal practices are in compliance with applicable laws and other governmental enactments. Seller assumes no obligation or liability for the information in this document. NO WARRANTIES ARE GIVEN; ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY EXCLUDED.

FILMTEC™ Membranes

FILMTEC High Flow 100 Gallons Per Day Drinking Water Element

Features

FILMTEC™ reverse osmosis membrane elements for home drinking water are the industry's most reliable. Advanced membrane technology and automated fabrication allow these elements to deliver consistent performance that equipment suppliers, water treatment dealers and residential customers can rely on. FILMTEC elements are shipped dry for convenient handling and long shelf-life.

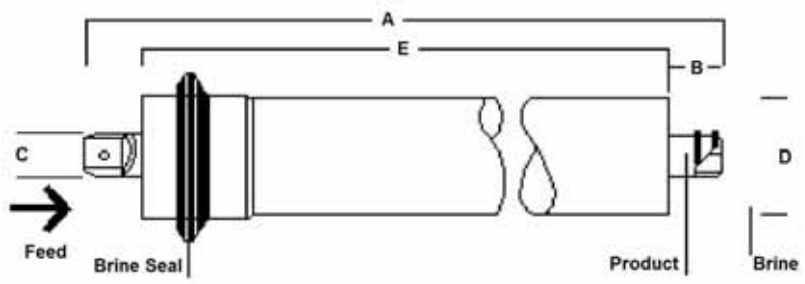
FILMTEC TW30-1812-100 is rated a 50 psi and will purify about 20% more water than competitive elements rated at 60 psi.

Product Specifications

Product	Part Number	Applied Pressure psig (bar)	Permeate Flow Rate gpd (l/h)	Stabilized Salt Rejection (%)
TW30-1812-100	170102	50 (3.4)	100 (16)	90

1. Permeate flow and salt rejection based on the following test conditions: 250 ppm softened tapwater, 77°F (25°C), 15% recovery and the specified applied pressure.
2. Minimum salt rejection is 90.0%.
3. Permeate flows for individual elements may vary +/-20%.
4. Product specifications may vary slightly as improvements are implemented.
5. For ease of installation, element o-rings have been pre-lubricated with glycerin.

Figure 1



Product	Dimensions – Inches (mm) A	B	C	D	E
TW30-1812-100	11.74 (298)	0.87 (22)	0.68 (17)	1.80 (45.7)	10.0 (254)

1. TW30-1812-100 elements fit nominal 2-inch I.D. pressure vessel.

1 inch = 25.4 mm

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature	113°F (45°C)
• Maximum Operating Pressure	300 psig (21 bar)
• Maximum Feed Flow Rate	2.0 gpm (7.6 lpm)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Silt Density Index (SDI)	5
• Free Chlorine Tolerance[c]	< 0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Figure 2. Impact of Pressure on Permeate Flow (constant temperature, recovery)

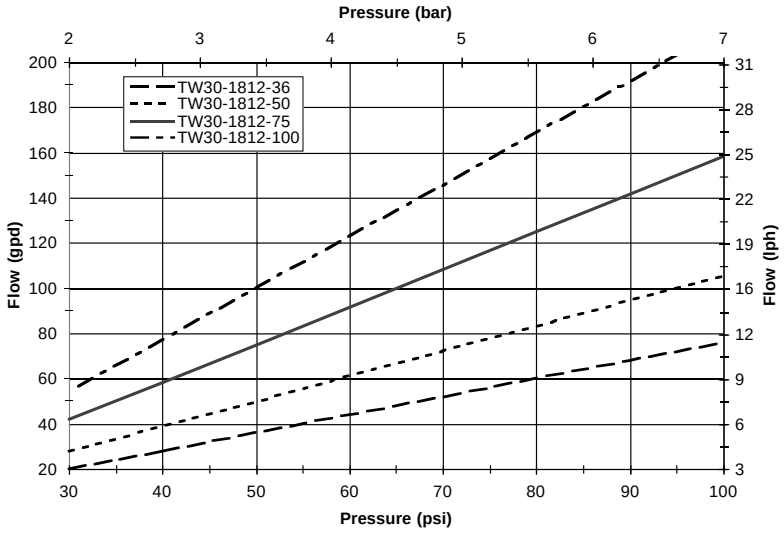
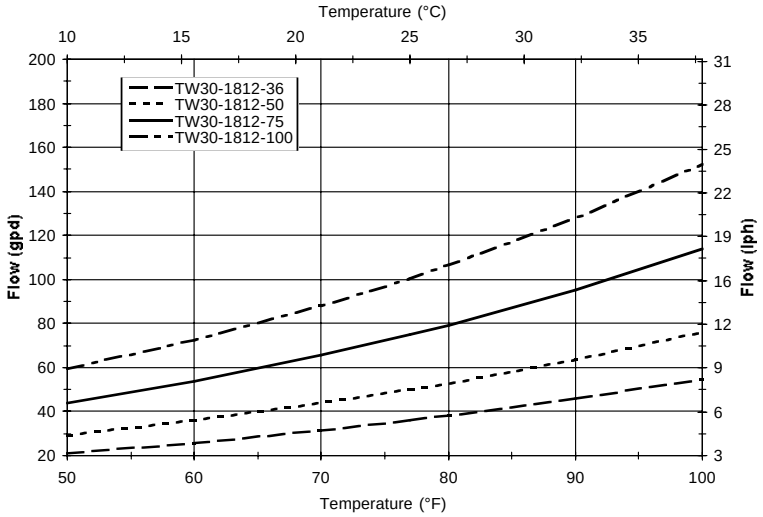


Figure 3. Impact of Temperature on Permeate Flow (constant pressure, recovery)



For information about other FILMTEC™ home drinking water elements, please refer to specification sheet 609-09010 or go to www.filmtec.com.

General Information

- The first full tank of permeate should be discarded. Do not use this initial permeate for drinking water or food preparation.
- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The membrane shows some resistance to short-term attack by chlorine (hypochlorite). Continuous exposure, however, may damage the membrane and should be avoided.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements. Their use will void the element limited warranty.

Note: These elements have not been through the French approval process for use in potable water.

Notice: The use of this product in and of itself does not necessarily guarantee the removal of cysts and pathogens from water. Effective cyst and pathogen reduction is dependent on the complete system design and on the operation and maintenance of the system.

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FILMTEC™ Membranes

FILMTEC Small Commercial Elements

Features

FILMTEC™ reverse osmosis (RO) elements offer the highest quality water for small commercial systems purifying less than one gallon per minute (0.2 m^3/d) of RO water.

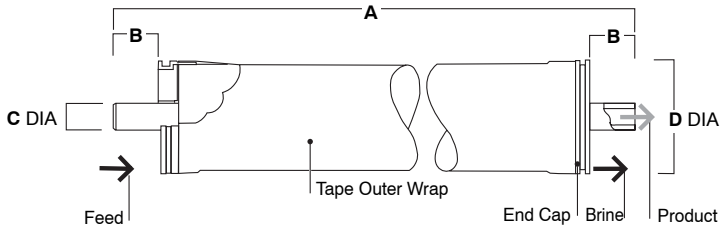
- FILMTEC membranes are available in a variety of sizes to meet a wide range of space requirements.
- FILMTEC XLE extra low energy elements operate at the lowest pressure in the industry, resulting in lower energy costs and enabling system builders to use lower cost components.
- In addition to the highest quality water and the lowest energy costs, FILMTEC membranes also deliver savings by providing the industry's longest lasting and most reliable performance.

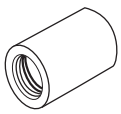
Product Specifications

Product	Part Number	Active Area ft^2 (m^2)	Applied Pressure psig (bar)	Permeate Flow Rate gpd (m^3/d)	Stabilized Salt Rejection (%)
TW30-2026	80635	7 (0.7)	225 (15.5)	220 (0.83)	99.5
TW30-2514	80639	7 (0.7)	225 (15.5)	200 (0.76)	99.5
TW30-2521	80641	13 (1.2)	225 (15.5)	325 (1.23)	99.5
XLE-2521	154530	13 (1.2)	100 (6.9)	365 (1.38)	99.0
TW30-4014	80605	20 (1.9)	225 (15.5)	525 (1.99)	99.5
TW30-4021	80608	36 (3.3)	225 (15.5)	900 (3.41)	99.5
XLE-4021	154540	36 (3.3)	100 (6.9)	1,025 (3.88)	99.0

1. Permeate flow and salt rejection based on the following test conditions: TW30 elements are tested on a 2,000 ppm NaCl feed stream, XLE performance based on a 500 ppm NaCl feed stream, pressure specified above, 77°F (25°C) and the following recovery rates; TW30-2026 – 10%, TW30-2521, XLE-2521, TW30-4021, XLE-4021 – 8%, TW30-2514, TW30-4014 – 5%.
2. Permeate flows for individual elements may vary +/-20%.
3. For the purpose of improvement, specifications may be updated periodically.

Figure 1





FilmTec sells coupler part number 89055 for use in multiple element housings. Each coupler includes two 2-210 EPR o-rings, FilmTec part number 89255. Note: couplers for 0.68 inch (17 mm) permeate tubes are not sold by FilmTec.

Product	Maximum Feed Flow Rate gpm (m^3/h)	Dimensions – Inches (mm) A	B	C	D
TW30-2026[1]	5 (1.1)	26.0 (660)	1.18 (30)	0.68 (17)	1.8 (46)
TW30-2514	6 (1.4)	14.0 (356)	1.19 (30)	0.75 (19)	2.4 (61)
TW30-2521	6 (1.4)	21.0 (533)	1.19 (30)	0.75 (19)	2.4 (61)
XLE-2521	6 (1.4)	21.0 (533)	1.19 (30)	0.75 (19)	2.4 (61)
TW30-4014	14 (3.2)	14.0 (356)	1.05 (27)	0.75 (19)	3.9 (99)
TW30-4021	14 (3.2)	21.0 (533)	1.05 (27)	0.75 (19)	3.9 (99)
XLE-4021	14 (3.2)	21.0 (533)	1.05 (27)	0.75 (19)	3.9 (99)

1. TW30-2026 has double o-rings on each end of the permeate tube. Couplers for 0.68 inch (17 mm) permeate tubes are not sold by FilmTec. 1 inch = 25.4 mm
2. Refer to FilmTec Design Guidelines for multiple-element systems.
3. TW30-2026 elements fit nominal 2.0 inch pressure vessels. TW30-2514, TW30-2521 and XLE-2521 elements fit nominal 2.5 inch I.D. pressure vessels. TW30-4014, TW30-4021, and XLE-4021 elements fit nominal 4 inch I.D. pressure vessels.

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature	113°F (45°C)
• Maximum Operating Pressure	600 psig (41 bar)
• Maximum Pressure Drop	13 psig (0.9 bar)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Silt Density Index (SDI)	5
• Free Chlorine Tolerance[c]	<0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 30 psi (2.1 bar).
- Avoid static permeate-side backpressure at all times.

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FILMTEC™ Membranes

FILMTEC Tape-Wrapped 2540 Elements for Commercial Applications

Features

A complete range of FILMTEC™ 2540-size elements is available to meet a wide variety of customer needs for commercial applications, from the highest purity water to the lowest total system costs.

- FILMTEC XLE-2540 is the most productive, lowest pressure RO membrane available, delivering the lowest total system cost.
- FILMTEC LP-2540 delivers high quality water at low pressure operation. The LP-2540 replaces many "first generation" low pressure membrane elements and will purify more water in many older systems, especially on cold water feeds.
- FILMTEC TW30-2540 is the industry standard for reliable operation and production of the highest quality water.

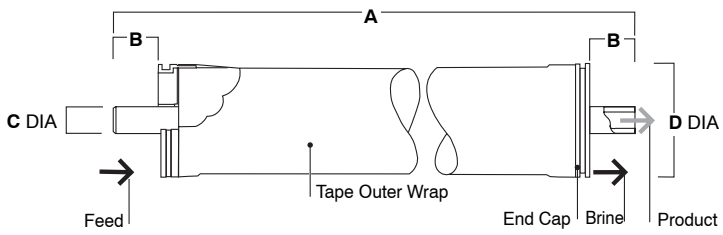
Tape-wrapped elements are built with the same high quality membranes and materials of construction as industrial elements, without the hard outershell. This makes them more economical for commerical systems with one or two elements per housing.

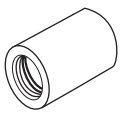
Product Specifications

Product	Part Number	Active Area ft^2 (m^2)	Feed Spacer Thickness (mil)	Permeate Flow Rate gpd (m^3/d)	Stabilized Salt Rejection (%)
XLE-2540	154543	28 (2.6)	28	850 (3.2)	99.0
LP-2540	231653	28 (2.6)	28	1,000 (3.8)	99.2
TW30-2540	80643	28 (2.6)	28	850 (3.2)	99.5

1. Permeate flow and salt rejection based on the following test conditions: 77°F (25°C), 15% recovery and applied pressure: 100 psig (6.9 bar) for XLE-2540, 145 psig (10 bar) for LP-2540 and 225 psig (15.5 bar) for TW30-2540. TW30-2540 is tested on a 2,000 ppm NaCl feed stream. LP-2540 and XLE-2540 are tested on a 500 ppm NaCl feed stream.
2. Permeate flows for individual elements may vary +/-20%.
3. LP-2540 can replace TW30HP-2540 for low pressure operation.
4. For the purpose of improvement, specifications may be updated periodically.

Figure 1





FilmTec sells coupler part number 89055 for use in multiple element housings. Each coupler includes two 2-210 EPR o-rings, FilmTec part number 89255.

Dimensions – Inches (mm)

Product	A	B	C	D
XLE-2540	40.0 (1,016)	1.19 (30.2)	0.75 (19)	2.4 (61)
LP-2540	40.0 (1,016)	1.19 (30.2)	0.75 (19)	2.4 (61)
TW30-2540	40.0 (1,016)	1.19 (30.2)	0.75 (19)	2.4 (61)

1. Refer to FilmTec Design Guidelines for multiple-element systems.
2. TW30-2540, LP-2540 and XLE-2540 elements fit nominal 2.5-inch I.D. pressure vessels.

1 inch = 25.4 mm

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature[a]	113°F (45°C)
• Maximum Operating Pressure	600 psig (41 bar)
• Maximum Feed Flow Rate	6 gpm (1.4 m^3/hr)
• Maximum Pressure Drop	13 psig (0.9 bar)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Silt Density Index	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 30 psi (2.1 bar).
- Avoid static permeate-side backpressure at all times.

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FILMTEC™ Membranes

FILMTEC Tape-Wrapped 4040 Elements for Commercial Applications

Features

A complete range of FILMTEC™ 4040-size elements is available to meet a wide variety of customer needs for commercial applications, from the highest purity water to the lowest total system costs.

- FILMTEC XLE-4040 is the most productive, lowest pressure RO membrane available, delivering the lowest total system cost.
- FILMTEC LP-4040 delivers high quality water at low pressure operation. LP-4040 replaces many "first generation" low pressure membrane elements and will purify more water in many older systems, especially on cold water feeds.
- FILMTEC TW30-4040 is the industry standard for reliable operation and production of the highest quality water.

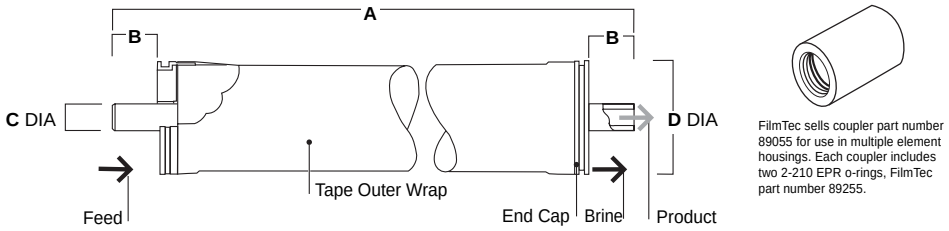
Tape-wrapped elements are built with the same high quality membranes and materials of construction as industrial elements, except for the hard outershell, and are more economical for commercial systems with one or two elements per housing.

Product Specifications

Product	Part number	Active Area ft^2 (m^2)	Feed Spacer Thickness (mil)	Permeate Flow Rate gpd (m^3/d)	Stabilized Salt Rejection (%)
XLE-4040	154546	87 (8.1)	28	2,600 (9.8)	99.0
LP-4040	212819	78 (7.2)	34	2,900 (11.0)	99.2
TW30-4040	80610	78 (7.2)	34	2,400 (9.1)	99.5

1. Permeate flow and salt rejection based on the following test conditions: 77°F (25°C), 15% recovery and applied pressure: 100 psig (6.9 bar) for XLE-4040, 145 psig (10 bar) for LP-4040 and 225 psig (15.5 bar) for TW30-4040. FILMTEC TW30-4040 specifications are based on a 2,000 ppm NaCl feed stream. FILMTEC LP-4040 and FILMTEC XLE-4040 specifications are based on a 500 ppm NaCl feed stream.
2. Permeate flows for individual elements may vary +/-20%.
3. For the purpose of improvement, specifications may be updated periodically.

Figure 1



FilmTec sells coupler part number 89055 for use in multiple element housings. Each coupler includes two 2-210 EPR o-rings, FilmTec part number 89255.

Dimensions – Inches (mm)

Product	A	B	C	D
XLE-4040	40.0 (1,016)	1.05 (26.7)	0.75 (19)	3.9 (99)
LP-4040	40.0 (1,016)	1.05 (26.7)	0.75 (19)	3.9 (99)
TW30-4040	40.0 (1,016)	1.05 (26.7)	0.75 (19)	3.9 (99)

1. Refer to FilmTec Design Guidelines for multiple-element systems.
2. FILMTEC TW30-4040, FILMTEC LP-4040 and FILMTEC XLE-4040 elements fit nominal 4-inch I.D. pressure vessel.

1 inch = 25.4 mm

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature	113°F (45°C)
• Maximum Operating Pressure	600 psig (41 bar)
• Maximum Feed Flow Rate	14 gpm (3.2 m^3/hr)
• Maximum Pressure Drop	13 psig (0.9 bar)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Silt Density Index (SDI)	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 30 psi (2.1 bar).
- Avoid static permeate-side backpressure at all times.

Regulatory Note

These membranes may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

Notice: The use of this product in and of itself does not necessarily guarantee the removal of cysts and pathogens from water. Effective cyst and pathogen reduction is dependent on the complete system design and on the operation and maintenance of the system.

Notice: No freedom from any patent owned by Seller or others is to be inferred. Because use conditions and applicable laws may differ from one location to another and may change with time, Customer is responsible for determining whether products and the information in this document are appropriate for Customer’s use and for ensuring that Customer’s workplace and disposal practices are in compliance with applicable laws and other governmental enactments. Seller assumes no obligation or liability for the information in this document. NO WARRANTIES ARE GIVEN; ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY EXCLUDED.

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FILMTEC™ Membranes

FILMTEC Extra Low Energy (XLE) Elements for Commercial Systems

Features

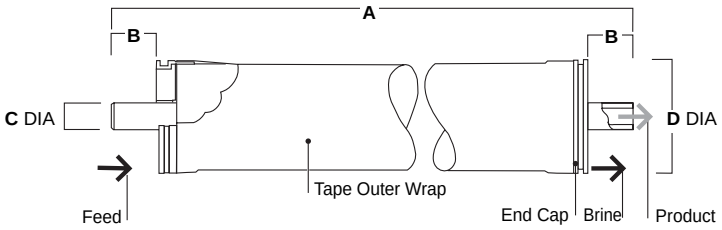
New FILMTEC™ XLE elements offer better system performance and economics by operating at very low applied pressure. XLE membrane, made with a patented technology, provides consistent and reliable system performance. And for added convenience, XLE elements are available in a dry state for rapid start-up (see Figure 1 on reverse). The new XLE series of elements replaces TW30LE elements which were made with an older membrane technology.

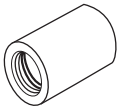
Product Specifications

Product	Part Number	Active Area ft² (m²)	Applied Pressure psig (bar)	Permeate Flow Rate gpd (m³/d)	Stabilized Salt Rejection (%)
XLE-2521	154530	13 (1.2)	100 (6.9)	365 (1.4)	99.0
XLE-2540	154543	28 (2.6)	100 (6.9)	850 (3.2)	99.0
XLE-4021	154540	36 (3.3)	100 (6.9)	1,025 (3.9)	99.0
XLE-4040	154546	87 (8.1)	100 (6.9)	2,600 (9.8)	99.0

1. Permeate flow and salt rejection based on the following test conditions: 500 ppm NaCl feedstream, pressure specified above, 77°F (25°C) and the following recovery rates: XLE-2521, XLE-4021 – 8%; XLE-2540, XLE-4040 – 15%.
2. Permeate flows for individual elements may vary +/-20%.
3. For the purpose of improvement, specifications may be updated periodically.

Figure 1





FilmTec sells coupler part number 89055 for use in multiple element housings. Each coupler includes two 2-210 EPR o-rings, FilmTec part number 89255.

Product	Maximum Feed Flow Rate gpm (m³/h)	Dimensions – Inches (mm) A	B	C	D
XLE-2521	6 (1.4)	21.0 (533)	1.19 (30.2)	0.75 (19)	2.4 (61)
XLE-2540	6 (1.4)	40.0 (1,016)	1.19 (30.2)	0.75 (19)	2.4 (61)
XLE-4021	14 (3.2)	21.0 (533)	1.05 (26.7)	0.75 (19)	3.9 (99)
XLE-4040	14 (3.2)	40.0 (1,016)	1.05 (26.7)	0.75 (19)	3.9 (99)

1. Refer to FilmTec Design Guidelines for multiple-element systems. 1 inch = 25.4 mm
2. XLE-2521 and XLE-2540 elements fit nominal 2.5-inch I.D. pressure vessel. XLE-4021 and XLE-4040 elements fit nominal 4-inch I.D. pressure vessel.

Operating Limits

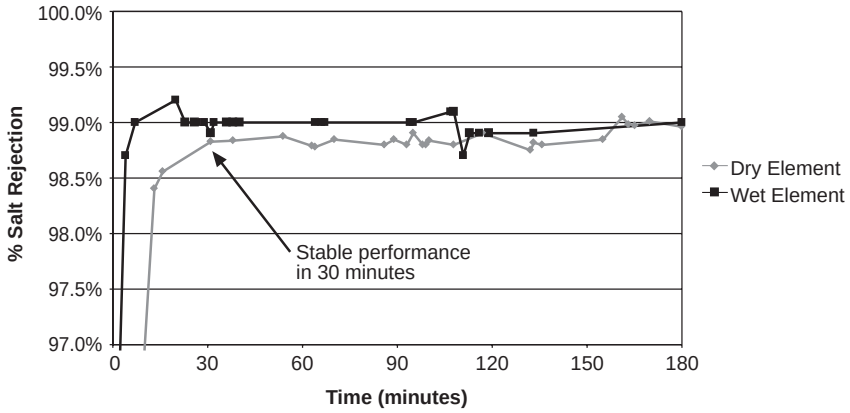
- Membrane Type: Polyamide Thin-Film Composite
- Maximum Operating Temperature[a]: 113°F (45°C)
- Maximum Operating Pressure: 600 psi (41 bar)
- Maximum Pressure Drop: 13 psig (0.9 bar)
- pH Range, Continuous Operation[a]: 2 - 11
- pH Range, Short-Term Cleaning[b]: 1 - 13
- Maximum Feed Silt Density Index: SDI 5
- Free Chlorine Tolerance[c]: <0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Figure 1. XLE-4040 start-up data



Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 30 psi (2.1 bar).
- Avoid static permeate-side backpressure at all times.

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FILMTEC™ Membranes

3. Brackish Water Elements

- FILMTEC BW30-400/34*i* Durable, High Productivity, High Rejection Brackish Water RO Element with *iLEC™* Interlocking Endcaps
- FILMTEC BW30-440*i* High Surface Area, High Rejection Brackish Water RO Element with *iLEC* Interlocking Endcaps
- FILMTEC LE-440*i* High Surface Area, Low-Energy Brackish Water RO Element with *iLEC* Interlocking Endcaps
- FILMTEC LE-400 High Productivity Low-Energy Brackish Water RO Element
- FILMTEC Fiberglassed Elements for Light Industrial Systems
- FILMTEC BW30-365 High Rejection Brackish Water RO Element
- FILMTEC BW30-400 High Rejection, High Surface Area Brackish Water RO Element
- 8” BW30LE-440 High Surface Area Low-Energy Brackish Water RO Element
- FILMTEC XLE-440 Extra Low Energy RO Element
- FILMTEC BW30-400/34*i*-FR Fouling Resistant RO Element with *iLEC* Interlocking Endcaps
- FILMTEC BW30-365-FR Fouling Resistant RO Element
- FILMTEC BW30-400-FR High Productivity Fouling Resistant RO Element

FILMTEC™ Membranes

FILMTEC BW30-400/34*i* Durable High Productivity, High Rejection Brackish Water RO Element with *iLEC*™ Interlocking Endcaps

Features

The FILMTEC™ BW30-400/34*i* element is the ultimate element for durable, high-rejection, high-productivity performance in high fouling or challenging feed conditions, enabling trouble-free operation and a low cost of water.

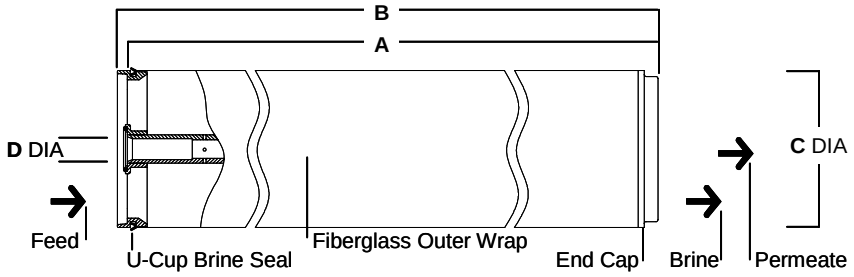
- Features a 34 mil feed spacer to lessen the impact of fouling on pressure drop across a vessel and enhance cleaning effectiveness.
- Offers the proven performance and high productivity of the FILMTEC BW30 membrane
- Delivers a lower total cost of water by enabling lower capital and/or operating expenses compared to 365 sq. ft. elements.
- Includes *iLEC*™ interlocking endcaps, which reduce system operating costs and the risk of o-ring leaks that can cause poor water quality.

Product Specifications

Product	Part number	Active area ft^2 (m^2)	Feed spacer thickness (mil)	Permeate flow rate gpd (m^3/d)	Stabilized salt rejection (%)	Minimum salt rejection (%)
BW30-400/34*i*	248151	400 (37)	34	10,500 (40)	99.5%	99.0%

1. Permeate flow and salt rejection based on the following standard conditions: 2,000 ppm NaCl, 225 psi (15.5 bar), 77°F (25°C), pH 8 and 15% recovery.
2. Flow rates for individual elements may vary but will be no more than 7% below the value shown.
3. Sales specifications may vary as design revisions take place.
4. Active area guaranteed +/-5%. Active area as stated by FilmTec is not comparable to nominal membrane area often stated by some manufacturers. Measurement method described in Form No. 609-00434.

Figure 1



	Dimensions – inches (mm)			
Product	A	B	C	D
BW30-400/34*i*	40.0 (1,016)	40.5 (1,029)	7.9 (201)	1.125 ID (29)

1. Refer to FilmTec Design Guidelines for multiple-element applications and recommended element recovery rates for various feed sources. 1 inch = 25.4 mm
2. Element to fit nominal 8.0-inch (203 mm) I.D. pressure vessel.
3. Individual elements with *iLEC* endcaps measure 40.5 inches (1,029 mm) in length (B). The net length (A) of the elements when connected is 40.0 inches (1,016 mm).

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature[a]	113°F (45°C)
• Maximum Operating Pressure	600 psig (41 bar)
• Maximum Pressure Drop	15 psig (1.0 bar)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Flow	85 gpm (19 m^3/hr)
• Maximum Feed Silt Density Index	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid static permeate-side backpressure at all times.

Regulatory Note

These membranes may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

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FILMTEC™ Membranes

FILMTEC BW30-440*i* High Surface Area, High Rejection Brackish Water RO Element with *iLEC*™ Interlocking Endcaps

Features

The FILMTEC™ BW30-440*i* element is a high-productivity element combining the highest active membrane area in the industry with the high rejection BW30 membrane. It is designed to minimize capital expenses in high-purity industrial water applications without increasing operating flux.

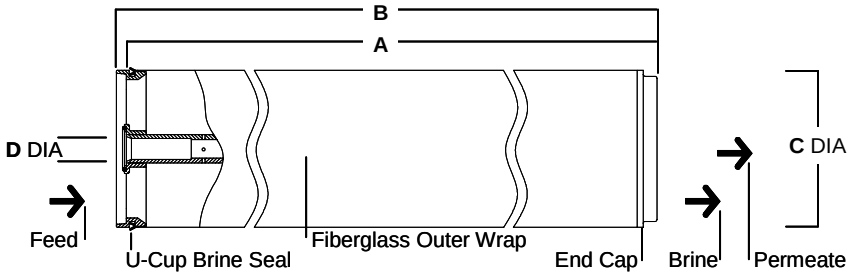
- Produces 10% more water compared to the FILMTEC BW30-400 element at the same operating pressure and high rejection, enabling lower capital expense for new systems, or increased water production in an existing system.
- Includes *iLEC*™ interlocking endcaps, which reduce system operating costs and the risk of o-ring leaks that can cause poor water quality.
- Designed using an industry standard 1.125 inch ID permeate tube for interchangeability with other brackish water elements.

Product Specifications

Product	Part number	Active area ft^2 (m^2)	Feed spacer thickness (mil)	Permeate flow rate gpd (m^3/d)	Stabilized salt rejection (%)	Minimum salt rejection (%)
BW30-440*i*	249107	440 (41)	28	11,500 (43)	99.5%	99.0%

1. Permeate flow and salt rejection based on the following standard conditions: 2,000 ppm NaCl, 225 psi (15.5 bar), 77°F (25°C), pH 8 and 15% recovery.
2. Flow rates for individual elements may vary but will be no more than 7% below the value shown.
3. Sales specifications may vary as design revisions take place.
4. Active area guaranteed +/-3%. Active area as stated by FilmTec is not comparable to nominal membrane area often stated by some manufacturers. Measurement method described in Form No. 609-00434.

Figure 1



Product	Dimensions – inches (mm) A	B	C	D
BW30-440*i*	40.0 (1,016)	40.5 (1,029)	7.9 (201)	1.125 ID (29)

1. Refer to FilmTec Design Guidelines for multiple-element applications and recommended element recovery rates for various feed sources. 1 inch = 25.4 mm
2. Element to fit nominal 8.0-inch (203 mm) I.D. pressure vessel.
3. Individual elements with *iLEC* endcaps measure 40.5 inches (1,029 mm) in length (B). The net length (A) of the elements when connected is 40.0 inches (1,016 mm).

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature[a]	113°F (45°C)
• Maximum Operating Pressure	600 psig (41 bar)
• Maximum Pressure Drop	15 psig (1.0 bar)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Flow	85 gpm (19 m^3/hr)
• Maximum Feed Silt Density Index	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid static permeate-side backpressure at all times.

Regulatory Note

These membranes may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

Notice: The use of this product in and of itself does not necessarily guarantee the removal of cysts and pathogens from water. Effective cyst and pathogen reduction is dependent on the complete system design and on the operation and maintenance of the system.

Notice: No freedom from any patent owned by Seller or others is to be inferred. Because use conditions and applicable laws may differ from one location to another and may change with time, Customer is responsible for determining whether products and the information in this document are appropriate for Customer’s use and for ensuring that Customer’s workplace and disposal practices are in compliance with applicable laws and other governmental enactments. Seller assumes no obligation or liability for the information in this document. NO WARRANTIES ARE GIVEN; ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY EXCLUDED.

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FILMTEC™ Membranes

FILMTEC LE-440***i*** High Surface Area, Low-Energy Brackish Water RO Element with ***i****LEC*™ Interlocking Endcaps

Features

The FILMTEC™ LE-440***i*** element is a low-energy element featuring the highest active membrane area in the industry. It enables high productivity and low energy operation, while maintaining high-rejection performance, minimizing operating expense and lowering the total cost of water for industrial and municipal applications.

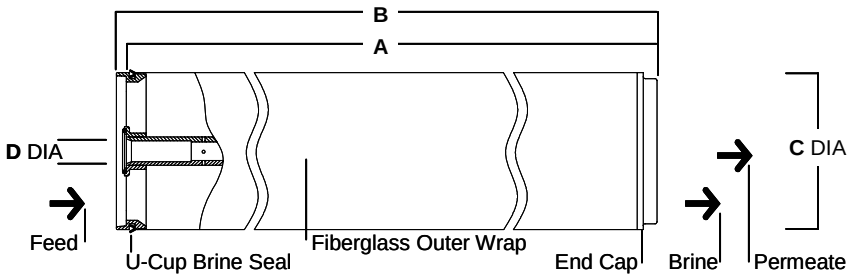
- Delivers the same permeate flow at an equivalent operating flux at 40% lower feed pressure, compared to the FILMTEC BW30-440***i*** element.
- Offers permeate flow rate 10 percent higher while producing similar permeate quality than that of the FILMTEC LE-400 element, enabling the lowest total cost of water in high-purity industrial applications.
- Includes ***i****LEC*™ interlocking endcaps, which reduce system operating costs and the risk of o-ring leaks that cause poor water quality.
- Designed using an industry standard 1.125 inch ID permeate tube for interchangeability with other brackish water elements.

Product Specifications

Product	Part number	Active area ft^2 (m^2)	Feed spacer thickness (mil)	Permeate flow rate gpd (m^3/d)	Stabilized salt rejection (%)	Minimum salt rejection (%)
LE-440***i***	246670	440 (41)	28	12,650 (48)	99.3%	99.0%

1. Permeate flow and salt rejection based on the following standard conditions: 2,000 ppm NaCl, 150 psi (10.3 bar), 77°F (25°C), pH 8 and 15% recovery.
2. For comparison, the LE-440***i*** will have a permeate flow of 13,400 gpd (51 m^3/d) and stabilized salt rejection of 99.3% when normalized to a feed solution of 1,500 ppm NaCl as used by some manufacturers.
3. Flow rates for individual elements may vary but will be no more than 15% below the value shown.
4. Sales specifications may vary as design revisions take place.
5. Active area guaranteed +/-3%. Active area as stated by FilmTec is not comparable to nominal membrane area often stated by some manufacturers. Measurement method described in Form No. 609-00434.

Figure 1



Dimensions – inches (mm)

Product	A	B	C	D
LE-440***i***	40.0 (1,016)	40.5 (1,029)	7.9 (201)	1.125 ID (29)

1. Refer to FilmTec Design Guidelines for multiple-element applications and recommended element recovery rates for various feed sources. 1 inch = 25.4 mm
2. Element to fit nominal 8.0-inch (203 mm) I.D. pressure vessel.
3. Individual elements with ***i****LEC* endcaps measure 40.5 inches (1,029 mm) in length (B). The net length (A) of the elements when connected is 40.0 inches (1,016 mm).

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature[a]	113°F (45°C)
• Maximum Operating Pressure	600 psig (41 bar)
• Maximum Pressure Drop	15 psig (1.0 bar)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Flow	85 gpm (19 m^3/hr)
• Maximum Feed Silt Density Index	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid static permeate-side backpressure at all times.

Regulatory Note

These membranes may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

Notice: The use of this product in and of itself does not necessarily guarantee the removal of cysts and pathogens from water. Effective cyst and pathogen reduction is dependent on the complete system design and on the operation and maintenance of the system.

Notice: No freedom from any patent owned by Seller or others is to be inferred. Because use conditions and applicable laws may differ from one location to another and may change with time, Customer is responsible for determining whether products and the information in this document are appropriate for Customer’s use and for ensuring that Customer’s workplace and disposal practices are in compliance with applicable laws and other governmental enactments. Seller assumes no obligation or liability for the information in this document. NO WARRANTIES ARE GIVEN; ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY EXCLUDED.

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FILMTEC™ Membranes

FILMTEC LE-400 High Productivity Low-Energy Brackish Water RO Element

Features

The FILMTEC™ LE-400 element is a low-energy element for industrial and municipal applications that operates at low pressure to deliver energy savings in new equipment or replacement situations where energy cost is an important factor and unit price is a key driver.

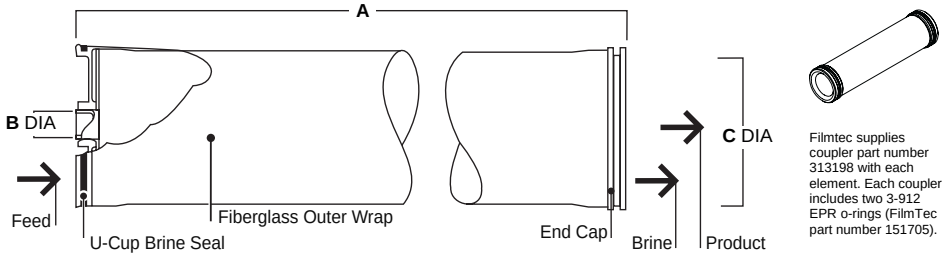
- Delivers equivalent permeate flow at 40% lower feed pressure, compared to the FILMTEC BW30-400.
- Offers the proven performance and high productivity of the FILMTEC BW30-400 element construction, with lower energy use and operating expense.
- The new FILMTEC LE-400 has an industry standard 1.125 inch ID permeate tube to facilitate element replacement.

Product Specifications

Product	Part number	Active area ft^2 (m^2)	Feed spacer thickness (mil)	Permeate flow rate gpd (m^3/d)	Stabilized salt rejection (%)	Minimum salt rejection (%)
LE-400	249109	400 (37)	28	11,500 (44)	99.3%	99.0%

1. Permeate flow and salt rejection based on the following standard conditions: 2,000 ppm NaCl, 150 psi (10.3 bar), 77°F (25°C), pH 8 and 15% recovery.
2. For comparison, the LE-400 will have a permeate flow of 12,200 gpd (46 m^3/d) and stabilized salt rejection of 99.3% when normalized to a feed solution of 1,500 ppm NaCl as used by some manufacturers.
3. Flow rates for individual elements may vary but will be no more than 15% below the value shown.
4. Sales specifications may vary as design revisions take place.
5. Active area guaranteed +/-3%. Active area as stated by FilmTec is not comparable to nominal membrane area often stated by some manufacturers. Measurement method described in Form No. 609-00434.

Figure 1



Product	Dimensions – inches (mm) A	B	C
LE-400	40.0 (1,016)	1.125 ID (29)	7.9 (201)

1. Refer to FilmTec Design Guidelines for multiple-element applications and recommended element recovery rates for various feed sources. 1 inch = 25.4 mm
2. Element to fit nominal 8.0-inch (203 mm) I.D. pressure vessel.

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature[a]	113°F (45°C)
• Maximum Operating Pressure	600 psig (41 bar)
• Maximum Pressure Drop	15 psig (1.0 bar)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Flow	85 gpm (19 m^3/hr)
• Maximum Feed Silt Density Index	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid static permeate-side backpressure at all times.

Regulatory Note

These membranes may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

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FILMTEC™ Membranes

FILMTEC Fiberglassed Elements for Light Industrial Systems

Features

FILMTEC™ brackish water reverse osmosis membrane elements provide consistent, outstanding system performance in light industrial applications.

- FILMTEC LE-4040 delivers highest performance at lowest pressure resulting in less energy usage and lower costs.
- FILMTEC BW30-4040 is the industry standard for reliable operation and production of the highest quality water.
- FILMTEC BW30-2540 elements are designed for systems smaller than 1 gpm (0.2 m^3/h) offering a hard shell exterior for extra strength.

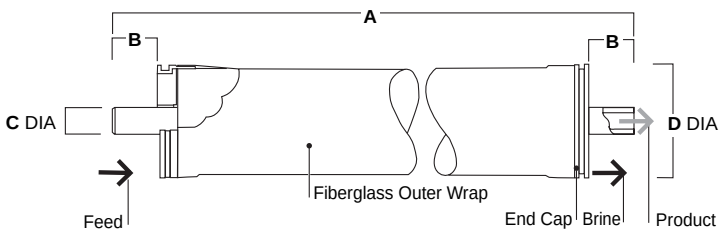
Elements with a hard shell exterior are recommended for systems with multiple-element housings containing three or more membranes, as they are designed to withstand higher pressure drops.

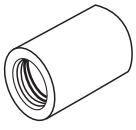
Product Specifications

Product	Part Number	Active Area ft^2 (m^2)	Feed Spacer Thickness (mil)	Permeate Flow Rate gpd (m^3/d)	Stabilized Salt Rejection (%)
LE-4040	275173	78 (7.2)	34	2,500 (9.5)	99.0
BW30-4040	80783	78 (7.2)	34	2,400 (9.1)	99.5
BW30-2540	80766	28 (2.6)	28	850 (3.2)	99.5

1. Permeate flow and salt rejection based on the following test conditions: 2,000 ppm NaCl, applied pressure: 150 psig (10.3 bar) for LE-4040 and 225 psig (15.5 bar) for BW30-4040 and BW30-2540, 77°F (25°C) and 15% recovery.
2. Permeate flows for individual elements may vary +/-20%.
3. For the purpose of improvement, specifications may be updated periodically.
4. LE-4040 replaces BW30LE-4040.

Figure 1





FilmTec sells coupler part number 89055 for use in multiple element housings. Each coupler includes two 2-210 EPR o-rings, FilmTec part number 89255.

Dimensions – Inches (mm)

Product	A	B	C	D
LE-4040	40.0 (1,016)	1.05 (26.7)	0.75 (19)	3.9 (99)
BW30-4040	40.0 (1,016)	1.05 (26.7)	0.75 (19)	3.9 (99)
BW30-2540	40.0 (1,016)	1.19 (30.2)	0.75 (19)	2.4 (61)

1. Refer to FilmTec Design Guidelines for multiple-element systems. 1 inch = 25.4 mm
2. BW30-2540 elements fit nominal 2.5-inch I.D. pressure vessel. BW30LE-4040 and BW30-4040 elements fit nominal 4-inch I.D. pressure vessel.

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature[a]	113°F (45°C)
• Maximum Operating Pressure	600 psi (41 bar)
• Maximum Feed Flow Rate - 4040 elements	16 gpm (3.6 m^3/h)
- 2540 elements	6 gpm (1.4 m^3/h)
• Maximum Pressure Drop	15 psig (1.0 bar)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning[b]	1 - 13
• Maximum Feed Silt Density Index	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid static permeate-side backpressure at all times.

Regulatory Note

These membranes may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

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FILMTEC™ Membranes

FILMTEC BW30-365 High Rejection Brackish Water RO Element

Features

For years, the FILMTEC™ BW30-365 has been the element of choice for system designers, OEMs and system operators requiring consistently high performance and maximum element life when treating difficult feed waters. This element offers proven performance, high rejection and outstanding robustness and durability across a wide range of feed conditions where unit price is a key driver.

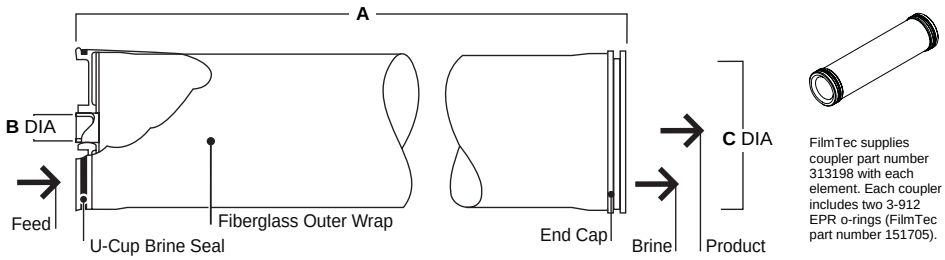
- Features the industry's thickest feed spacer (34 mil) to lessen the impact of fouling.
- May be cleaned over the widest pH range (pH 1-13) for the most effective cleaning.
- The BW30-365 is best suited for systems operating on challenging feed streams, where reliable pretreatment is not an option, or where maximum cleanability delivers value.

Product Specifications

Product	Part number	Active area ft^2 (m^2)	Feed spacer thickness (mil)	Permeate flow rate gpd (m^3/d)	Stabilized salt rejection (%)	Minimum salt rejection (%)
BW30-365	80773	365 (34)	34	9,500 (36)	99.5%	99.0%

1. Permeate flow and salt rejection based on the following standard conditions: 2,000 ppm NaCl, 225 psi (15.3 bar), 77°F (25°C), pH 8 and 15% recovery.
2. Flow rates for individual elements may vary but will be no more than 7% below the value shown.
3. Sales specifications may vary as design revisions take place.
4. Active area guaranteed +/-3%. Active area as stated by FilmTec is not comparable to nominal membrane area often stated by some manufacturers. Measurement method described in Form No. 609-00434.

Figure 1



Dimensions – inches (mm)

Product	A	B	C
BW30-365	40.0 (1,016)	1.125 ID (29)	7.9 (201)

1. Refer to FilmTec Design Guidelines for multiple-element applications and recommended element recovery rates for various feed sources. 1 inch = 25.4 mm
2. Element to fit nominal 8.0-inch (203 mm) I.D. pressure vessel.

Operating Limits

Membrane Type	Polyamide Thin-Film Composite
Maximum Operating Temperature [a]	113°F (45°C)
Maximum Operating Pressure	600 psig (41 bar)
Maximum Pressure Drop	15 psig (1.0 bar)
pH Range, Continuous Operation[a]	2 - 11
pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
Maximum Feed Flow	85 gpm (19 m^3/hr)
Maximum Feed Silt Density Index	SDI 5
Free Chlorine Tolerance[c]	< 0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid static permeate-side backpressure at all times.

Regulatory Note

These membranes may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

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FILMTEC™ Membranes

FILMTEC BW30-400 High Rejection, High Surface Area Brackish Water RO Element

Features

The FILMTEC™ BW30-400 is the product of choice when the highest quality permeate is required. It was the first 400 square foot membrane element on the market and continues to be widely used in new equipment and retrofits where system capital and productivity are factors.

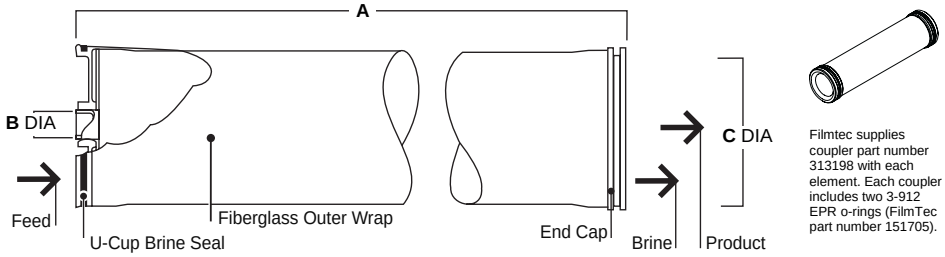
- FilmTec's superior automated manufacturing technology results in the most consistent performance element-to-element and year-after-year.
- BW30-400 elements deliver high flow and high rejection without being chlorinated during the manufacturing process. This is one reason why FILMTEC elements are more durable and may be cleaned over a wider pH range (pH 1-13) than other RO elements.
- With more than a decade of proven performance, BW30-400 is the product you can rely on for years of trouble-free operation.

Product Specifications

Product	Part number	Active area ft^2 (m^2)	Feed spacer thickness (mil)	Permeate flow rate gpd (m^3/d)	Stabilized salt rejection (%)	Minimum salt rejection (%)
BW30-400	98650	400 (37)	28	10,500 (40)	99.5%	99.0%

1. Permeate flow and salt rejection based on the following standard conditions: 2,000 ppm NaCl, 225 psi (15.5 bar), 77°F (25°C), pH 8 and 15% recovery.
2. Flow rates for individual elements may vary but will be no more than 7% below the value shown.
3. Sales specifications may vary as design revisions take place.
4. Active area guaranteed +/-3%. Active area as stated by FilmTec is not comparable to nominal membrane area often stated by some manufacturers. Measurement method described in Form No. 609-00434.

Figure 1



Dimensions – inches (mm)

Product	A	B	C
BW30-400	40.0 (1,016)	1.125 ID (29)	7.9 (201)

1. Refer to FilmTec Design Guidelines for multiple-element applications and recommended element recovery rates for various feed sources. 1 inch = 25.4 mm
2. Element to fit nominal 8.0-inch (203 mm) I.D. pressure vessel.

Operating Limits

Membrane Type	Polyamide Thin-Film Composite
Maximum Operating Temperature[a]	113°F (45°C)
Maximum Operating Pressure	600 psig (41 bar)
Maximum Pressure Drop	15 psig (1.0 bar)
pH Range, Continuous Operation[a]	2 - 11
pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
Maximum Feed Flow	85 gpm (19 m^3/hr)
Maximum Feed Silt Density Index	SDI 5
Free Chlorine Tolerance[c]	< 0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid static permeate-side backpressure at all times.

Regulatory Note

These membranes may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

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FILMTEC™ Membranes

8" BW30LE-440 High Surface Area Low-Energy Brackish Water RO Element

Features

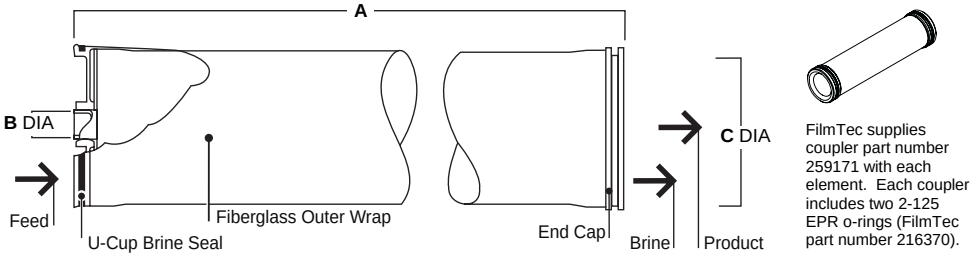
The FILMTEC™ BW30LE-440 element has a nominal active membrane area of 440 square feet (41 m^2) and an average permeate flow of 11,500 gpd (44 m^3/d) at 150 psi under standard conditions as noted below. External element dimensions are identical to those of conventional 8" elements; however, the I.D. of the product water tube is slightly larger (see Dimension B below). Optimizing membrane chemistry results in lower pressure operation than the FILMTEC BW30-400, which means system operating economy is enhanced. Because the high productivity of the FILMTEC BW30LE-440 element results from increased surface area and increased element efficiency, the rate of membrane fouling remains low. This means higher flow rates can be sustained over time and element service life is prolonged. The productivity advantages of the FILMTEC BW30LE-440 element can be employed in the design of new systems that produce the desired flow rate while operating at significantly lower feed pressures which can result in savings due to lower energy consumption and fewer pumps. The high surface area of the FILMTEC BW30LE-440 element permits designs of new RO systems that meet productivity targets with fewer elements than standard 8-inch elements resulting in lower installed system cost by reducing the number of system components and lower installation expense.

Product Specifications

Product	Nominal Active Surface Area ft^2 (m^2)	Product Water Flow Rate gpd (m^3/d)	Stabilized Salt Rejection Cl^- (%)
BW30LE-440	440 (41)	11,500[1] (44)	99.0

1. Permeate flow and salt rejection based on the following standard conditions: 2,000 ppm NaCl, 150 psi (1.0 MPa), 77°F (25°C), pH 8 and 15% recovery.
2. Flow rates for individual elements may vary but will be no more than 15% below the value shown.
3. Sales specifications may vary as design revisions take place.
4. Minimum salt rejection for individual element is 98.0%.

Figure 1



Product	Typical Recovery Rate (%)	Dimensions – Inches (mm) A	B	C
BW30LE-440	15	40.0 (1,016)	1.5[3] (38)	7.9 (201)

1. Typical recovery rate shown is for a single element. Recovery rate is calculated by dividing permeate flow rate by feed flow rate.
2. Refer to FilmTec Design Guidelines for multiple-element applications and recommended element recovery rates for various feed sources.
3. Element to fit nominal 8.00-inch (203 mm) I.D. pressure vessel.

1 inch = 25.4 mm

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature[a]	113°F (45°C)
• Maximum Operating Pressure	600 psig (41 bar)
• Maximum Pressure Drop	15 psig (1.0 bar)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Flow	85 gpm (19 m^3/hr)
• Maximum Feed Silt Density Index	SDI 5
• Free Chlorine Tolerance[c]	< 0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid permeate-side backpressure at all times.

Regulatory Note

These membranes may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

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FILMTEC™ Membranes

FILMTEC XLE-440 Extra Low Energy RO Element

Features

The FILMTEC™ XLE-440 is an extra low energy, high productivity brackish water reverse osmosis element designed to deliver high quality water at low operating costs for municipal and industrial water applications. Its high active area design coupled with the highly productive XLE membrane makes FILMTEC XLE-440 the lowest pressure RO element – resulting in lower energy costs.

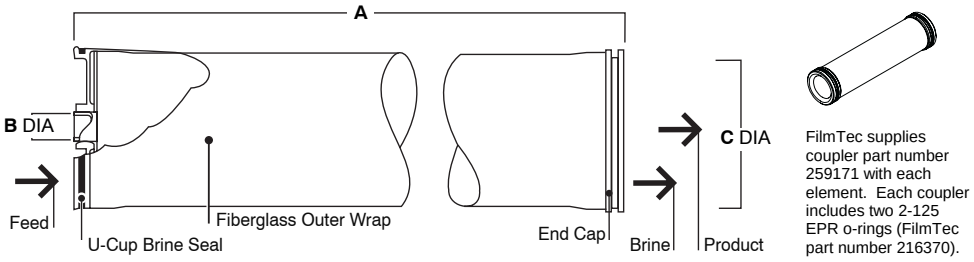
- XLE-440 will operate in many systems at less than half the feed pressure of a standard high rejection RO element and at up to 30% less pressure than other low energy membranes, resulting in lifetime energy savings greater than 100% of the initial membrane investment.
- With 440 square feet (41 square meters) of active membrane area, the FILMTEC XLE-440 element gives system designers the option of designing a system with fewer membrane elements, requiring lower capital expenditures for membranes and compenents.
- Automated, precision fabrication allows for the industry's highest active membrane area without compromising the thickness of the feed spacer, resulting in less fouling, less cleaning downtime and lower operating costs than competitive products using thinner spacers.
- XLE-440 is perfectly suited for cold water feeds as the element's high productivity will deliver lower energy costs and/or higher permeate flow.

Product Specifications

Product	Part Number	Nominal Active Area ft^2 (m^2)	Applied Pressure psig (bar)	Permeate Flow Rate gpd (m^3/d)	Stabilized Salt Rejection
XLE-440	101060	440 (41)	100 (6.9)	12,700 (48)	99.0%

1. Permeate flow and salt rejection based on the following test conditions: 500 ppm NaCl, pressure specified above, 77°F (25°C) and 15% recovery.
2. Permeate flows for individual elements may vary +25/-15%.
3. Minimum stabilized salt rejection is 98.0%.
4. The above specifications are benchmark values. Please be sure to operate according to system design guidelines.

Figure 1



	Dimensions – Inches (mm)		
Product	A	B	C
XLE-440	40.0 (1,016)	1.50 (38)	7.9 (201)

5. Refer to FilmTec Design Guidelines for multiple-element systems.
6. XLE-440 fits nominal 8-inch (203 mm) I.D. pressure vessel.

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature	113°F (45°C)
• Maximum Operating Pressure	600 psig (41 bar)
• Maximum Pressure Drop	15 psig (1.0 bar)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Silt Density Index (SDI)	SDI 5
• Free Chlorine Tolerance[c]	< 0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid static permeate-side backpressure at all times.

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FILMTEC™ Membranes

FILMTEC BW30-400/34*i*-FR Durable High Productivity Fouling Resistant RO Element with *iLEC*™ Interlocking Endcaps

Features

The FILMTEC™ BW30-400/34*i*-FR has optimized construction for durable, high rejection, high productivity performance in purifying water with high biological fouling tendency. With Dow's proprietary FR membrane technology that provides superior fouling resistance and cleanability, this product combines the best features of the FILMTEC BW30-365-FR and BW30-400-FR elements.

The BW30-400/34*i*-FR element features:

- A wide 34 mil feed spacer to lessen the impact of fouling and enhance cleaning effectiveness.
- 400 square feet active area for more productivity without increasing the operating flux.
- High rejection FILMTEC RO membrane that has the widest pH cleaning range in the industry (pH 1-13) that allows for effective cleaning of scale, organic compounds and biofilm.
- Automated, precision fabrication with a greater number of shorter membrane leaves, reduces the overall effect of fouling and maximizes membrane efficiency.
- *iLEC*™ interlocking endcaps, which reduce system operating costs and the risk of o-ring leaks that compromise system integrity and cause poor water quality.

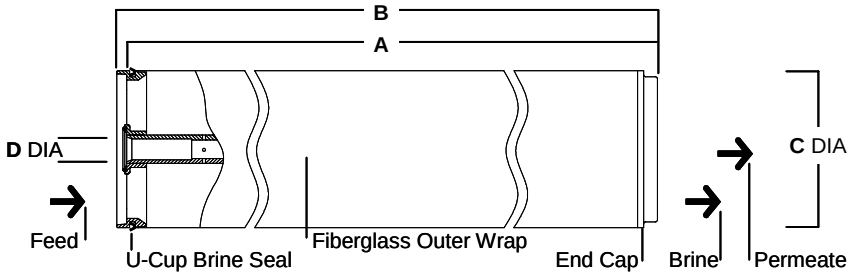
This unique combination of features offers system operators the best long-term economics and most trouble-free operation currently available for RO membrane purification of fouling waters.

Product Specifications

Product	Part number	Active area ft^2 (m^2)	Feed spacer thickness (mil)	Permeate flow rate gpd (m^3/d)	Stabilized salt rejection (%)	Minimum salt rejection (%)
BW30-400/34*i*-FR	273805	400 (37)	34	10,500 (40)	99.5	99.0

1. Permeate flow and salt rejection based on the following standard conditions: 2,000 ppm NaCl, 225 psi (15.5 bar), 77°F (25°C), pH 8 and 15% recovery.
2. Flow rates for individual elements may vary but will be no more than 7% below the value shown.
3. Sales specifications may vary as design revisions take place.
4. Active area guaranteed +/-5%. Active area as stated by FilmTec is not comparable to nominal membrane area often stated by some manufacturers. Measurement method described in Form No. 609-00434.

Figure 1.



Dimensions – inches (mm)

Product	A	B	C	D
BW30-400/34*i*-FR	40.0 (1,016)	40.5 (1,029)	7.9 (201)	1.125 ID (29)

1. Refer to FilmTec Design Guidelines for multiple-element applications. 1 inch = 25.4 mm
2. BW30-400-FR fits nominal 8-inch (203 mm) I.D. pressure vessel.
3. Individual elements with *iLEC* endcaps measure 40.5 inches (1,029 mm) in length (B). The net length (A) of the elements when connected is 40.0 inches (1,016 mm).

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature[a]	113°F (45°C)
• Maximum Operating Pressure	600 psig (41 bar)
• Maximum Pressure Drop	15 psig (1.0 bar)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Silt Density Index	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drops are 15 psi (1.0 bar) per element or 50 psi (3.4 bar) per multi element pressure vessel (housing) which ever value is more limiting.
- Avoid static permeate-side backpressure at all times.

Regulatory Note

These membranes may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

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FILMTEC™ Membranes

FILMTEC BW30-365-FR Fouling Resistant RO Element

Features

FILMTEC™ BW30-365-FR elements have purified high biofouling feed waters since 1997. Numerous customers around the world have experienced lower operating costs by using FILMTEC fouling resistant elements due to their superior fouling resistance and cleanability. The BW30-365-FR element features:

- A wider (34 mil) feed spacer than any other industrial water purification element to facilitate improved cleaning.
- A proprietary modification to the FT30 membrane chemistry providing superior cleanability and resistance to fouling.
- FILMTEC membrane with the widest pH cleaning range in the industry (pH 1-13) allowing for the most effective cleaning of scaling, organic compounds and biofilm.
- More but shorter membrane leaves resulting in a more efficient membrane element design reducing the overall effect of fouling.

The FILMTEC BW30-365-FR element can be used for both potable and non-potable water applications.

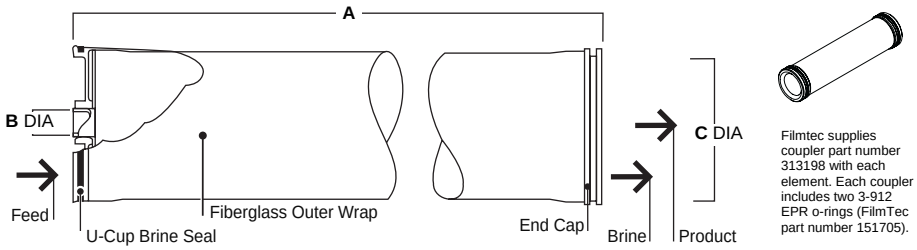
A system designer can take advantage of this high productivity, high rejection, fouling resistant reverse osmosis (RO) element in any system design where the potential of high biofouling is expected. In addition, existing installations that are experiencing high biofouling or frequent cleanings can be upgraded by retrofitting to the FILMTEC BW30-365-FR element. In either case FILMTEC BW30-365-FR elements can reduce the operating costs in most biofouling cases by lowering membrane fouling, reducing average system operating pressure, and extending membrane life.

Product Specifications

Product	Part number	Active area ft^2 (m^2)	Feed spacer thickness (mil)	Permeate flow rate gpd (m^3/d)	Stabilized salt rejection (%)	Minimum salt rejection (%)
BW30-365-FR	174961	365 (34)	34	9,500 (36)	99.5	99.0

1. Permeate flow and salt rejection based on the following standard conditions: 2,000 ppm NaCl, 225 psi (15.3 bar), 77°F (25°C), pH 8 and 15% recovery.
2. Flow rates for individual elements may vary but will be no more than 7% below the value shown.
3. Sales specifications may vary as design revisions take place.
4. Active area guaranteed +/-3%. Active area as stated by FilmTec is not comparable to nominal membrane area often stated by some manufacturers. Measurement method described in Form No. 609-00434.

Figure 1.



Product	Dimensions – inches (mm) A	B	C
BW30-365-FR	40.0 (1016)	1.125 (29)	7.9 (201)

1. Refer to FilmTec Design Guidelines (Form Number 609-21010) for multiple-element systems.
2. BW30-365-FR fits nominal 8-inch (203 mm) I.D. pressure vessel.

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature[a]	113°F (45°C)
• Maximum Operating Pressure	600 psig (41 bar)
• Maximum Pressure Drop	15 psig (1.0 bar)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Flow	70 gpm (16 m^3/h)
• Maximum Feed Silt Density Index	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Performance Improvement

Figure 2 illustrates the rapid rise of differential pressure vs. time in the 1st stage of an RO system using standard brackish water RO elements. In just 35 days the differential pressure rose significantly leading to higher energy consumption. Also the pressure drop in the second stage doubled. Other performance throttling effects on the RO membrane are:

- Loss of or decline in membrane flux resulting in lower productivity;
- Frequent chemical cleanings triggering an increase in operation and maintenance costs;
- Reduction in permeate quality;
- Shortened useful membrane/element life.

Figure 2. Historical Startup Data – Standard RO Elements Differential Pressure

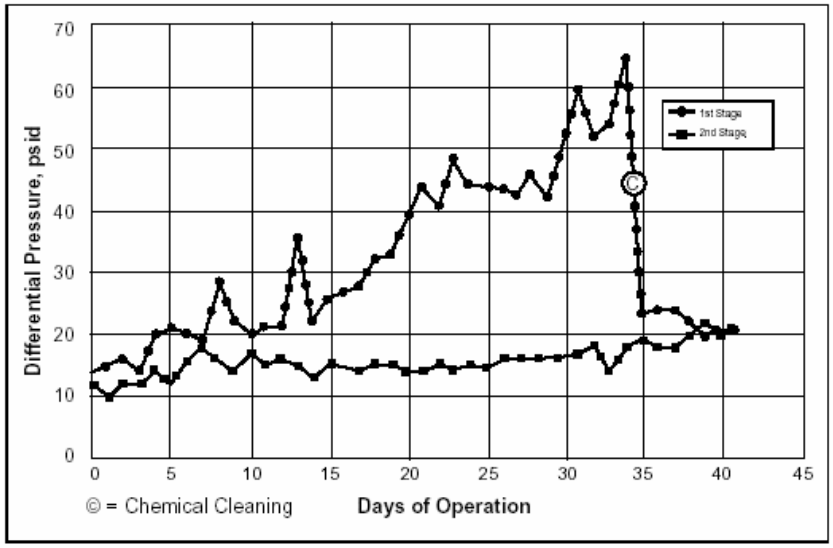
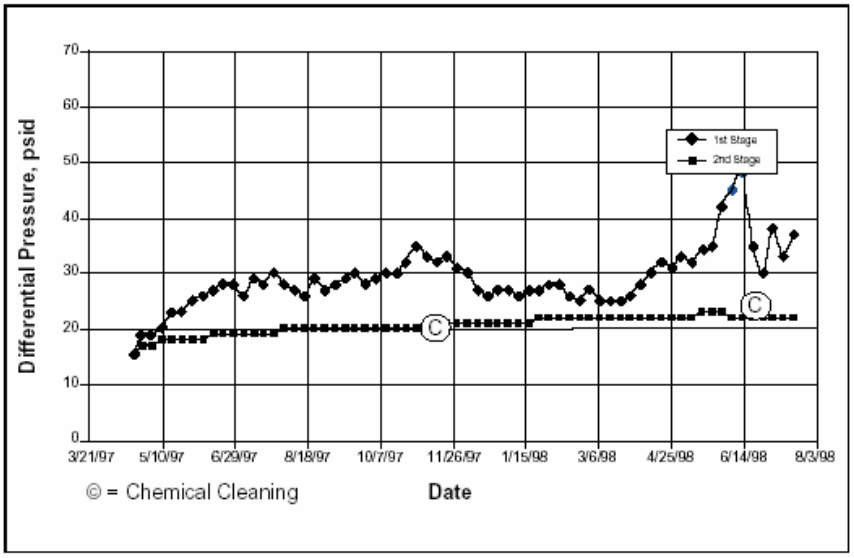


Figure 3 shows the stable operation, in the 1st and 2nd stages, of a FILMTEC™ BW30-365-FR element. Note that in this example, the cleaning frequency was more than 6 months.

To learn more on how this new FILMTEC FR element can reduce operating costs and improve RO system reliability, we refer you to our brochure “FILMTEC Fouling Resistant Membrane Elements – Winning The Battle Against Biofilm Formation”, Form No. 609-00261.

Figure 3. Performance of Fouling Resistant RO Elements Differential Pressure



Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid static permeate-side backpressure at all times.

Regulatory Note

These membranes may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

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Note: These elements have not been through the French approval process for use in potable water.

Notice: The use of this product in and of itself does not necessarily guarantee the removal of cysts and pathogens from water. Effective cyst and pathogen reduction is dependent on the complete system design and on the operation and maintenance of the system.

Notice: No freedom from any patent owned by Seller or others is to be inferred. Because use conditions and applicable laws may differ from one location to another and may change with time, Customer is responsible for determining whether products and the information in this document are appropriate for Customer's use and for ensuring that Customer's workplace and disposal practices are in compliance with applicable laws and other governmental enactments. Seller assumes no obligation or liability for the information in this document. NO WARRANTIES ARE GIVEN; ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY EXCLUDED.

FILMTEC™ Membranes

FILMTEC BW30-400-FR High Productivity Fouling Resistant RO Element

Features

Designed to purify water with high biological or organic fouling potential in systems with well-controlled pretreatment, FILMTEC™ BW30-400-FR reverse osmosis elements incorporate Dow's proprietary FR membrane technology that provides superior fouling resistance and cleanability. This product is an extension of the FILMTEC BW30-365-FR element that has demonstrated its value for numerous customers around the world. The BW30-400-FR element features:

- High active area (400 square feet) for more productivity without increasing the operating flux.
- High rejection FILMTEC RO membrane that has the widest pH cleaning range in the industry (pH 1-13) that allows for effective cleaning of scale, organic compounds and biofilm.
- Automated, precision fabrication with a greater number of shorter membrane leaves, reduces the overall effect of fouling and maximizes membrane efficiency.

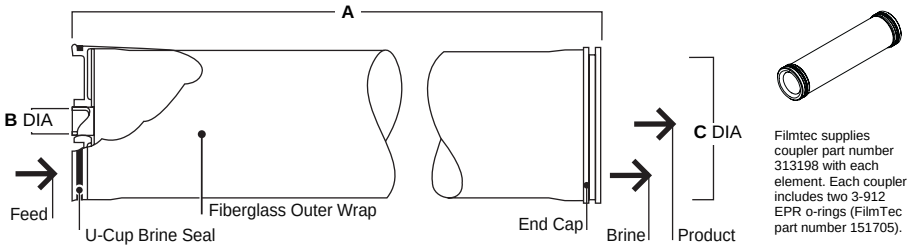
These features offer system operators the best long-term economics and most trouble-free operation for RO membrane purification of fouling waters.

Product Specifications

Product	Part number	Active area ft^2 (m^2)	Feed spacer thickness (mil)	Permeate flow rate gpd (m^3/d)	Stabilized salt rejection (%)	Minimum salt rejection (%)
BW30-400-FR	202681	400 (37)	28	10,500 (40)	99.5	99.0

1. Permeate flow and salt rejection based on the following standard conditions: 2,000 ppm NaCl, 225 psi (15.3 bar), 77°F (25°C), pH 8 and 15% recovery.
2. Flow rates for individual elements may vary but will be no more than 7% below the value shown.
3. Sales specifications may vary as design revisions take place.
4. Active area guaranteed +/-3%. Active area as stated by FilmTec is not comparable to nominal membrane area often stated by some manufacturers. Measurement method described in Form No. 609-00434.

Figure 1.



Product	Dimensions – inches (mm) A	B	C
BW30-400-FR	40.0 (1,016)	1.125 (29)	7.9 (201)

1. Refer to FilmTec Design Guidelines for multiple-element applications.
2. BW30-400-FR fits nominal 8-inch (203 mm) I.D. pressure vessel.

1 inch = 25.4 mm

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature[a]	113°F (45°C)
• Maximum Operating Pressure	600 psig (41 bar)
• Maximum Pressure Drop	15 psig (1.0 bar)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Silt Density Index	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid permeate-side backpressure at all times.

Regulatory Note

These membranes may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

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FILMTEC™ Membranes

4. Seawater Elements

- FILMTEC SW30XHR-400*i* Seawater Reverse Osmosis Element with *iLEC™* Interlocking Endcaps
- FILMTEC SW30ULE-400*i* Seawater Reverse Osmosis Element with *iLEC* Interlocking Endcaps
- FILMTEC SW30XLE-400*i* Seawater Reverse Osmosis Element with *iLEC* Interlocking Endcaps
- FILMTEC SW30HR LE-400*i* Seawater Reverse Osmosis Element with *iLEC* Interlocking Endcaps
- FILMTEC SW30HR LE-400 Seawater Reverse Osmosis Element
- FILMTEC SW30HR-370/34*i* Seawater Reverse Osmosis Element with *iLEC* Interlocking Endcaps
- FILMTEC SW30HR-380 High Rejection Seawater RO Element
- FILMTEC Seawater RO Elements for Marine Systems

FILMTEC™ Membranes

FILMTEC™ SW30XHR-400*i* Seawater Reverse Osmosis Element with *iLEC*™ Interlocking Endcaps

Features

Dow Water Solutions offers various premium seawater reverse osmosis (RO) elements designed to produce high quality water and reduce capital and operation cost of seawater RO systems. These products combine premium membrane performance with automated precision fabrication to provide reliable and consistent performance.

FILMTEC™ SW30XHR-400*i* element is the highest rejection seawater element in the FILMTEC element range, enabling stringent water quality requirements to be met with single pass seawater systems in most situations. The benefits of FILMTEC SW30XHR-400*i* elements include:

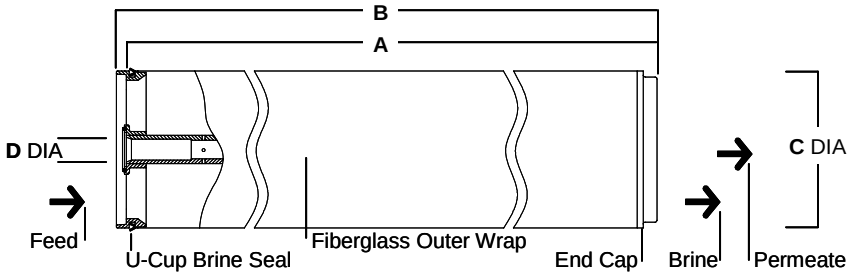
- Very high NaCl and boron rejection to help meet World Health Organization (WHO) and other drinking water standards more cost effectively.
- Utilization of the distinct *iLEC*™ interlocking endcaps that help reduce system operating costs and reduce the risk of o-ring leaks that cause poor water quality.
- Guaranteed active area of 400 square feet maximizes productivity and enables accurate and predictable system design and operating flux.
- Effective use in permeate staged seawater desalination systems without impairing the performance of the downstream stage.
- High performance over the operating lifetime without the use of oxidative post-treatments. FILMTEC elements are more durable and may be cleaned over a wider pH range (1-13) than other RO elements.
- Automated, precision fabrication with a greater number of shorter membrane leaves reducing the effect of overall fouling and maximizing element efficiency.

Product Specifications

Product	Part Number	Active Area ft^2 (m^2)	Maximum Operating Pressure psig (bar)	Permeate Flow Rate gpd (m^3/d)	Stabilized Boron Rejection %	Minimum Salt Rejection %	Stabilized Salt Rejection %
SW30XHR-400*i*	293991	400 (37)	1,200 (83)	6000 (23)	93	99.60	99.75

1. The above benchmark values are based on the following test conditions: 32,000 ppm NaCl, 800 psi (5.5 MPa), 77°F (25°C), pH 8 and 8% recovery.
2. Permeate flows for individual elements may vary +/-15%.
3. Product specifications may vary slightly as improvements are implemented.
4. Active area guaranteed +/-5%. Active area as stated by Dow Water Solutions is not comparable to the nominal membrane area figure often stated by some element suppliers. Measurement method described in Form No. 609-00434.

Figure 1



Product	Feed Spacer (mil)	Dimensions – Inches (mm) A	B	C
SW30XHR-400*i*	28	40 (1,016)	1.125 (29)	7.9 (201)

1. Refer to FilmTec Corporation Design Guidelines for multiple-element systems.
2. Elements fit nominal 8-inch (203 mm) I.D. pressure vessel.

1 inch = 25.4 mm

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature	113°F (45°C)
• Maximum Element Pressure Drop	13 psig (0.9 bar)
• pH Range, Continuous Operation[a]	2 – 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 – 13
• Maximum Feed Silt Density Index (SDI)	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

a. Maximum temperature for continuous operation above pH 10 is 95°F (35°C).
b. Refer to Cleaning Guidelines in form number 609-23010.
c. Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty. FilmTec Corporation recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void. Refer to FILMTEC™ Reverse Osmosis and Nanofiltration Element Three-Year Prorated Limited Warranty (Form No. 609-35010).
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid static permeate-side backpressure at all times.

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Notice: The use of this product in and of itself does not necessarily guarantee the removal of cysts and pathogens from water. Effective cyst and pathogen reduction is dependent on the complete system design and on the operation and maintenance of the system.

FILMTEC™ Membranes

FILMTEC™ SW30ULE-400*i* Seawater Reverse Osmosis Element with *iLEC*™ Interlocking Endcaps

Features and Benefits

Dow Water Solutions offers various premium seawater Reverse Osmosis (RO) elements which combine premium membrane performance with automated precision fabrication and maximize system output to unprecendented performance.

FILMTEC™ SW30ULE-400*i* is an element with one of the highest flow rates in the industry, and high rejection of NaCl and boron. This performance can lead to significant capital and operation cost savings, especially when this element is mixed with other element types in the same pressure vessel, using the "internally staged design" approach. The benefits of the FILMTEC SW30ULE-400*i* elements include:

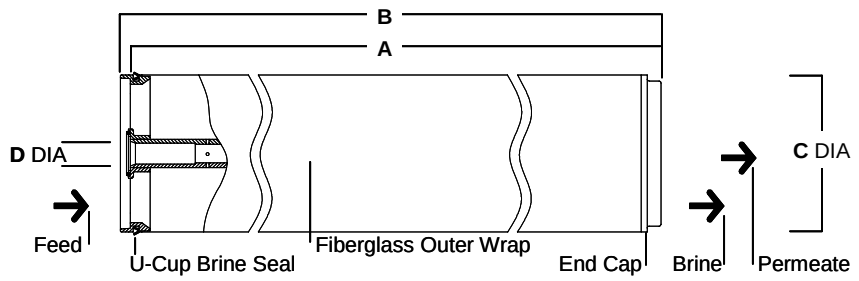
- One of the highest seawater element flow rate in the industry. This may lead to lower capital and operation cost in a seawater system.
- High NaCl and Boron rejection to help meet World Health Organization (WHO) and other drinking water standards.
- Effective use in permeate staged seawater desalination systems without impairing the performance of the downstream stage.
- High performance over the operating lifetime without the use of oxidative post-treatments.
- Automated, precision fabrication with a greater number of shorter membrane leaves reduces the effect of overall fouling and maximizes element efficiency.

Product Specifications

Product	Part Number	Active Area ft^2 (m^2)	Maximum Operating Pressure psig (bar)	Permeate Flow Rate gpd (m^3/d)	Stabilized Boron Rejection %	Minimum Salt Rejection %	Stabilized Salt Rejection %
SW30ULE-400*i*	259124	400 (37)	1,200 (83)	11,000 (41.6)	87	99.55	99.70

1. The above benchmark values are based on the following test conditions: 32,000 ppm NaCl, 800 psi (5.5 MPa), 77°F (25°C), pH 8 and 8% recovery.
2. Permeate flows for individual elements may vary +/-15%.
3. Product specifications may vary slightly as improvements are implemented.
4. Developmental product available for sale.

Figure 1



Product	Feed Spacer (mil)	Dimensions – Inches (mm) A	B	C	D
SW30ULE-400*i*	28	40 (1,016)	40.5 (1,029)	7.9 (201)	1.125 (29)

1. Refer to FilmTec Design Guidelines for multiple-element systems.
2. Elements fit nominal 8-inch (203 mm) I.D. pressure vessel.

1 inch = 25.4 mm

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature	113°F (45°C)
• Maximum Element Pressure Drop	13 psig (0.9 bar)
• pH Range, Continuous Operation[a]	2 – 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 – 13
• Maximum Feed Silt Density Index (SDI)	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

a. Maximum temperature for continuous operation above pH 10 is 95°F (35°C).
b. Refer to Cleaning Guidelines in specification sheet 609-23010.
c. Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty. FilmTec Corporation recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled "How to Start-Up an RO Membrane System" (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void. Refer to the FILMTEC™ Reverse Osmosis and Nanofiltration Element Three-Year Prorated Limited Warranty (609-35010) for more detail.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid static permeate-side backpressure at all times.
- Wear protective eye shields, gloves, and sleeves to avoid prolonged contact with eyes, skin, and clothing.

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FILMTEC™ Membranes

FILMTEC SW30XLE-400*i* Seawater Reverse Osmosis Element with *iLEC* Interlocking Endcaps

Features

FilmTec offers various premium seawater reverse osmosis (RO) elements to reduce capital and operation cost of seawater RO systems. FILMTEC™ products combine premium membrane performance with automated precision fabrication and maximize system output to unprecedented performance.

FILMTEC SW30XLE-400*i* offers an unequalled combination of productivity and rejection. This is the lowest energy seawater element available on the market, enabling lowest operation cost. It is also ideal for two-pass seawater designs and high TDS brackish water applications. FILMTEC SW30XLE-400*i* comes with the unique *iLEC*™ Interlocking Endcaps that reduce system operating costs and reduce the risk of o-ring leaks that cause poor water quality. See Form No. 609-00446 for information on the trouble-free cost-saving benefits of *iLEC* Interlocking Endcaps. Benefits of SW30XLE-400*i* include:

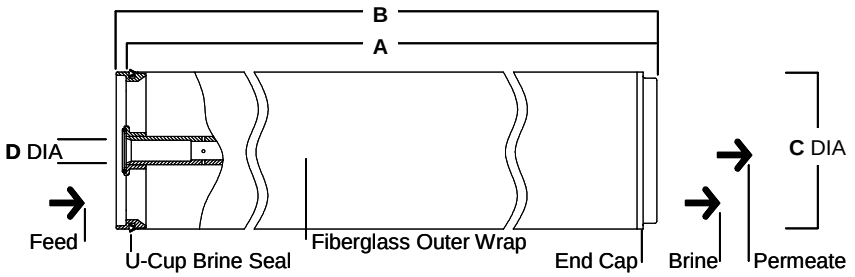
- Highest productivity available, with active area of 400 sq. ft., enables systems to be designed to deliver the lowest total cost of water by optimizing energy consumption, system productivity and operating flux.
- Can effectively be used in permeate staged seawater desalination systems without impairing the performance of the downstream stage.
- Delivers high performance over the operating lifetime without the use of oxidative post-treatments like many competitive products. This is one reason FILMTEC elements are more durable and may be cleaned more effectively over a wider pH range (1-13) than other RO elements.
- Automated, precision fabrication with a greater number of shorter membrane leaves reduces the effect of overall fouling and maximizes element efficiency, lowering your cost of operation.

Product Specifications

Product	Part number	Active area ft^2 (m^2)	Maximum operating pressure psig (bar)	Permeate flow rate gpd (m^3/d)	Stabilized boron rejection %	Minimum salt rejection %	Stabilized salt rejection %
SW30XLE-400*i*	219219	400 (37)	1,200 (83)	9,000 (34)	88	99.55	99.70

1. The above values are normalized to the following conditions: 32,000 ppm NaCl, 5 ppm Boron, 800 psi (5.5 MPa), 77°F (25°C), pH 8, 8% recovery.
2. Permeate flows for individual elements may vary +/-15%.
3. Product specifications may vary slightly as improvements are implemented.
4. Active area guaranteed +/-5%. Active area as stated by FilmTec is not comparable to the nominal membrane area figure often stated by some element suppliers. Measurement method described in Form No. 609-00434

Figure 1



Product	Feed spacer (mil)	Dimensions – inches (mm) A	B	C	D
SW30XLE-400*i*	28	40 (1,016)	40.5 (1,029)	7.9 (201)	1.125 (29)

1. Refer to FilmTec Design Guidelines for multiple-element systems. 1 inch = 25.4 mm
2. Elements fit nominal 8-inch (203 mm) I.D. pressure vessel.
3. Individual *iLEC* elements measure 40.5 inches (1,029 mm) in length (B). The net length (A) of *iLEC* elements when connected is 40 inches (1,016 mm).

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature[a]	113°F (45°C)
• Maximum Element Pressure Drop	15 psig (1.0 bar)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Silt Density Index (SDI)	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

a. Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

b. Refer to Cleaning Guidelines in specification sheet 609-23010.

c. Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty. FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid static permeate-side backpressure at all times.

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Notice: The use of this product in and of itself does not necessarily guarantee the removal of cysts and pathogens from water. Effective cyst and pathogen reduction is dependent on the complete system design and on the operation and maintenance of the system.

Notice: No freedom from any patent owned by Seller or others is to be inferred. Because use conditions and applicable laws may differ from one location to another and may change with time, Customer is responsible for determining whether products and the information in this document are appropriate for Customer’s use and for ensuring that Customer’s workplace and disposal practices are in compliance with applicable laws and other governmental enactments. Seller assumes no obligation or liability for the information in this document. NO WARRANTIES ARE GIVEN; ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY EXCLUDED.

FILMTEC™ Membranes

FILMTEC SW30HR LE-400***i*** Seawater Reverse Osmosis Element with ***iLEC***™ Interlocking Endcaps

Features

Dow Water Solutions offers various premium seawater reverse osmosis (RO) elements designed to reduce capital and operation cost of seawater RO systems. FILMTEC™ elements combine premium membrane performance with automated precision fabrication and maximize system output to provide unprecedented performance.

The FILMTEC™ SW30HR LE-400***i*** element offers a combination of high rejection and low energy requirements to allow lower total costs with medium and high salinity feedwater. FILMTEC SW30HR LE-400***i*** element comes with the distinct ***iLEC***™ Interlocking Endcaps that help reduce system operating costs and reduce the risk of o-ring leaks that cause poor water quality. See Form No. 609-00446 for information on the cost-saving benefits of ***iLEC*** Interlocking Endcaps. Benefits of the FILMTEC SW30HR LE-400***i*** element include:

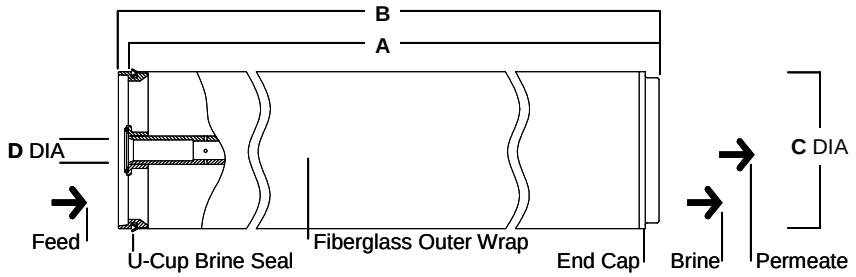
- Enables systems to be designed and operated to optimize operating cost through lower energy consumption or to optimize capital cost through higher productivity at lower operating fluxes.
- High NaCl and boron rejection to help meet World Health Organization (WHO) and other drinking water standards.
- Effective use in permeate staged seawater desalination systems without impairing the performance of the downstream stage.
- High performance over the operating lifetime without the use of oxidative post-treatments. This is one reason FILMTEC elements are more durable and may be cleaned more effectively over a wider pH range (1-13) than other RO elements.
- Automated, precision fabrication with a greater number of shorter membrane leaves reducing the effect of overall fouling and maximizing element efficiency, helping to lower your cost of operation.

Product Specifications

Product	Part number	Active area ft^2 (m^2)	Maximum operating pressure psig (bar)	Permeate flow rate gpd (m^3/d)	Stabilized boron rejection %	Minimum salt rejection %	Stabilized salt rejection %
SW30HR LE-400***i***	246512	400 (37)	1,200 (83)	7,500 (28)	91	99.60	99.75

1. The above values are normalized to the following conditions: 32,000 ppm NaCl, 5 ppm boron, 800 psi (5.5 MPa), 77°F (25°C), pH 8, 8% recovery.
2. Permeate flows for individual elements may vary +/-15%.
3. Product specifications may vary slightly as improvements are implemented.
4. Active area guaranteed +/-5%. Active area as stated by Dow Water Solutions is not comparable to the nominal membrane area figure often stated by some element suppliers. Measurement method described in Form No. 609-00434.

Figure 1



Product	Feed spacer (mil)	Dimensions – inches (mm) A	B	C	D
SW30HR LE-400***i***	28	40 (1,016)	40.5 (1,029)	7.9 (201)	1.125 (29)

1. Refer to FilmTec Corporation Design Guidelines for multiple-element systems. 1 inch = 25.4 mm
2. Elements fit nominal 8-inch (203 mm) I.D. pressure vessel
3. Individual ***iLEC*** elements measure 40.5 inches (1,029 mm) in length (B). The net length (A) of ***iLEC*** elements when connected is 40 inches (1,016 mm).

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature[a]	113°F (45°C)
• Maximum Element Pressure Drop	15 psig (1.0 bar)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Silt Density Index (SDI)	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

a. Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

b. Refer to Cleaning Guidelines in Form No. 609-23010.

c. Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty. FilmTec Corporation recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void. Refer to FILMTEC™ Reverse Osmosis and Nanofiltration Element Three-Year Prorated Limited Warranty (Form No. 609-35010)
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid static permeate-side backpressure at all times.

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FILMTEC™ Membranes

FILMTEC SW30HR LE-400 Seawater Reverse Osmosis Element

Features

Dow Water Solutions offers various premium seawater reverse osmosis (RO) elements designed to reduce capital and operation cost of seawater RO systems. FILMTEC™ elements combine premium membrane performance with automated precision fabrication and maximize system output to provide unprecedented performance.

The FILMTEC™ SW30HR LE-400 element offers a combination of high rejection and low energy requirements to allow lower total costs with medium and high salinity feedwater. Benefits of the FILMTEC SW30HR LE-400 element include:

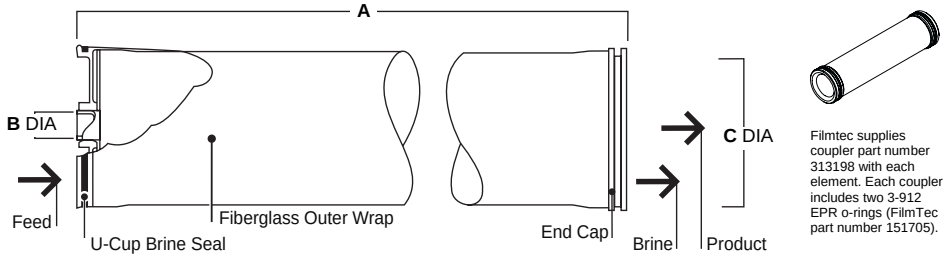
- Enables systems to be designed and operated to optimize operating cost through lower energy consumption or to optimize capital cost through higher productivity at lower operating fluxes.
- High NaCl and boron rejection to help meet World Health Organization (WHO) and other drinking water standards.
- Effective use in permeate staged seawater desalination systems without impairing the performance of the downstream stage.
- High performance over the operating lifetime without the use of oxidative post-treatments. This is one reason FILMTEC elements are more durable and may be cleaned more effectively over a wider pH range (1-13) than other RO elements.
- Automated, precision fabrication with a greater number of shorter membrane leaves reducing the effect of overall fouling and maximizing element efficiency, helping to lower your cost of operation.

Product Specifications

Product	Part number	Active area ft^2 (m^2)	Maximum operating pressure psig (bar)	Permeate flow rate gpd (m^3/d)	Stabilized boron rejection %	Minimum salt rejection %	Stabilized salt rejection %
SW30HR LE-400	217822	400 (37)	1,200 (83)	7,500 (28)	91	99.60	99.75

1. The above values are normalized to the following conditions: 32,000 ppm NaCl, 5 ppm boron, 800 psi (5.5 MPa), 77°F (25°C), pH 8, 8% recovery.
2. Permeate flows for individual elements may vary +/-15%.
3. Product specifications may vary slightly as improvements are implemented.
4. Active area guaranteed +/-5%. Active area as stated by Dow Water Solutions is not comparable to the nominal membrane area figure often stated by some element suppliers. Measurement method described in Form No. 609-00434.

Figure 1



Product	Feed Spacer (mil)	Dimensions – Inches (mm) A	B	C
SW30HR LE-400	28	40 (1,016)	1.125 (29)	7.9 (201)

1. Refer to FilmTec Corporation Design Guidelines for multiple-element systems.
2. Elements fit nominal 8-inch (203 mm) I.D. pressure vessel.

1 inch = 25.4 mm

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature[a]	113°F (45°C)
• Maximum Element Pressure Drop	15 psig (1.0 bar)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Silt Density Index (SDI)	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

a. Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

b. Refer to Cleaning Guidelines in Form No. 609-23010.

c. Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty. FilmTec Corporation recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void. Refer to FILMTEC™ Reverse Osmosis and Nanofiltration Element Three-Year Prorated Limited Warranty (Form No. 609-35010).
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid static permeate-side backpressure at all times.

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FILMTEC™ Membranes

FILMTEC SW30HR-370/34*i* Seawater Reverse Osmosis Element with *iLEC*™ Interlocking Endcaps

Features

Dow Water Solutions offers various premium seawater reverse osmosis (RO) elements designed to produce high quality water and reduce capital and operation cost of seawater RO systems. These products combine premium membrane performance with automated precision fabrication to provide reliable and consistent performance.

FILMTEC™ SW30HR-370/34*i* element is a durable, high-rejection, high-productivity seawater element for use in high fouling or challenging feedwater conditions, helping to support smooth operations and low cost of water.

The benefits of FILMTEC SW30HR-370/34*i* elements include:

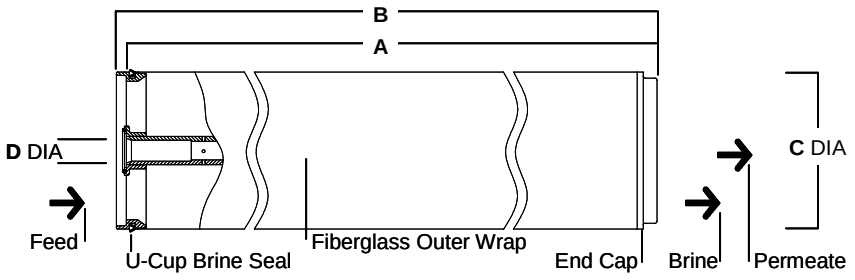
- A wide 34 mil feed spacer to lessen the impact of fouling on pressure drop across a vessel and enhance cleaning effectiveness.
- Guaranteed active area of 370 square feet maximizing productivity and enabling accurate and predictable system design and operating flux.
- Utilization of the distinct *iLEC*™ interlocking endcaps that help to reduce system operating costs and reduce the risk of o-ring leaks that cause poor water quality.
- Effective use in permeate staged seawater desalination systems without impairing the performance of the downstream stage.
- High performance over the operating lifetime without the use of oxidative post-treatments. FILMTEC elements are more durable and may be cleaned over a wider pH range (1-13) than other RO elements.
- Automated, precision fabrication with a greater number of shorter membrane leaves reducing the effect of overall fouling and maximizing element efficiency.

Product Specifications

Product	Part Number	Active Area ft^2 (m^2)	Maximum Operating Pressure psig (bar)	Permeate Flow Rate gpd (m^3/d)	Stabilized Boron Rejection %	Minimum Salt Rejection %	Stabilized Salt Rejection %
SW30HR-370/34*i*	297258	370 (34.4)	1,200 (83)	6,300 (24)	91	99.60	99.75

1. The above benchmark values are based on the following test conditions: 32,000 ppm NaCl, 5 ppm Boron, 800 psi (5.5 MPa), 77°F (25°C), pH 8 and 8% recovery.
2. Permeate flows for individual elements may vary +/-15%.
3. Product specifications may vary slightly as improvements are implemented.
4. Active area guaranteed +/-5%. Active area as stated by FilmTec Corporation is not comparable to the nominal membrane area figure often stated by some element suppliers. Measurement method described in Form No. 609-00434.

Figure 1



Dimensions – Inches (mm)

Product	Feed Spacer (mil)	A	B	C	D
SW30HR-370/34*i*	34	40 (1,016)	40.5 (1,029)	7.9 (201)	1.125 (29)

1. Refer to FilmTec Corporation Design Guidelines for multiple-element systems.
2. Elements fit nominal 8-inch (203 mm) I.D. pressure vessel.

1 inch = 25.4 mm

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature	113°F (45°C)
• Maximum Element Pressure Drop	13 psig (0.9 bar)
• pH Range, Continuous Operation[a]	2 – 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 – 13
• Maximum Feed Silt Density Index (SDI)	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

a. Maximum temperature for continuous operation above pH 10 is 95°F (35°C).
b. Refer to Cleaning Guidelines in specification sheet 609-23010.
c. Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty. FilmTec Corporation recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void. Refer to FILMTEC™ Reverse Osmosis and Nanofiltration Element Three-Year Prorated Limited Warranty (Form No. 609-35010)
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid static permeate-side backpressure at all times.

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FILMTEC™ Membranes

FILMTEC SW30HR-380 High Rejection Seawater RO Element

Features

The FILMTEC™ SW30HR-380 is a premium grade seawater reverse osmosis element featuring both high active area and high salt rejection to offer the best long-term economics for seawater desalination systems.

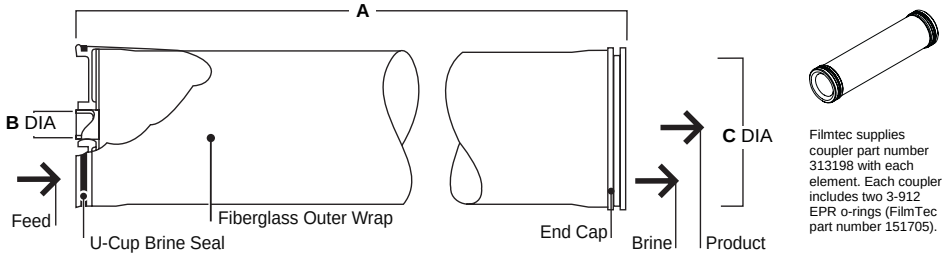
- FILMTEC SW30HR-380 delivers the highest boron rejection to help customers meet World Health Organization (WHO) and other drinking water standards.
- FILMTEC SW30HR-380 elements deliver high performance over their operating lifetime without the use of oxidative post-treatments like many competitive products. This is one reason why FILMTEC elements are more durable and may be cleaned more effectively over a wide pH range than other RO elements.
- Automated, precision fabrication with a greater number of shorter membrane leaves, reduces the overall effect of fouling and maximizes membrane efficiency.

Product Specifications

Product	Part Number	Active Area ft^2 (m^2)	Applied Pressure psig (bar)	Permeate Flow Rate gpd (m^3/d)	Stabilized Salt Rejection (%)
SW30HR-380	135137	380 (35)	800 (55)	6,000 (23)	99.7

1. Permeate flow and salt rejection based on the following test conditions: 32,000 mg/L NaCl, pressure specified above, 77°F (25°C), pH 8 and 8% recovery.
2. Permeate flows for individual elements may vary +/-15%.
3. Minimum salt rejection is 99.6%.
4. Sales specifications may vary as design revisions take place.
5. Feed spacer is 28 mil.

Figure 1



Dimensions – Inches (mm)

Product	A	B	C
SW30HR-380	40.0 (1,016)	1.125 (29)	7.9 (201)

1. Refer to FilmTec Design Guidelines for multiple-element applications and recommended element recovery rates for various feed sources.
2. SW30HR-380 fits nominal 8.00-inch (203 mm) I.D. pressure vessel.

1 inch = 25.4 mm

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature[a]	113°F (45°C)
• Maximum Operating Pressure	1,000 psig (69 bar)[d]
• Maximum Pressure Drop	15 psig (1.0 bar)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Silt Density Index	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

[d] Operation at pressures up to 1,200 psig (83 bar) is allowable under certain conditions. Consult your Dow representative for advice on applications above 1,000 psig (69 bar).

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid permeate-side backpressure at all times.

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FILMTEC™ Membranes

FILMTEC Seawater RO Elements for Marine Systems

Features

Improved FILMTEC™ seawater reverse osmosis elements offer the highest productivity while maintaining excellent salt rejection.

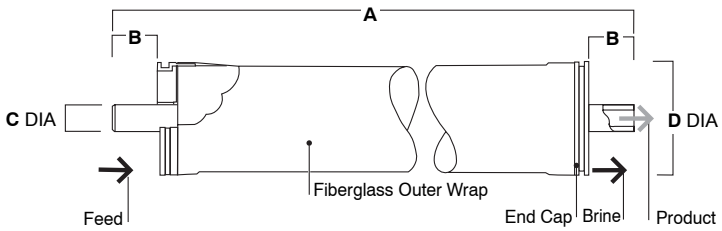
- FILMTEC SW30 membrane elements have the highest flow rates available to meet the water demands of both sea-based and land-based desalinators.
- FILMTEC SW30 elements may also be operated at lower pressure to reduce pump size, cost and operating expenses.
- Improved FILMTEC seawater membrane combined with automated, precision element fabrication result in the most consistent product performance available.

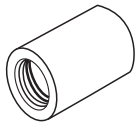
Product Specifications

Product	Part Number	Active Area ft^2 (m^2)	Applied Pressure psig (bar)	Permeate Flow Rate gpd (m^3/d)	Stabilized Salt Rejection (%)
SW30-2514	80733	6.5 (0.6)	800 (55)	150 (0.6)	99.4
SW30-2521	80734	13 (1.2)	800 (55)	300 (1.1)	99.4
SW30-2540	80737	29 (2.8)	800 (55)	700 (2.6)	99.4
SW30-4021	80740	33 (3.1)	800 (55)	800 (3.0)	99.4
SW30-4040	80741	80 (7.4)	800 (55)	1,950 (7.4)	99.4

1. Permeate flow and salt rejection based on the following test conditions: 32,000 ppm NaCl, pressure specified above, 77°F (25°C) and the following recovery rates; SW30-2514 – 2%, SW30-2521 & SW30-4021 – 4%, SW30-2540 & SW30-4040 – 8%.
2. Permeate flows for individual elements may vary +/-20%.
3. For the purpose of improvement, specifications may be updated periodically.

Figure 1





FilmTec sells coupler part number 89055 for use in multiple element housings. Each coupler includes two 2-210 EPR o-rings, FilmTec part number 89255.

Product	Maximum Feed Flow Rate gpm (m^3/h)	Dimensions – Inches (mm) A	B	C	D
SW30-2514	6 (1.4)	14.0 (356)	1.19 (30.2)	0.75 (19)	2.4 (61)
SW30-2521	6 (1.4)	21.0 (533)	1.19 (30.2)	0.75 (19)	2.4 (61)
SW30-2540	6 (1.4)	40.0 (1,016)	1.19 (30.2)	0.75 (19)	2.4 (61)
SW30-4021	16 (3.6)	21.0 (533)	1.05 (26.7)	0.75 (19)	3.9 (99)
SW30-4040	16 (3.6)	40.0 (1,016)	1.05 (26.7)	0.75 (19)	3.9 (99)

1. Refer to FilmTec Design Guidelines for multiple-element systems.
2. SW30-2514, SW30-2521 and SW30-2540 elements fit nominal 2.5-inch I.D. pressure vessels. SW30-4021 and SW30-4040 elements fit nominal 4-inch I.D. pressure vessel.

1 inch = 25.4 mm

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature	113°F (45°C)
• Maximum Operating Pressure	1,000 psi (69 bar)
• Maximum Pressure Drop	15 psig (1.0 bar)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning[b]	1 - 13
• Maximum Feed Silt Density Index	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid static permeate-side backpressure at all times.

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FILMTEC™ Membranes

5. Nanofiltration Elements

- Nanofiltration Elements Available for Pilot Testing
- FILMTEC NF90-400 Nanofiltration Element
- FILMTEC NF270-400 Nanofiltration Element

FILMTEC™ Membranes

Nanofiltration Elements Available for Pilot Testing

For pilot testing, the following nanofiltration elements are available.

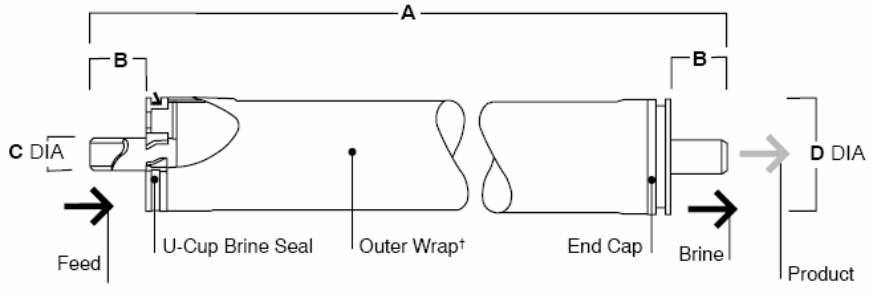
Product	Application
NF200	Medium to high salt passage, medium calcium passage (50-65%), high atrazine rejection (95%) and high TOC rejection.
NF270	High salt passage, medium calcium passage (40-60%) and high TOC removal.
NF90	High salt removal (90%), high iron removal, pesticide, herbicide removal and TOC removal.

Product Specifications

Product	Nominal Active Surface Area (ft^2 (m^2))	GMID	Product Water (gpd)	Flow Rate (L/h)	Solute Passage (%)	Atrazine Passage (%)
NF200-2540	28 (2.6)	89592				
$CaCl_2$			550	86.7	50-65	< 7
$MgSO_4$			460	72.5	< 3	
NF200-4040	82 (7.6)	89198				
$CaCl_2$			1,600	252.3	50-65	< 7
$MgSO_4$			1,350	212.9	< 3	
NF270-2540	28 (2.6)	149986				
$CaCl_2$			1,000	157.7	40-60	
$MgSO_4$			850	134	< 3	
NF270-4040	82 (7.6)	149987				
$CaCl_2$			2,925	461.3	40-60	
$MgSO_4$			2,500	394.3	< 3	
NF90-2540	28 (2.6)	149982				
NaCl			525	82.8	5-15	
$MgSO_4$			600	94.6	< 3	
NF90-4040	82 (7.6)	149983				
NaCl			1,400	220.8	5-15	
$MgSO_4$			1,850	291.7	< 3	

1. Permeate flow and salt rejection based on the following test conditions:
   500 ppm $CaCl_2$, 70 psi (0.5 MPa), 77°F (25°C) and 15% recovery.
   2,000 ppm $MgSO_4$, 70 psi (0.5 MPa), 77°F (25°C) and recovery as indicated below.
   2,000 ppm NaCl, 70 psi (0.5 MPa), 77°F (25°C) and recovery as indicated below
2. Flow rates for individual elements may vary +/- 25%.

Figure 1



Product	Single Element Recorery	Dimensions – Inches (mm) A	B	C	D
2540 Configuration[5]	15%	40 (1,016)	1.19 (30)	0.75 (19)	2.401 (61)
4040 Configuration[6]	15%	40 (1,016)	1.05 (27)	0.75 (19)	3.913 (99.4)

4. Consult the most recent Design Guidelines for multiple element applications and recommended element recovery rates for various feed sources. 1 inch = 25.4 mm
5. Element to fit 2.45-inch (62 mm) I.D. pressure vessel.
6. Element to fit 4.00-inch (102 mm) I.D. pressure vessel.

† Tape outer wrap for 2540 configuration and fiberglass outer wrap for 4040 configuration.

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Pressure	600 psig (41 bar)
• Maximum Operating Temperature[a]	104°F (40°C)
• Free Chlorine Tolerance[a]	< 0.1 ppm
• pH Range, Continuous Operation[b]	2 - 11
• pH Range, Short-term Cleaning (30 min.)[c]	1 - 12
• Maximum Feed Flow	
2540	6 gpm (1.4 m^3/h)
4040	16 gpm (3.6 m^3/h)
• Maximum Feed Silt Density Index	SDI 5

[a] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

[b] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[c] Refer to Cleaning Guidelines in specification sheet 609-23010.

Important Operating Information

1. Keep elements moist at all times after initial wetting.
2. If operating specifications given in this Product Information bulletin are not strictly followed, the limited warranty will be null and void.
3. Permeate obtained from first hour of operation should be discarded.
4. To prevent biological growth during storage, shipping or system shutdowns it is recommended that FILMTEC™ elements be immersed in a protective solution. The standard storage solution contains 1.5 percent (by weight) sodium metabisulfite (food grade).
5. Elements must be in use for at least six hours before formaldehyde is used as a biocide. If the elements are exposed to formaldehyde before being in use for this period of time, a loss in flux may result.
6. The membrane shows some resistance to short-term attack by chlorine (hypochlorite). Continuous exposure, however, may damage the membrane and should be avoided.
7. The customer if fully responsible for the effects of incompatible chemicals on elements. Their use will void the element limited warranty.

Warranty Terms

These products are covered by a 12 month materials and workmanship warranty and a 3 year pro-rated warranty.

GMID

Dow Global Material Identification number (FilmTec part number).

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FILMTEC™ Membranes

FILMTEC NF90-400 Nanofiltration Element

Features

The FILMTEC™ NF90-400 nanofiltration element is a high area, high productivity element designed to remove a high percentage of salts, nitrate, iron and organic compounds such as pesticides, herbicides and THM precursors.

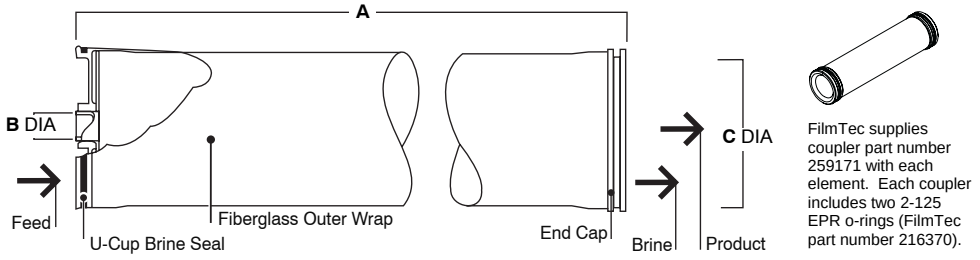
The high active area membrane combined with low net driving pressure of the membrane allows the removal of these compounds at low operating pressure.

Product Specifications

Product	GMID	Nominal Active Surface Area ft^2 (m^2)	Product Water Flow Rate gpd (m^3/d)	Stabilized Salt Rejection (%)
NF90-400	149985	400 (37)		
NaCl			7,500 (28.4)	85 - 95
$MgSO_4$			9,500 (36.0)	>97

1. Permeate flow and salt passage based on the following test conditions:
   2,000 mg/l NaCl, 70 psi (0.48 MPa), 77°F (25°C) and 15% recovery.
   2,000 mg/l $MgSO_4$, 70 psi (0.48 MPa), 77°F (25°C) and 15% recovery.
2. Flow rates for individual elements may vary +/-15%.
3. The above specifications are benchmark values. Please be sure to operate according to our system design guidelines.

Figure 1



Product	Single-Element Recovery	Dimensions – Inches (mm) A	B	C
NF90-400	15%	40 (1,016)	1.5 (38)	7.9 (201)

1. Refer to FilmTec Design Guidelines for multiple-element applications and recommended element recovery rates for various feed sources. 1 inch = 25.4 mm
2. Element to fit nominal 8.00-inch (203 mm) I.D. pressure vessel.

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature	113°F (45°C)
• Maximum Operating Pressure	600 psig (41 bar)
• Maximum Pressure Drop	15 psig (1.0 bar)
• pH Range, Continuous Operation[a]	3 - 10
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Flow	70 gpm (15.9 m^3/hr)
• Maximum Feed Silt Density Index	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature	113°F (45°C)
• Maximum Operating Pressure	600 psig (41 bar)
• Maximum Pressure Drop	15 psig (1.0 bar)
• pH Range, Continuous Operation[a]	3 – 10
• pH Range, Short-Term Cleaning (30 min.)[b]	1 – 12
• Maximum Feed Flow	70 gpm (15.9 m^3/hr)
• Maximum Feed Silt Density Index	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-00298) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid permeate-side backpressure at all times.

Notice: The use of this product in and of itself does not necessarily guarantee the removal of cysts and pathogens from water. Effective cyst and pathogen reduction is dependent on the complete system design and on the operation and maintenance of the system.

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DOW*

FILMTEC™ Membranes

FILMTEC NF270-400 Nanofiltration Element

Features

The FILMTEC™ NF270-400 element is a high area, high productivity element designed to remove a high percentage of TOC and THM precursors while having a medium to high salt passage; medium hardness passage.

The FILMTEC NF270-400 element is an ideal element for surface and ground water applications where good organic removal is desired with partial softening in order to maintain a minimum level of hardness for organoleptic properties and preservation of distribution networks.

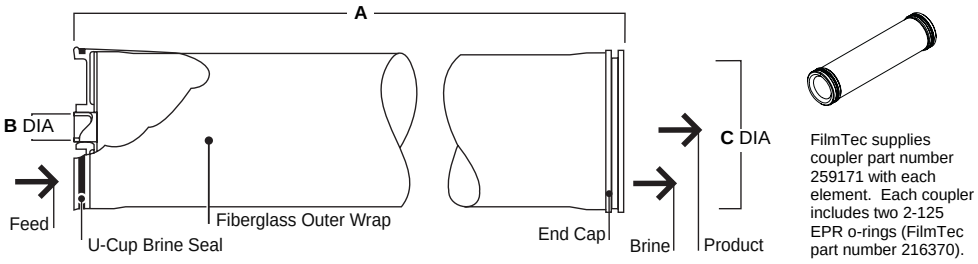
The high active area membrane combined with low net driving pressure of the membrane allows the removal of these compounds at low operating pressure.

Product Specifications

Product	GMID	Nominal Active Surface Area ft^2 (m^2)	Product Water Flow Rate gpd (m^3/d)	Stabilized Salt Passage (%)
NF270-400	148822	400 (37)		
$CaCl_2$			14,700 (55.6)	40-60
$MgSO_4$			12,500 (47.3)	< 3

1. Permeate flow and salt passage based on the following test conditions:
   500 mg/l $CaCl_2$, 70 psi (0.48 MPa), 77°F (25°C) and 15% recovery.
   2,000 mg/l $MgSO_4$, 70 psi (0.48 MPa), 77°F (25°C) and 15% recovery.
2. Flow rates for individual elements may vary +/-15%.
3. The above specifications are benchmark values. Please be sure to operate according to our system design guidelines.

Figure 1



Product	Single-Element Recovery	Dimensions – Inches (mm) A	B	C
NF270-400	15%	40 (1,016)	1.5 (38)	7.9 (201)

1. Refer to FilmTec Design Guidelines for multiple-element applications and recommended element recovery rates for various feed sources.
2. Element to fit nominal 8.00-inch (203 mm) I.D. pressure vessel.

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature	113°F (45°C)
• Maximum Operating Pressure	600 psig (41 bar)
• Maximum Pressure Drop	15 psig (1.0 bar)
• pH Range, Continuous Operation[a]	3 - 10
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 12
• Maximum Feed Flow	70 gpm (15.9 m^3/hr)
• Maximum Feed Silt Density Index	SDI 5
• Free Chlorine Tolerance[c]	<0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (3.4 bar).
- Avoid permeate-side backpressure at all times.

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FILMTEC™ Membranes

6. Engineering Information

- RO/NF Membrane Description
- FT30 Reverse Osmosis Membrane Specifications
- Membrane System Design Guidelines
- Dechlorinating Feedwater
- Cleaning Procedures for FILMTEC FT30 Elements
- FT30 Reverse Osmosis Membrane Biological Protection and Disinfection
- Disinfecting RO Systems with Hydrogen Peroxide
- Understanding RO Element Salt Rejection Specifications
- Temperature Correction Factor

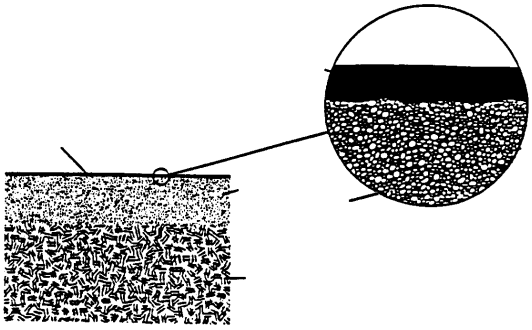
FILMTEC Membranes

Basics of RO and NF: Membrane Description

Membrane Description

The FILMTEC™ membrane is a thin film composite membrane consisting of three layers: a polyester support web, a microporous polysulfone interlayer, and an ultra thin polyamide barrier layer on the top surface. Each layer is tailored to specific requirements. A schematic diagram of the membrane is shown in Figure 1.10.

Figure 1.10 Schematic cross-section of a FILMTEC thin film composite membrane

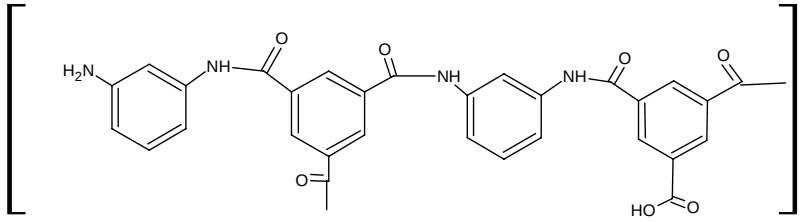


Polyamide, Microporous Polysulfone, Polyester Support Web, Ultrathin Barrier Layer
0.2 micro-m, 40 micro-m, 120 micro-m

FilmTec produces two different types of polyamide membranes for use in water purification. The first is the FT30 chemistry, which is an aromatic polyamide and is used in all FILMTEC reverse osmosis membranes and the NF90 nanofiltration membrane patented by John Cadotte at FilmTec in 1969. The second type is a mixed aromatic, aliphatic polyamide used in all nanofiltration membranes and was also initially developed by John Cadotte at FilmTec. Thirty years of further innovations at FilmTec have led to the broadest range of nanofiltration and reverse osmosis membranes in the industry. FILMTEC membranes cover a flux performance range from 0.04 to 0.55 gfd/psi (1 to 14 l/m^{2}h / bar). This 14 fold difference in water permeability is covered by two polyamide types with small changes in composition and larger changes in the water content of the membrane: the aromatic FT30 membrane and the aliphatic/aromatic nanofiltration membrane. The latter type is sometimes referred to as polypiperazine membrane.

Figure 1.11 represents the approximate structure of the FT-30 aromatic polyamide membrane. The presence of both amine and carboxylate end groups are shown.

Figure 1.11 Barrier layer of the FT30 aromatic polyamide membrane



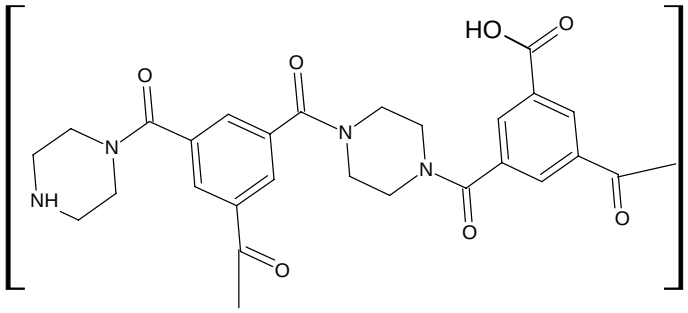
Free Amine Carboxylate

Membrane Description (cont.)

The FT-30 membrane is an aromatic polyamide made from 1,3 phenylene diamine and the tri acid chloride of benzene. This remarkably chemically resistant and structurally strong polymer contains carboxyllic acid and free (not reacted) amines at different levels. High chemical stability makes it the most durable and easy to clean membrane material available.

The approximate structure of most of the FILMTEC nanofiltration membranes is shown in Figure 1.12. This is an aromatic/aliphatic polyamide with amine and caboxylates end groups.

Figure 1.12 Barrier layer of the aromatic/aliphatic polyamide nanofiltration membrane



Free Amine

Carboxylate

Because of the trace additives and the different dissociation constants of the piperazine found in this polymer we are able to have a wider range of both monovalent and divalent salts transporting through this polymer. This has allowed us to design a wide range of nanofiltration membranes that have different salt selectivity for different separations.

The major structural support is provided by the non-woven web, which has been calendered to produce a hard, smooth surface free of loose fibers. Since the polyester web is too irregular and porous to provide a proper substrate for the salt barrier layer, a microporous layer of engineering plastic (polysulfone) is cast onto the surface of the web.

The polysulfone coating is remarkable in that it has surface pores controlled to a diameter of approximately 150 Angstroms. The barrier layer, about 2,000 Angstroms thick, can withstand high pressures because of the support provided by the polysulfone layer. The combination of the polyester web and the polysulfone layer has been optimized for high water permeability at high pressure.

The barrier layer is relatively thick; making FILMTEC membranes highly resistant to mechanical stresses and chemical degradation.

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FILMTEC™ Membranes

FT30 Reverse Osmosis Membrane Specifications

Features

The FILMTEC™ FT30 reverse osmosis membrane gives excellent performance for a wide variety of applications including low-pressure tapwater purification, single-pass seawater desalination, chemical processing, and waste treatment. This membrane exhibits high rejection at low pressures with very stable long-term operation.

Solute	MW	Rejection (%)
Sodium fluoride NaF[1]	42	99
Sodium cyanide NaCN (pH 11)	49	97
Sodium chloride NaCl	58	99
Silica SiO_2 (50 ppm)	60	98
Sodium bicarbonate $NaHCO_3$	84	99
Sodium nitrate $NaNO_3$	85	97
Magnesium chloride $MgCl_2$	95	99
Calcium chloride $CaCl_2$	111	99
Magnesium sulfate $MgSO_4$	120	> 99
Nickel sulfate $NiSO_4$	155	> 99
Copper sulfate $CuSO_4$	160	> 99
Formaldehyde	30	35
Methanol	32	25
Ethanol	46	70
Isopropanol	60	90
Urea	60	70
Lactic acid (pH 2)	90	94
Lactic acid (pH 5)	90	99
Glucose	180	98
Sucrose	342	99
Chlorinated pesticides (traces)	–	> 99

1. Solute rejection (approximate) 2,000 ppm solute, 225 psi (1.6 MPa), 77°F (25°C), pH 7 (unless otherwise noted).
2. Fluoride rejection is strongly pH dependent (about 75% at pH 5, 50% at pH 4, 30% at pH 3.5 and 0% below pH 3).
3. FT30 membrane is available in a wide variety of spiral-wound configurations.

Operating Limits

- Membrane type — Thin-film composite polyamide
- Maximum operating pressure — 1,000 psi (6.9 MPa)
- Maximum operating temperature — 113°F (45°C)
- Free chlorine tolerance — < 0.1 ppm
- pH range, continuous operation — 2 - 11
- pH range, short-term cleaning (30 min.) — 1 - 13

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FILMTEC™ Membranes

System Design: Membrane System Design Guidelines

Membrane System Design Guidelines

The factor which has the greatest influence on the membrane system design is the fouling tendency of the feed water. Membrane fouling is caused by particles and colloidal material which are present in the feed water and are concentrated at the membrane surface. The Silt Density Index (SDI) value of the pretreated feed water correlates fairly well with the amount of fouling material present. The concentration of the fouling materials at the membrane surface increases with increasing permeate flux (the permeate flow rate per unit membrane area) and increasing FILMTEC™ element recovery (the ratio of permeate flow rate to feed flow rate for a single element). A system with high permeate flux rates is, therefore likely to experience higher fouling rates and more frequent chemical cleaning.

A membrane system should be designed such that each element of the system operates within a frame of recommended operating conditions to minimize the fouling rate and to exclude mechanical damage. These element operating conditions are limited by the maximum recovery, the maximum permeate flow rate, the minimum concentrate flow rate and the maximum feed flow rate per element. The higher the fouling tendency of the feed water the stricter are the limits of these parameters. The proposed limits are recommended guidelines based on many years of experience with FILMTEC membranes.

The average flux of the entire system, i.e. the system permeate flow rate related to the total active membrane area of the system, is a characteristic number of a design. The system flux is a useful number to quickly estimate the required number of elements for a new project. Systems operating on high quality feed waters are typically designed at high flux values whereas systems operating on poor quality feed waters are designed at low flux values. However, even within the same feed water category, systems are designed with higher or lower flux values, depending on the focus being either on minimizing the capital expenses or minimizing the long term operational expenses. The ranges of flux values given in the tables below are typical numbers for the majority of systems, but they are not meant to be limits.

A continuous RO/NF process designed according to the system design guidelines and with a well-designed and operated pretreatment system will show stable performance with no more than about four cleanings per year in standard applications. Exceeding the recommended limits may result in more frequent cleanings, reduced capacity, increased feed pressure and reduced membrane life. A moderate violation of the limits for a short time may be acceptable as long as the physical limits – the maximum pressure drop and the maximum feed pressure – are not exceeded. On the other hand, a conservative approach is to anticipate a higher fouling tendency and to design the system according to the stricter limits in order to enjoy a trouble free system operation and an increased membrane life.

Membrane System Design Guidelines for 8-Inch FILMTEC™ Elements

The following tables show the recommended guidelines for designing RO systems with 8-inch FILMTEC™ elements according to feed water type.

Table 3.4 Design guidelines for 8-inch FILMTEC elements in water treatment applications

Feed source		RO Permeate	Well Water	Surface Supply		Wastewater (Filtered Municipal Effluent)		Seawater	
						MF[1]	Conventional	Well or MF[1]	Open intake
Feed silt density index		SDI < 1	SDI < 3	SDI < 3	SDI < 5	SDI < 3	SDI < 5	SDI < 3	SDI < 5
Average system flux	gfd	21-25	16-20	13-17	12-16	10-14	8-12	8-12	7-10
	l/m²h	36-43	27-34	22-29	20-27	17-24	14-20	13-20	11-17
Maximum element recovery %		30	19	17	15	14	12	15	13
Active Membrane Area		Maximum permeate flow rate, gpd (m³/d)							
320 ft² elements		9,000 (34)	7,500 (28)	6,500 (25)	5,900 (22)	5,300 (20)	4,700 (18)	6,700 (25)	6,100 (23)
365 ft² elements		10,000 (38)	8,300 (31)	7,200 (27)	6,500 (25)	5,900 (22)	5,200 (20)		
380 ft² elements		10,600 (40)	8,600 (33)	7,500 (28)	6,800 (26)	5,900 (22)	5,200 (20)	7,900 (30)	7,200 (27)
390 ft² elements		10,600 (40)	8,900 (34)	7,700 (29)	7,000 (26)	6,300 (24)	5,500 (21)		
400 ft² elements		11,000 (42)	9,100 (34)	7,900 (30)	7,200 (27)	6,400 (24)	5,700 (22)		
440 ft² elements		12,000 (45)	10,000 (38)	8,700 (33)	7,900 (30)	7,100 (27)	6,300 (24)		
Element type		Minimum concentrate flow rate[2], gpm (m³/h)							
BW elements (365 ft²)		10 (2.3)	13 (3.0)	13 (3.0)	15 (3.4)	16 (3.6)	18 (4.1)		
BW elements (400 ft² and 440 ft²)		10 (2.3)	13 (3.0)	13 (3.0)	15 (3.4)	18 (4.1)	20 (4.6)		
NF elements		10 (2.3)	13 (3.0)	13 (3.0)	15 (3.4)	18 (4.1)	18 (4.1)		
Full-fit elements		25 (5.7)	25 (5.7)	25 (5.7)	25 (5.7)	25 (5.7)	25 (5.7)		
SW elements		10 (2.3)	13 (3.0)	13 (3.0)	15 (3.4)	16 (3.6)	18 (4.1)	13 (3.0)	15 (3.4)

Element type	Active area ft² (m²)	Maximum feed flow rate[2], gpm (m³/h)							
BW elements	365 (33.9)	65 (15)	65 (15)	63 (14)	58 (13)	52 (12)	52 (12)		
BW or NF elements	400 (37.2)	75 (17)	75 (17)	73 (17)	67 (15)	61 (14)	61 (14)		
BW elements	440 (40.9)	75 (17)	75 (17)	73 (17)	67 (15)	61 (14)	61 (14)		
Full-fit elements	390 (36.2)	85 (19)	75 (17)	73 (17)	67 (15)	61 (14)	61 (14)		
SW elements	320 (29.7)	65 (15)	65 (15)	63 (14)	58 (13)	52 (12)	52 (12)	63 (14)	56 (13)
SW elements	380 (35.3)	72 (16)	72 (16)	70 (16)	64 (15)	58 (13)	58 (13)	70 (16)	62 (14)

[1] MF: Microfiltration - continuous filtration process using a membrane with pore size of <0.5 micron.

[2] The maximum recommended pressure drop across a single element is 15 psid (1bar) or 50 psid (3.5 bar) across multiple elements in a pressure vessel, whichever value is more limiting. We recommend designing at maximum of 80% (12 psid) for any element in a system.

Note: The limiting values listed above have been incorporated into the ROSA (Reverse Osmosis System Analysis) software. Designs of systems in excess of the guidelines results in a warning on the ROSA printout.

Membrane System Design Guidelines for Midsize FILMTEC™ Elements

The following tables show the recommended guidelines for designing RO systems with 2.5 and 4-inch FILMTEC™ elements in light industrial and small commercial applications.

Light industrial systems in Table 3.5 have the same requirements as for large systems, requiring stable performance over several years. They are typically for piloting large systems, with continuous operation, CIP facilities and none (or minimal) concentrate recirculation. The expected membrane lifetime is more than 3 years.

Table 3.5 Design guidelines for FILMTEC elements in light industrial and small seawater applications

Feed source	RO permeate	Well water	Softened Municipal	Surface	Wastewater (filtered tertiary effluent)		Seawater	
					MF[1]	Conventional	Well or MF[1]	Open intake
Feed silt density index	SDI < 1	SDI < 3	SDI < 3	SDI < 5	SDI < 3	SDI < 5	SDI < 3	SDI < 5
Typical target flux, gfd (l/m²h)	22 (37)	18 (30)	16 (27)	14 (24)	13 (22)	11 (19)	13 (22)	11 (19)
Maximum element recovery %	30	19	17	15	14	12	15	13
Element diameter	**Maximum permeate flow rate, gpd (m³/d)**							
2.5-inch	800 (3.0)	700 (2.6)	600 (2.3)	500 (1.9)	500 (1.9)	400 (1.5)	700 (2.6)	600 (2.3)
4.0-inch	2,300 (8.7)	1,900 (7.2)	1,700 (6.4)	1,500 (5.7)	1,400 (5.3)	1,200 (4.5)	1,800 (6.8)	1,500 (5.7)
Element type	**Minimum concentrate flow rate, gpm (m³/h)[1]**							
2.5-inch diameter	0.7 (0.16)	1 (0.2)	1 (0.2)	1 (0.2)	1 (0.2)	1 (0.2)	1 (0.2)	1 (0.2)
4.0-inch diameter (except full-fits)	2 (0.5)	3 (0.7)	3 (0.7)	3 (0.7)	4 (0.9)	5 (1.1)	3 (0.7)	4 (0.9)
Full-fit 4040	6 (1.4)	6 (1.4)	6 (1.4)	6 (1.4)	6 (1.4)	6 (1.4)	NA	NA

Element type	Active area ft² (m²)	Maximum feed flow rate U.S. gpm (m³/h)	Maximum pressure drop per element psig (bar)	Maximum feed pressure psig (bar)
Tape-wrapped 2540	28 (2.6)	6 (1.4)	13 (0.9)	600 (41)
Fiberglased 2540	28 (2.6)	6 (1.4)	15 (1.0)	600 (41)
Seawater 2540	29 (2.7)	6 (1.4)	13 (0.9)	1,000 (69)
Tape-wrapped 4040	87 (8.1)	14 (3.2)	13 (0.9)	600 (41)
TW30-4040	82 (7.6)	14 (3.2)	13 (0.9)	600 (41)
Fiberglassed 4040	82 (7.6)	16 (3.6)	15 (1.0)	600 (41)
SW Fiberglassed 4040	80 (7.4)	16 (3.6)	15 (1.0)	1,000 (69)
Full-fit 4040	85 (7.9)	18 (4.1)	15 (1.0)	600 (41)

[1] MF: Microfiltration - continuous filtration process using a membrane with pore size of <0.5 micron.

[2]2We recommend that the pressure drop for new/clean elements be at least 20% below the maximum.

Note: The limiting values listed above have been incorporated into the ROSA (Reverse Osmosis System Analysis) software. Designs of systems in excess of the guidelines results in a warning on the ROSA printout.

Membrane System Design Guidelines for Midsize FILMTEC™ Elements (cont.)

In Table 3.6, the small commercial systems are typically between 1–6 elements that are either regularly replaced or else cleaned (every half year or year) or performance loss is acceptable. The expected element lifetime is not more than 3 years. This is a low-cost, compact solution for intermittently operated systems.

Table 3.6 Design guidelines for FILMTEC™ elements in small commercial applications

Feed source	RO permeate	Softened Municipal	Well water	Surface or Municipal Water
Feed silt density index	SDI < 1	SDI < 3	SDI < 3	SDI < 5
Typical target flux, gfd (l/m²h)	30 (51)	30 (51)	25 (42)	20 (34)
Maximum element recovery %	30	30	25	20
Maximum permeate flow rate, gpd (m³/d)				
2.5-inch diameter	1,100 (4.2)	1,100 (4.2)	900 (3.4)	700 (2.7)
4.0-inch diameter	3,100 (11.7)	3,100 (11.7)	2,600 (9.8)	2,100 (7.9)
Minimum concentrate flow rate[1], gpm (m³/h)				
2.5-inch diameter	0.5 (0.11)	0.5 (0.11)	0.7 (0.16)	0.7 (0.16)
4.0-inch diameter	2 (0.5)	2 (0.5)	3 (0.7)	3 (0.7)

Element type	Active area ft² (m²)	Maximum feed flow rate U.S. gpm (m³/h)	Maximum pressure drop per element[1] psig (bar)	Maximum feed pressure psig (bar)
Tape-wrapped 2540	28 (2.6)	6 (1.4)	13 (0.9)	600 (41)
Fiberglased 2540	28 (2.6)	6 (1.4)	15 (1.0)	600 (41)
Seawater 2540	29 (2.7)	6 (1.4)	13 (0.9)	1,000 (69)
Tape-wrapped 4040	87 (8.1)	14 (3.2)	13 (0.9)	600 (41)
TW30-4040	82 (7.6)	14 (3.2)	13 (0.9)	600 (41)
Fiberglassed 4040	82 (7.6)	16 (3.6)	15 (1.0)	600 (41)
SW Fiberglassed 4040	80 (7.4)	16 (3.6)	15 (1.0)	1,000 (69)

[1] We recommend that the pressure drop for new/clean elements be at least 20% below the maximum.

Note: The limiting values listed above have been incorporated into the ROSA (Reverse Osmosis System Analysis) software. Designs of systems in excess of the guidelines results in a warning on the ROSA printout.

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FILMTEC™ Membranes
Dechlorinating Feedwater

Introduction

Chlorine (Cl_2) has been used for many years to treat municipal and industrial water and wastewaters as a disinfectant because of its capacity to inactivate most pathogenic microorganisms quickly. The effectiveness of Cl_2 is dependent on the Cl_2 concentration, time of exposure, and the pH of the water. Chlorine is used for the disinfection of potable water where a residual chlorine concentration near 0.5 mg/L is commonly used. In a water treatment scheme, fouling of water intake lines, heat exchangers, sand filters, etc., may be prevented by maintaining a free Cl_2 residual of 0.5-1.0 mg/L.

When FILMTEC™ FT30 thin-film composite membrane is used in the reverse osmosis (RO) process, the RO feed must be dechlorinated to prevent oxidation of the membrane. FT30 membrane has a chlorine tolerance of up to 1,000 ppm-hours before noticeable loss of salt rejection is observed. If dechlorination upsets occur and if corrected in a timely manner, membrane damage can be minimized.

Definitions and Chemistry

$$Cl_2 + H_2O \leftrightarrows HOCl + H^+ + Cl^-$$

Residual chlorine.
Refers to the total amount of chlorine ("combined" and "free available" chlorine) remaining in the water at the time of measurement.

Combined available chlorine.
Refers to one or more of the family of chlorine-ammonia compounds, called chloramines, resulting from the reaction of chlorine with ammonia compounds present in the water.

Free available chlorine.
This form is actually hypochlorous acid, hypochlorite ion or a mixture of the two, depending on pH and temperature. Free chlorine is usually present after sufficient chlorine has been added to satisfy the demand of ammonium ions present.

Engineering Considerations

Chlorine is most commonly available as hypochlorites of calcium and sodium or chlorine gas. Capital cost, operating cost and water chemistry will be the predominate factors in deciding which type of system to use.

If the product water from an RO system is chlorinated, care must be exercised to insure that the chlorine does not diffuse back into the membrane. Air breaks, check valves, etc., should be employed appropriately.

Chloramines

Studies have demonstrated that chlorine reacts with organic compounds present in drinking water to produce a variety of trihalomethanes (THMs). Toxicological investigations have implicated certain THMs as carcinogens. The EPA has established a maximum THM contaminate level of 100 ppb for drinking water. To meet this requirement, many water facilities have sought to reduce levels of THMs. This can be done by using chloramine as a disinfectant. Chloramine does not generate THMs. However, considerable controversy has arisen concerning the efficiency of chloramine disinfection and its potential health effects.

Chloramines (cont.)

In aqueous solution, HOCl reacts with ammonia to form inorganic chloramines in a series of stepwise reactions.

$HOCl + NH_3 \leftrightarrows NH_2Cl$ (monochloramine) $+ H_2O$
$HOCl + NH_2Cl \leftrightarrows NHCl_2$ (dichloramine) $+ H_2O$
$HOCl + NHCl_2 \leftrightarrows NCl_2$ (nitrogen trichloride) $+ H_2O$

These reactions are governed primarily by pH and chlorine-to-nitrogen weight ratio.

FILMTEC™ FT30 membrane has a 300,000 ppm-hour tolerance for chloramine, which implies that dechlorination is not required. However, since chloramines are formed by adding ammonia to chlorine, it is possible that free chlorine will be present. Since this free chlorine can be damaging to the membrane, dechlorination should still be considered.

Dechlorination

Residual chlorine can be reduced to harmless chlorides by chemical reducing agents. Discussion follows on two of the most common proven techniques.

Activated carbon.

Chlorine reacts with activated carbon as follows:
$C + 2Cl_2 + 2H_2O \rightarrow 4HCl + CO_2$

The activated carbon should be replaced or regenerated periodically.

Sodium metabisulfite.

$Na_2S_2O_5 + H_2O \rightarrow 2NaHSO_3$
$NaHSO_3 + HOCl \rightarrow HCl + NaHSO_4$

In theory, 1.37 lb of sodium metabisulfite will remove 1.0 lb of free chlorine. In practice, however, 3.0 lb of sodium metabisulfite are normally used to remove 1.0 lb of chlorine from brackish water. For seawater, more sodium metabisulfite may be required when dissolved oxygen is present. Sodium metabisulfite has a usual shelf life of 4-6 months under cool, dry storage conditions. The solution life, however, varies with concentration as follows:

Solution (wt %)	Maximum Solution Life
2	3 days
10	1 week
20	1 month
30	6 months

The dechlorination reaction requires mixing to ensure completion. Therefore, static mixers should be utilized and the sodium metabisulfite injected prior to the cartridge filters.

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FILMTEC™ Membranes

Cleaning Procedures for FILMTEC FT30 Elements

The following are general recommendations for cleaning FILMTEC™ FT30 elements. More detailed procedures for cleaning a reverse osmosis (RO) system are typically included in the operating manual provided by the system supplier. It should be emphasized that frequent cleaning is not required for a properly designed and properly operated RO system, however because of the FT30 membrane's unique combination of pH range and temperature resistance, cleaning may be accomplished very effectively.

Cleaning Requirements

In normal operation, the membrane in reverse osmosis elements can become fouled by mineral scale, biological matter, colloidal particles and insoluble organic constituents. Deposits build up on the membrane surfaces during operation until they cause loss in normalized permeate flow, loss of normalized salt rejection, or both.

Elements should be cleaned when one or more of the below mentioned parameters are applicable:

- The normalized permeate flow drops 10%
- The normalized salt passage increases 5 - 10%
- The normalized pressure drop (feed pressure minus concentrate pressure) increases 10 - 15%

If you wait too long, cleaning may not restore the membrane element performance successfully. In addition, the time between cleanings becomes shorter as the membrane elements will foul or scale more rapidly.

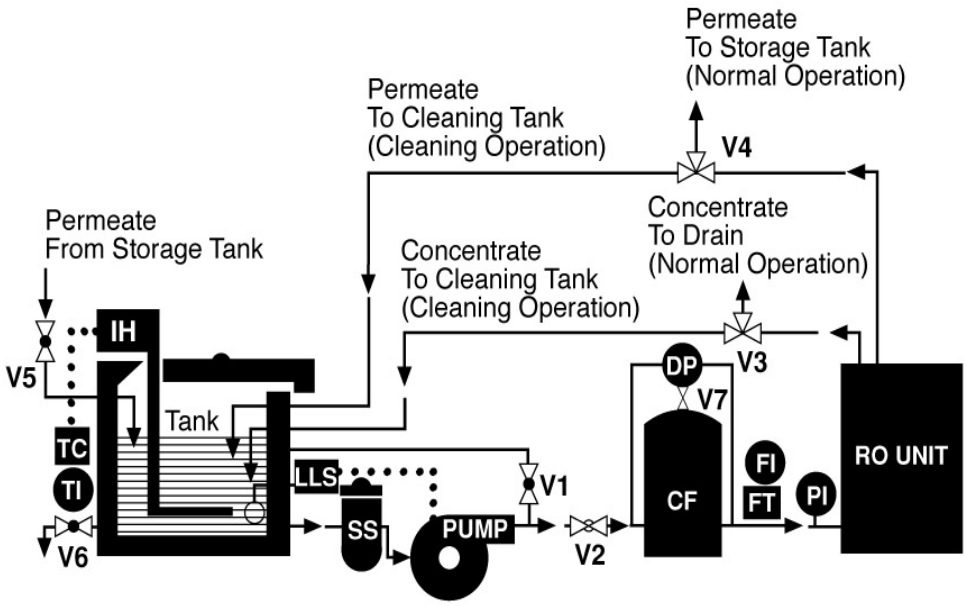
Differential Pressure (ΔP) should be measured and recorded across each stage of the array of pressure vessels. If the feed channels within the element become plugged, the ΔP will increase. It should be noted that the permeate flux will drop if feedwater temperature decreases. This is normal and does not indicate membrane fouling.

A malfunction in the pretreatment, pressure control, or increase in recovery can result in reduced product water output or an increase in salt passage. If a problem is observed, these causes should be considered first. The element(s) may not require cleaning. A computer program called FTNORM is available from FilmTec for normalizing performance data of FILMTEC™ RO membranes. This program can be used to assist in determining when to clean and can be downloaded from our web site (www.filmtec.com).

Safety Precautions

1. When using any chemical indicated here in subsequent sections, follow accepted safety practices. Consult the chemical manufacturer for detailed information about safety, handling and disposal.
2. When preparing cleaning solutions, ensure that all chemicals are dissolved and well mixed before circulating the solutions through the elements.
3. It is recommended the elements be flushed with good-quality chlorine-free water (20°C minimum temperature) after cleaning. Permeate water or deionized water are recommended. Care should be taken to operate initially at reduced flow and pressure to flush the bulk of the cleaning solution from the elements before resuming normal operating pressures and flows. Despite this precaution, cleaning chemicals will be present on the permeate side following cleaning. Therefore, the permeate must be diverted to drain for at least 30 minutes or until the water is clear when starting up after cleaning.
4. During recirculation of cleaning solutions, the maximum temperature must not be exceeded. The maximum allowed temperature is dependent on pH and membrane type. Table 1 contains information on the maximum allowed temperatures.
5. For elements greater than six inches in diameter, the flow direction during cleaning must be the same as during normal operation to prevent element telescoping, because the vessel thrust ring is installed only on the reject end of the vessel. This is also recommended for smaller elements. Equipment for cleaning is illustrated below.

Cleaning System Flow Diagram



TANK	Chemical Mixing Tank, polypropylene or FRP
IH	Immersion Heater (may be replaced by cooling coil for some site locations)
TI	Temperature Indicator
TC	Temperature Control
LLS	Lower Level Switch to shut off pump
SS	Security Screen–100 mesh
PUMP	Low-Pressure Pump, 316 SS or non-metallic composite
CF	Cartridge Filter, 5-10 micron polypropylene with PVC, FRP, or SS housing

DP	Differential Pressure Gauge
FI	Flow Indicator
FT	Flow Transmitter (optional)
PI	Pressure Indicator
V1	Pump Recirculation Valve, CPVC
V2	Flow Control Valve, CPVC
V3	Concentrate Valve, CPVC 3-way valve
V4	Permeate Valve, CPVC 3-way valve
V5	Permeate Inlet Valve, CPVC
V6	Tank Drain Valve, PVC, or CPVC
V7	Purge Valve, SS, PVC, or CPVC

Suggested Equipment

The equipment for cleaning is shown in the Cleaning System Flow Diagram. The pH of cleaning solutions used with FILMTEC™ elements can be in the range of 1 to 13 (see Table 1), and therefore non-corroding materials should be used in the cleaning system.

1. The mixing tank should be constructed of polypropylene or fiberglass-reinforced plastic (FRP). The tank should be provided with a removable cover and a temperature gauge. The cleaning procedure is more effective when performed at a warm temperature, and it is recommended that the solution be maintained according to the pH and temperature guidelines listed in Table 1. It is not recommended to use a cleaning temperature below 20°C because of the very slow chemical kinetics at low temperatures. In addition, chemicals such as sodium lauryl sulfate might precipitate at low temperatures. Cooling may also be required in certain geographic regions, so both heating/cooling requirements must be considered during the design. A rough rule of thumb in sizing a cleaning tank is to use approximately the empty pressure vessels volume and then add the volume of the feed and return hoses or pipes. For example, to clean ten 8-inch diameter pressure vessels with six elements per vessel, the following calculations would apply:

   A. Volume in Vessels

   $V1 = \pi r^2 L$

   $= 3.14\ (4\ in)^2\ (20\ ft)\ (7.48\ gal/ft^3) / (144\ in^2/ft^2)$

   $V1 = 52\ gal/vessel\ (0.2\ m^3)$

   $V10 = 52 \times 10 = 520\ gal\ (1.97\ m^3)$

   B. Volume in Pipes, assume 50 ft. length total 4" Sch 80 pipe

   $Vp = \pi r^2 L$

   $= 3.14\ (1.91\ in)^2\ (50\ ft)\ (7.48\ gal/ft^3) / (144\ in^2/ft^2)$

   $= 30\ gals\ (0.11\ m^3)$

   $Vct = V_{10} + Vp = 520 + 30 = 550\ gal.$

   Therefore, the cleaning tank should be about 550 gals (2.1 m^3).

2. The cleaning pump should be sized for the flows and pressures given in Table 2, making allowances for pressure loss in the piping and across the cartridge filter. The pump should be constructed of 316 SS or nonmetallic composite polyesters.
3. Appropriate valves, flow meters, and pressure gauges should be installed to adequately control the flow. Service lines may be either hard piped or hoses. In either case, the flow rate should be a moderate 10 ft/sec (3 m/sec) or less.

Cleaning Elements In Situ

There are six steps in the cleaning of elements:

1. Make up cleaning solution.
2. Low-flow pumping. Pump mixed, preheated cleaning solution to the vessel at conditions of low flow rate (about half of that shown in Table 2) and low pressure to displace the process water. Use only enough pressure to compensate for the pressure drop from feed to concentrate. The pressure should be low enough that essentially no or little permeate is produced. A low pressure minimizes redeposition of dirt on the membrane. Dump the concentrate, as necessary, to prevent dilution of the cleaning solution.
3. Recycle. After the process water is displaced, cleaning solution will be present in the concentrate stream. Then recycle the concentrate and permeate to the cleaning solution tank and allow the temperature to stabilize. Measure the pH of the solution and adjust the pH if needed.

Table 1. pH range and temperature limits during cleaning

Element type	Max Temp 50°C (122°F) pH range	Max Temp 45°C (113°F) pH range	Max Temp 35°C(95 °F) pH range	Max Temp 25°C (77°F) pH range
BW30, BW30LE, LE, XLE, TW30, TW30HP, NF90	Please contact Dow for assistance	1 - 10.5	1 - 12	1 - 13
SW30HR, SW30HR LE, SW30XLE, SW30	Please contact Dow for assistance	1 - 10.5	1 - 12	1 - 13
NF200, NF270	Not allowed	3 - 10	1 - 11	1 - 12
SR90	Not allowed	3 - 10	1 - 11	1 - 12

Table 2. Recommended feed flow rate per pressure vessel during high flow rate recirculation

Feed Pressure[1] (psig)	(bar)	Element Diameter (inches)	Feed Flow Rate per Pressure Vessel (gpm)	(m^3/hr)
20-60	1.5-4.0	2.5	3-5	0.7-1.2
20-60	1.5-4.0	4[2]	8-10	1.8-2.3
20-60	1.5-4.0	6	16-20	3.6-4.5
20-60	1.5-4.0	8	30-40	6.-9.1
20-60	1.5-4.0	8[3]	35-45	8.0-10.2

1. Dependent on number of elements in pressure vessel.
2. 4-inch full-fit elements should be cleaned at 12-14 gpm (2.7-3.2 m^3/hr).
3. For full-fit and 440 sq. ft. area elements.

4. Soak. Turn the pump off and allow the elements to soak. Sometimes a soak period of about 1 hour is sufficient. For difficult fouling an extended soak period is beneficial; soak the elements overnight for 10-15 hours. To maintain a high temperature during an extended soak period, use a slow recirculation rate (about 10 percent of that shown in Table 2).
5. High-flow pumping. Feed the cleaning solution at the rates shown in Table 2 for 30-60 minutes. The high flow rate flushes out the foulants removed from the membrane surface by the cleaning. If the elements are heavily fouled, a flow rate which is 50 percent higher than shown in Table 2 may aid cleaning. At higher flow rates, excessive pressure drop may be a problem. The maximum recommended pressure drops are 15 psi per element or 50 psi per multi-element vessel, whichever value is more limiting. Please note that the 15 psi per element or the 50 psi per multi-element vessel should NOT be used as a cleaning criteria. Cleaning is recommended when the pressure drop increases 15%. Pressure drop above 50 psi in a single stage may cause significant membrane damage.
6. Flush out. RO permeate or deionized water is recommended for flushing out the cleaning solution. Prefiltered raw water or feed water should be avoided as its components may react with the cleaning solution: precipitation of foulants may occur in the membrane elements. The minimum flush out temperature is 20°C.

Cleaning Tips

1. It is strongly recommended to clean the stages of the RO or NF system separately. This is to avoid having the removed foulant from stage 1 pushed into the 2nd stage resulting in minimal performance improvement from the cleaning. If the system consists of 3 stages, stage 2 and stage 3 should also be cleaned separately.
   For multi-stage systems, while each stage should be cleaned separately, the flushing and soaking operations may be done simultaneously in all stages. Fresh cleaning solution needs to be prepared when the cleaning solution becomes turbid and/or discolored. High-flow recirculation, however, should be carried out separately for each stage, so the flow rate is not too low in the first stage or too high in the last. This can be accomplished either by using one cleaning pump and operating one stage at a time, or by using a separate cleaning pump for each stage.

2. The fouling or scaling of elements typically consists of a combination of foulants and scalants, for instance a mixture of organic fouling, colloidal fouling and biofouling. Therefore, it is very critical that the first cleaning step is wisely chosen. FilmTec strongly recommends alkaline cleaning as the first cleaning step. Acid cleaning should only be applied as the first cleaning step if it is known that only calcium carbonate or iron oxide/hydroxide is present on the membrane elements.

   Acid cleaners typically react with silica, organics (for instance humic acids) and biofilm present on the membrane surface which may cause a further decline of the membrane performance. Sometimes, an alkaline cleaning may restore this decline that was caused by the acid cleaner, but often an extreme cleaning will be necessary. An extreme cleaning is carried out at pH and temperature conditions that are outside the membrane manufacturer's guidelines or by using cleaning chemicals that are not compatible with the membrane elements. An extreme cleaning should only be carried out as a last resort as it can result in membrane damage.

   If the RO system suffers from colloidal, organic fouling or biofouling in combination with calcium carbonate, then a two- step cleaning program will be needed: alkaline cleaning followed by an acid cleaning. The acid cleaning may be performed when the alkaline cleaning has effectively removed the organic fouling, colloidal fouling and biofouling.

3. Always measure the pH during cleaning. If the pH increases more than 0.5 pH units during acid cleaning, more acid needs to be added. If the pH decreases more than 0.5 pH units during alkaline cleaning, more caustic needs to be added.

4. Long soak times. It is possible for the solution to be fully saturated and the foulants can precipitate back onto the membrane surface. In addition, the temperature will drop during this period, therefore the soaking becomes less effective. It is recommended to circulate the solution regularly in order to maintain the temperature (temperature should not drop more than 5°C) and add chemicals if the pH needs to be adjusted.

5. Turbid or strong colored cleaning solutions should be replaced. The cleaning is repeated with a fresh cleaning solution.

6. If the system has to be shutdown for more than 24 hours, the elements should be stored in 1% w/w sodium metabisulfite solution.

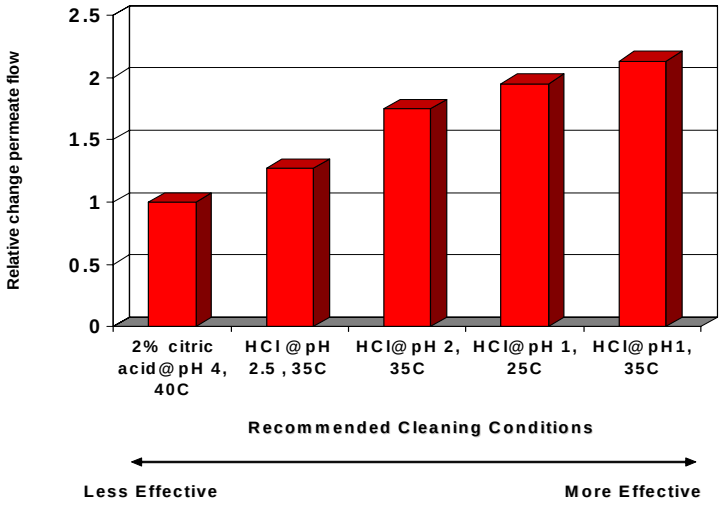
Effect of pH on foulant removal

In addition to applying the correct cleaning sequence (alkaline cleaning step first), selecting the correct pH is very critical for optimum foulant removal. If foulant is not successfully removed, the membrane system performance will decline faster as it is easier for the foulant to deposit on the membrane surface area. The time between cleanings will become shorter, resulting in shorter membrane element life and higher operating and maintenance costs.

Most effective cleaning allows longer system operating time between cleanings and results in the lowest operating costs.

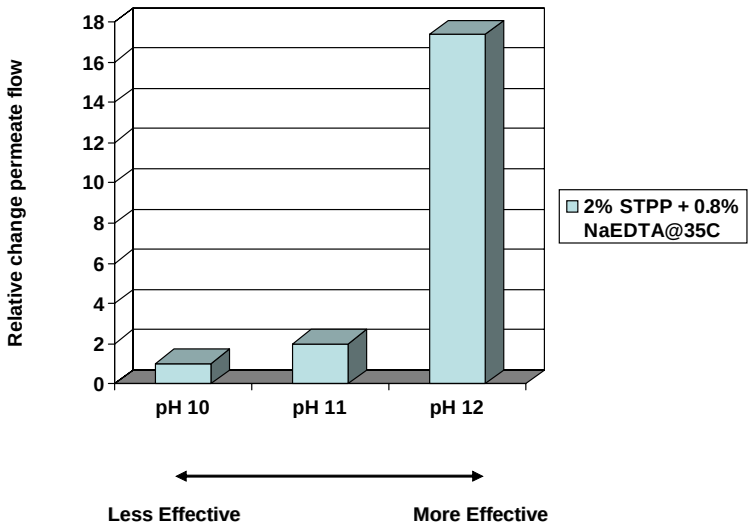
Figure 1 and 2 below show the importance of the selecting the right pH for successful cleaning.

Figure 1. Effect of pH on the removal of calcium carbonate



Calcium carbonate is best removed by cleaning with hydrochloric acid at pH 1-2.

Figure 2. Effect of pH on the removal of biofouling



Biofouling is best removed by cleaning at pH 12.

Cleaning Chemicals

Table 3 lists suitable cleaning chemicals. Acid cleaners and alkaline cleaners are the standard cleaning chemicals. The acid cleaners are used to remove inorganic precipitates including iron, while the alkaline cleaners are used to remove organic fouling including biological matter. Sulfuric acid should never used for cleaning because of the risk of calcium sulfate precipitation. Reverse osmosis permeate or deionized water should be used for the preparation of cleaning solutions.

Table 3. Simple cleaning solutions for FT30 membrane

Cleaner / Foulant	0.1% (W) NaOH and pH 12, 35°C max. or 1.0% (W) Na_4EDTA and pH 12, 35°C max.	0.1% (W) NaOH and pH 12, 35°C max. or 0.025% (W) Na-DSS and pH 12, 35°C max.	0.2% (W) HCl, 25°C and pH 1 - 2	1.0% (W) $Na_2S_2O_4$, 25°C and pH 5	0.5% (W) H_3PO_4, 25 °C and pH 1 - 2	1.0% (W) NH_2SO_3H, 25°C and pH 3 - 4
Inorganic Salts (for example, $CaCO_3$)			Preferred	Alternative	Alternative	
Sulfate Scales ($CaSO_4$, $BaSO_4$)	OK					
Metal Oxides (for example, iron)				Preferred	Alternative	Alternative
Inorganic Colloids (silt)		Preferred				
Silica	Alternative	Preferred				
Biofilms	Alternative	Preferred				
Organic	Alternative	Preferred				

The temperatures and pH listed in table 3 are applicable for BW30, BW30LE, LE, XLE, TW30, TW30HP, SW30HR, SW30HR LE , SW30XLE, SW30 and NF90 membrane elements. For more information regarding the allowed temperatures and pH for cleaning, please refer to table 1.

Notes:

1. (W) denotes weight percent of active ingredient.
2. Foulant chemical symbols in order used: $CaCO_3$ is calcium carbonate; $CaSO_4$ is calcium sulfate; $BaSO_4$ is barium sulfate.
3. Cleaning chemical symbols in order used: NaOH is sodium hydroxide; Na_4EDTA is the tetra-sodium salt of ethylene diamine tetraacetic acid and is available from The Dow Chemical Company under the trademark VERSENE* 100 and VERSENE 220 crystals; Na-DSS is sodium salt of dodecylsulfate; Sodium Laurel Sulfate; HCl is hydrochloric acid (Muratic Acid); H_3PO_4 is phosphoric acid; NH_2SO_3H is sulfamic acid; $Na_2S_2O_4$ is sodium hydrosulfite.
4. For effective sulfate scale cleaning, the condition must be caught and treated early. Adding NaCl to the cleaning solution of NaOH and Na_4EDTA may help as sulfate solubility increases with increasing salinity. Successful cleaning of sulfate scales older than 1 week is doubtful.
5. Citric Acid is another cleaning alternative for metal oxides and calcium carbonate scale. It is less effective (see also figure 1 of this document). It may contribute to biofouling especially when it is not properly rinsed out.

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FILMTEC™ Membranes

FT30 Reverse Osmosis Membrane Biological Protection and Disinfection

Following are recommendations for the biological protection and disinfection of spiral wound elements containing FT30 membrane. In using any chemicals indicated in subsequent sections, follow accepted safety practices. Consult the chemical manufacturer for detailed information with questions about safety, handling and disposal.

Membrane Preservatives

To prevent biological growth during storage, shipping or system shutdowns, it is recommended that FILMTEC™ RO elements be immersed in a protective solution. The standard storage solution contains 1.0 percent (by weight) sodium metabisulfite (food grade). This storage solution will not adversely affect membrane flux or performance.

Chlorinated Disinfectants

FILMTEC FT30 membrane can withstand short-term exposure to free chlorine (hypochlorite); however, its resistance is limited. The membrane can be used successfully in installations where system upsets result in temporary exposure to free chlorine. Eventual degradation may occur after approximately 200-1,000 hours of exposure to 1 ppm concentrations of free chlorine. The rate of chlorine attack depends on various feedwater characteristics. Under alkaline pH conditions, chlorine attack is faster than at neutral or acidic pH. Chlorine attack is also faster at higher concentrations of heavy metals (e.g., iron) which catalyze membrane degradation. Disinfection with agents containing combined chlorine is generally not recommended. This includes such compounds as chloramine, chloramine-T, and N-chloroisocyanurate. FT30 is resistant to mild chlorinating agents such as these at low concentrations. However, their effectiveness as disinfectants at low concentrations is limited. These compounds can also slowly damage the membrane, because they are in equilibrium with small amounts of free chlorine.

Pure chlorine dioxide can be used successfully at 500 ppm concentration if the storage period is less than one week, but it is not an effective biocide for longer periods. Chlorine dioxide that is generated on site from chlorine and sodium chlorate is always contaminated with free chlorine, which attacks the membrane. The FT30 membrane is permeable to chloramine and to chlorine dioxide. Either of these will pass through the membrane, resulting in a small residual disinfectant in the permeate.

Other Disinfectants

Hydrogen peroxide or hydrogen peroxide/peracetic acid solutions can be used at concentrations up to 0.2 percent. The temperature must not exceed 25°C (77°F), or damage to the membrane may occur. Also, heavy metals such as iron must not be present, because they catalyze membrane degradation in the presence of hydrogen peroxide solutions. Continuous exposure at this concentration may eventually damage the membrane. Instead, periodic use is recommended.

Formaldehyde can be used as a disinfectant. However, this reagent should not be used unless the element has been operated for at least six hours, or a severe flux loss may occur. After this initial operating period, 0.5 to 3.0 percent concentrations may be used.

Other Disinfectants (cont.)

A one-time permanent flux loss of 5 to 10 percent is likely to occur after the first use of formaldehyde. Subsequent applications will result in a temporary flux loss, which will last for 2-4 hours after flushing out the formaldehyde. Copper sulfate can be used to control the growth of algae. Typically, copper sulfate is fed continuously at 0.1 to 0.5 ppm concentrations. The pH must be low enough to prevent the precipitation of copper hydroxide.

Iodine, quaternary germicides and phenolic compounds cause flux losses and are not recommended for use as disinfectants.

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FILMTEC™ Membranes
Disinfecting RO Systems with Hydrogen Peroxide

Introduction

Hydrogen peroxide or a mixture of hydrogen peroxide and peracetic acid has been used successfully for disinfecting reverse osmosis (RO) systems that use FILMTEC™ FT30 membranes.

Examples of commercial hydrogen peroxide/peracetic acid solutions are Renalin® and Minncare® from Minntech Corporation.

These solutions come in a concentrated form and are diluted 1:100 with RO permeate to obtain a 0.25 percent peroxide solution. For more than four years, an RO system in Minneapolis which uses the FT30 membrane has been disinfected once weekly by soaking overnight in diluted Renalin. There has been no indication of membrane degradation during this time.

There are two factors which greatly influence the rate of hydrogen peroxide attack on the membrane: temperature and iron. The disinfecting solution should not exceed 25°C (77°F). FT30 membrane samples tested with 0.5 percent hydrogen peroxide at 34°C showed a very high salt passage after several hours. At 24°C, however, membrane samples demonstrated compatibility with 0.5 percent hydrogen peroxide after 96 hours.

The presence of iron or other transition metals in conjunction with hydrogen peroxide solutions can also cause membrane degradation. FT30 samples were tested using a 0.15 percent solution of hydrogen peroxide and tapwater containing iron. After 150 hours, the salt passage of the membrane began to increase dramatically.

Procedure

For RO systems using the FT30 membrane, the following procedure for disinfection with hydrogen peroxide or Renalin solutions is recommended:

1. Any type of deposit on the membrane or other parts of the system should be removed with an alkaline cleaner before disinfecting. Removal of these deposits, which harbor microorganisms, will maximize the degree of disinfection. After alkaline cleaning, flush the system with RO permeate.
2. Clean the RO system with acid (e.g., 0.1 percent by volume hydrochloric acid or 0.4 percent by volume phosphoric acid) to remove any iron from the membrane surface. Flush the unit with RO permeate.
3. Circulate a solution of 0.20-0.25 percent hydrogen peroxide diluted with RO permeate at a temperature below 25°C (77°F) for 20 minutes. A pH of 3-4 gives optimal biocidal results and longer membrane lifetime.
4. Allow the elements to soak in the disinfecting solution for 2-12 hours. A soak time of 2 hours would be expected to kill more than 90 percent of the bacteria, whereas a 12-hour soak time would achieve a 99 percent kill.

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Dow
Water Solutions

FILMTEC
Reverse Osmosis Membranes

Understanding RO Element Salt Rejection Specifications

June 2004

Understanding RO Element Salt Rejection Specifications

There is a great deal of discussion these days about membrane salt rejection specifications for reverse osmosis (RO) brackish water elements. Some membrane element suppliers have recently upgraded their specifications to reflect higher salt rejection. These suppliers have made their salt rejection specifications a primary point of differentiation from competitive elements including FILMTEC™ elements.

Focusing on a manufacturer's published salt rejection specifications ignores other important factors that have an impact on RO element performance. And, it does not take into account a fundamental truth: The actual long-term salt rejection performance of RO elements under your system conditions is far more important than the performance of individual elements in initial factory tests.

Now, you might wonder, aren't manufacturers' published salt rejection specs an indication of the performance you can expect in actual service? The fact is, it depends on how well the test conditions approximate your system conditions. Given the widely varying feedwater compositions RO elements can face in actual service – and differences in other system conditions including temperature, pressure and pH – no factory test will ever be a perfect match for your system.

In addition, the way suppliers manufacture their elements, prepare them for testing and establish test conditions can greatly influence test results, making useful, apples-to-apples comparisons of published salt rejection specifications difficult, if not impossible.

Does this mean salt rejection specifications should be ignored when choosing an element? Not at all, but it does mean that the importance of salt rejection should be kept in perspective relative to the other important measures you'll use to gauge the performance of your system. And, it means that you'll want to understand how various manufacturers establish their specs and how closely those printed numbers are likely to resemble what you will actually experience in your system.

Let's start with a review of what salt rejection is and why it is helpful in measuring RO element performance.

What is salt rejection?

Reverse osmosis membranes are designed to remove dissolved salts from water. While water passes readily through the RO membrane, dissolved salt passes through very slowly. Under natural conditions of osmosis, water will diffuse through a semipermeable membrane toward a region of higher salt concentration in order to equalize solution strength on both sides of the membrane. In order to overcome and reverse this osmotic tendency, pressure is applied to the feedwater, thereby producing a purified permeate stream.

Salt rejection is a measure of how well a membrane element rejects the passage of dissolved ions. Although an RO element may be called upon to reject many different ions, sodium chloride (NaCl) is used as a measurement standard. With few exceptions RO membranes reject divalent ions better than monovalent ions such as sodium and chloride. Therefore, if a membrane exhibits excellent rejection of NaCl, the membrane can be expected to perform even better in rejecting the passage of such divalent ions as iron, calcium, magnesium, and sulfate. Thus NaCl (salt) rejection has been universally accepted as the standard for measuring a membrane element's ionic rejection performance.

It is important to remember that, while we are focusing here on rejection of ionic contaminants, membranes are also called upon to remove, or at least tolerate, other impurities in feedwaters, including organics, silica, and gases. Your evaluation of RO elements should also include analysis of their ability to remove or tolerate these non-ionic contaminants.

Keeping salt rejection in perspective

It is also important to bear in mind that evaluation of long-term RO element performance involves consideration of more than salt rejection. Membrane flux, element flow capacity, system pressure requirements, membrane fouling rates, membrane response to cleaning operations and tolerance of cleaning procedures, and the durability of the element all can be important factors in choosing an element. Each can affect the overall productivity of your water treatment system and the capital and operating costs associated with it.

How is salt rejection measured?

Actual salt flow through the membrane is measured in terms of mass per unit of volume. Available instruments measure the specific conductance (or conductivity) of the permeate stream and this information is easily translated into the number of milligrams of salt that pass through the membrane in each liter of permeate. Salt rejection is then expressed as a percentage derived from the following equation:

$$\text{Rejection (\%)} = \frac{\text{Conc}_f - \text{Conc}_p}{\text{Conc}_f} \times 100$$

Conc_f = Log mean Average Salt Concentration

$$= \text{Feed Concentration} \times \frac{\ln [1/(1-Y)]}{Y}$$

Y = recovery
Conc_p = Salt Concentration of Product

Differences in test methods lead to differences in specifications

The most obvious problem with the current emphasis on manufacturers' published specifications is that these artificial tests on individual elements do not take into account specific field conditions. These field conditions determine how an RO element will actually perform in long-term service as part of an overall water treatment system. But there is another, less obvious problem with using manufacturers' salt rejection specifications to choose an RO element.

A careful review of test methodology reveals that the test methods used by membrane manufacturers can vary, resulting in noncomparable specifications and misleading interpretations of published salt rejection data. This point is illustrated Table 1, which is a comparison of test conditions used by three leading RO element manufacturers.

Table 1. Comparison of salt rejection test methods used by three RO element suppliers

Test parameter	FilmTec	Brand "X"	Brand "Y"
Temperature	25°C	25°C	25°C
pH	8	7.5	6.5 - 7.0
Recovery	15%	10%	15%
Feed pressure	225 psig	225 psig	225 psig
Feed concentration	2,000 ppm	2,000 ppm	1,500 ppm
Test time	20 minutes	30 minutes	30 minutes

Clearly, there are no "standard" test conditions for salt rejection. Yet, the salt rejection (and also the product flow rate) calculated during salt challenge tests is a function of the test conditions. If a test is conducted with a lower feed concentration (Brand "Y") or a lower recovery (Brand "X"), the data are not comparable to those of elements tested at higher values. FilmTec's test conditions are the most stringent of any used in the RO industry.

In addition, the duration of salt rejection tests has a significant impact on the results. This is because RO membrane elements provide peak salt rejection performance when they reach a stabilized operating condition. The longer an element is tested, the closer it moves toward this stabilized, steady state.

Because manufacturers test differently, it is difficult, if not impossible, to compare the technical specifications for competing products on an “apples-to-apples” basis.

How differences in element manufacturing processes confuse salt rejection test results

Differences in manufacturing processes have a fundamental impact on the salt rejection numbers various suppliers report for their elements. Some RO element manufacturers fabricate membrane elements using a direct dry process. Chemicals used in making the element are dried in during the manufacturing process and must be flushed out before the element can be put into service. These elements may be flushed for 24 hours or longer to remove all chemical residue. Then they’re tested.

Under the element production process used by FilmTec Corporation, there is no need for an extended rinse procedure to remove manufacturing chemicals. Chemicals are washed out of the membrane by a water bath before the membrane is dried. Instead of a 24-hour flushing rinse, only a brief element rinse is required prior to testing and shipment.

The difference in the FilmTec manufacturing process and others involving extended flushing rinses is important because all RO membrane elements tend to exhibit higher salt rejection after extended wetting. The 24-hour rinse some manufacturers must use to leach out chemical residues pre-conditions their elements to perform better in factory salt rejection tests.

What do manufacturers’ salt rejection specifications really mean?

Salt rejection specifications published by element manufacturers are actually based on data from plant quality assurance testing or from postproduction testing some manufacturers use to classify the products they manufacture.

Quality assurance tests—Quality assurance (QA) testing is required in RO element manufacturing operations, as it is in any precision manufacturing environment, to ensure the integrity of the elements manufacturers produce. The QA or compliance test used by manufacturers is a “salt challenge test” which measures element salt rejection under specific test conditions before the element can be shipped from the plant. Element flow is also measured during these tests.

Although these QA tests do not replicate actual service conditions and were not originally intended to produce field performance specifications, over the years some manufacturers have encouraged you to interpret the test results in that way.

Post-production element classification—The second way in which published salt rejection specifications are generated is during post-production tests that some manufacturers use to classify their products by level of performance. This type of testing is necessary when a manufacturer’s production process lacks the precision to produce elements that consistently exhibit the same level of performance. The manufacturer must test all elements for salt rejection to properly assign the appropriate product designation and the particular performance specification under which the product will be sold.

FilmTec’s precision fabrication process eliminates the need for this kind of post-production classification testing because elements produced in our advanced production facilities are more consistent and their performance is very predictable. In fact the FilmTec manufacturing process is so precise, the need for quality assurance salt rejection testing may eventually be eliminated altogether. This would result in a very significant advantage. If salt rejection testing is not required, there will be no need to wet the dry elements produced by our process in order to conduct the preshipment QA test. And this means elements could be shipped from our plant in a dry state. The advantages of dry elements are significant:

- There is no need for microbiological protection during shipment and storage.
- The elements have a longer “shelflife”.
- They are easier to handle.
- Shipping costs are lower due to the reduced dry element weight.
- And time-consuming flush-out procedures are not required to remove preservative chemicals from the elements before your water treatment system is brought on line.

FilmTec has been shipping dry elements since 1985. Today we offer dry products ranging from low pressure elements for use in home tapwater systems to 8” brackish water elements for large commercial, municipal and industrial systems.

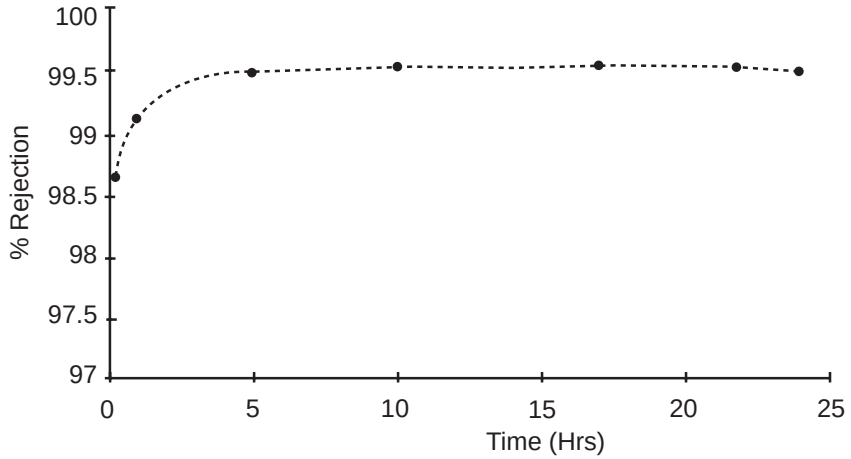
Stabilized system salt rejection is more important than rejection in Q.A. tests

As you can see, placing too much emphasis on published salt rejection data produced by manufacturers’ quality assurance tests can be dangerous. But these test numbers are also not very useful to you in assessing the actual performance you can expect from membrane elements in your system.

Because of the differences in the way membrane elements are made, element salt rejection can only be fairly compared after a week or more of actual “wet” service. Analysis of actual element performance exhibited in the field — with specific feedwater quality and system conditions — is the best indicator of long-term salt rejection because it eliminates the misleading effects of artificial test conditions, preliminary rinses, and other pretest element preparation.

Extensive field testing has shown, for example, that the salt rejection performance of FILMTEC elements exceeds the numbers generated by our Q.A. tests when the elements reach a stabilized condition, typically within a few hours of initial system startup (See Figure 1). In fact, many operators have found that FILMTEC elements provide salt rejection well above the published minimum specification immediately at system startup. This reflects the effect of membrane immersion in a preservative solution during shipment and storage prior to installation.

Figure 1. Typical salt rejection performance of FILMTEC elements after system start-up



The bottom line is, it is common for FILMTEC elements to provide stabilized salt rejection of 99.5% or even higher in actual water treatment service. Of course, as with any elements, system feedwater and operating conditions can be significant determinants of the actual salt rejection experienced in any particular system.

Does salt rejection improve for all elements after the initial hours of system operation? Not necessarily. Elements exposed to a 24-hour rinse prior to manufacturer salt rejection testing are often already at the peak of their salt rejection performance and may exhibit little if any improvement under system conditions over time.

Furthermore, if the elements were tested under artificially generous conditions of recovery, feed concentration, temperature, or pressure—or over an extended test period—their performance may actually decline from the published salt rejection level once they are installed. In contrast, long-term monitoring of the performance of FILMTEC elements in numerous field installations—over a broad spectrum of feedwaters and under a wide range of operating conditions—has shown that their salt rejection remains highly consistent.

So what good is a published salt rejection specification?

Because they are derived from artificial test methods, manufacturers' salt rejection specifications do not reflect stabilized rejection under actual system conditions. Because there is no standard test method, and because differences in manufacturing processes bias the results of factory tests, manufacturers' salt rejection specifications cannot be fairly compared, one-to-the next.

Nevertheless, published specifications do show that a particular element is subject to a particular manufacturer's quality assurance or product classification standard. These specifications also have some value as indicators of the minimum performance that can be expected from an element, provided that the specifications have been established conservatively and don't overstate what you can expect long term.

In the case of FILMTEC elements, our minimum salt rejection specifications are set primarily for quality assurance purposes to ensure the integrity of our products. However, we have begun publishing a stabilized salt rejection specification of 99.5% as a supplement to our minimum specification. This specification is based on laboratory salt challenge tests conducted under the same basic conditions as our minimum salt rejection test except the duration of the test is extended to allow the membrane to reach a stabilized condition.

The FilmTec stabilized salt rejection specification more closely reflects the performance our elements typically provide in the field. Of course, even our extended laboratory tests cannot take into account the many system variables our elements may encounter in actual service. However, in combination with existing field data, both the mimimum and stabilized salt rejection specifications help establish a starting point for projecting the actual performance of FILMTEC elements in your specific system.

If not published salt rejection specs, what can you use to choose the best element?

It's a mistake to focus too much on estimating the performance of individual RO elements when projection of the total performance of your water treatment system is more productive and revealing.

The ROSA Reverse Osmosis System Analysis computer program was developed by the Liquid Separations group of The Dow Chemical Company to project the performance of water purification systems based on FILMTEC elements. Using specific information about your system, the program simulates the operation of the system to provide an accurate picture of what you can expect from FILMTEC elements under real-life conditions for the useful life of the elements.

The ROSA program focuses on the total system, taking into account...

- Feedwater content (including actual concentrations of sodium chloride, other ionic impurities, and silica).
- Operating conditions including pH, temperature, feed pressure, and recovery.
- Your specific water quality requirements.
- Length of service.

This program routinely projects salt rejection well above the minimum specification we publish for our elements. Field tests—coupled with the 15 years of on-line performance logged by FILMTEC elements—verify the accuracy of these projections, further evidence of the importance of stabilized salt rejection data versus numbers derived from artificial factory tests.

Of course, when you choose an RO element, you are also choosing an element supplier. It pays to evaluate not only the element you are offered but also the manufacturer's technical expertise and track record of success in installations similar to yours. FILMTEC elements are backed by a complete package of technical support that is unsurpassed in the industry. Innovations such as our advanced precision manufacturing capabilities, dry element technology, and the ROSA program show that FilmTec leads the way in advanced technology and technical support.

In conclusion...

While it's true that some suppliers publish higher salt rejection specs than FilmTec does, these numbers distort more than enlighten. More significant than the reported differences in salt rejection between elements are the differences in element manufacturing techniques, testing methods, and test conditions that account for these disparities.

The fact is, by manipulating test conditions and other factors, element manufacturers can provide almost any salt rejection number they'd like to promote. But in our view, this is an unproductive use of resources that adds cost but no value to the product they deliver to you.

We hope that this paper encourages you to look beyond often misleading manufacturer specifications to more effectively assess the potential performance of RO elements in your actual system. We're confident that FILMTEC elements will continue to stand up to your most thorough analyses—and your toughest service requirements—just as they have in hundreds of installations globally since FilmTec Corporation was founded more than 15 years ago.

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FILMTEC™ Membranes
Addendum: Temperature Correction Factor

Table 9.6 Temperature correction factor

Temperature ° C	Temperature Correction Factor	Temperature ° C	Temperature Correction Factor	Temperature ° C	Temperature Correction Factor	Temperature ° C	Temperature Correction Factor	Temperature ° C	Temperature Correction Factor
10.0	1.711	14.0	1.475	18.0	1.276	22.0	1.109	26.0	0.971
10.1	1.705	14.1	1.469	18.1	1.272	22.1	1.105	26.1	0.968
10.2	1.698	14.2	1.464	18.2	1.267	22.2	1.101	26.2	0.965
10.3	1.692	14.3	1.459	18.3	1.262	22.3	1.097	26.3	0.962
10.4	1.686	14.4	1.453	18.4	1.258	22.4	1.093	26.4	0.959
10.5	1.679	14.5	1.448	18.5	1.254	22.5	1.090	26.5	0.957
10.6	1.673	14.6	1.443	18.6	1.249	22.6	1.086	26.6	0.954
10.7	1.667	14.7	1.437	18.7	1.245	22.7	1.082	26.7	0.951
10.8	1.660	14.8	1.432	18.8	1.240	22.8	1.078	26.8	0.948
10.9	1.654	14.9	1.427	18.9	1.236	22.9	1.075	26.9	0.945
11.0	1.648	15.0	1.422	19.0	1.232	23.0	1.071	27.0	0.943
11.1	1.642	15.1	1.417	19.1	1.227	23.1	1.067	27.1	0.940
11.2	1.636	15.2	1.411	19.2	1.223	23.2	1.064	27.2	0.937
11.3	1.630	15.3	1.406	19.3	1.219	23.3	1.060	27.3	0.934
11.4	1.624	15.4	1.401	19.4	1.214	23.4	1.056	27.4	0.932
11.5	1.618	15.5	1.396	19.5	1.210	23.5	1.053	27.5	0.929
11.6	1.611	15.6	1.391	19.6	1.206	23.6	1.049	27.6	0.926
11.7	1.605	15.7	1.386	19.7	1.201	23.7	1.045	27.7	0.924
11.8	1.600	15.8	1.381	19.8	1.197	23.8	1.042	27.8	0.921
11.9	1.594	15.9	1.376	19.9	1.193	23.9	1.038	27.9	0.918
12.0	1.588	16.0	1.371	20.0	1.189	24.0	1.035	28.0	0.915
12.1	1.582	16.1	1.366	20.1	1.185	24.1	1.031	28.1	0.913
12.2	1.576	16.2	1.361	20.2	1.180	24.2	1.028	28.2	0.910
12.3	1.570	16.3	1.356	20.3	1.176	24.3	1.024	28.3	0.908
12.4	1.564	16.4	1.351	20.4	1.172	24.4	1.021	28.4	0.905
12.5	1.558	16.5	1.347	20.5	1.168	24.5	1.017	28.5	0.902
12.6	1.553	16.6	1.342	20.6	1.164	24.6	1.014	28.6	0.900
12.7	1.547	16.7	1.337	20.7	1.160	24.7	1.010	28.7	0.897
12.8	1.541	16.8	1.332	20.8	1.156	24.8	1.007	28.8	0.894
12.9	1.536	16.9	1.327	20.9	1.152	24.9	1.003	28.9	0.892
13.0	1.530	17.0	1.323	21.0	1.148	25.0	1.000	29.0	0.889
13.1	1.524	17.1	1.318	21.1	1.144	25.1	0.997	29.1	0.887
13.2	1.519	17.2	1.313	21.2	1.140	25.2	0.994	29.2	0.884
13.3	1.513	17.3	1.308	21.3	1.136	25.3	0.991	29.3	0.882
13.4	1.508	17.4	1.304	21.4	1.132	25.4	0.988	29.4	0.879
13.5	1.502	17.5	1.299	21.5	1.128	25.5	0.985	29.5	0.877
13.6	1.496	17.6	1.294	21.6	1.124	25.6	0.982	29.6	0.874
13.7	1.491	17.7	1.290	21.7	1.120	25.7	0.979	29.7	0.871
13.8	1.486	17.8	1.285	21.8	1.116	25.8	0.977	29.8	0.869
13.9	1.480	17.9	1.281	21.9	1.112	25.9	0.974	29.9	0.866

Corrected Flow Rate = (Measured Flow Rate)*(TCF @ Feed Water Temp.)

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FILMTEC™ Membranes

7. Other

- FILMTEC Heat Sanitizable RO Elements
- RO Elements for Sanitary Applications
- 8” Semiconductor Grade Reverse Osmosis Elements

DOW™ Food and Dairy Membranes

Reverse Osmosis and Desalting Nanofiltration Elements for Food and Processing Applications

DOW™ reverse osmosis (RO) membrane elements contain sanitary, high-rejection FT30 reverse osmosis membrane that has been successfully used to process a wide range of food, beverage, and dairy streams. These elements are especially effective in dewatering product concentration. The DOW Food and Dairy RO-8038 is the only element constructed with a polypropylene outer shell, designed to withstand the most rigorous processing applications and conditions.

DOW nanofiltration (NF) membrane elements are used by food and dairy processors for a variety of desalting, purification and other separations. All NF elements contain an improved nanofiltration membrane sheet designed to reject organics with a molecular weight above 300 amu while passing monovalent salts.

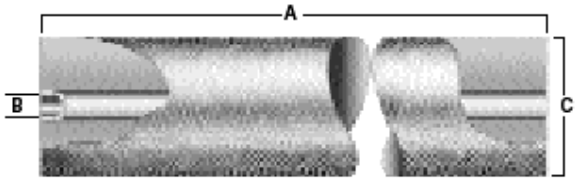
The DOW RO-390-FF product is the industry's premier membrane for evaporator condensate polishing. RO-390-FF has more active area than competitive elements to maximize performance and reduce capital cost by requiring the fewest elements for polishing applications.

All materials of construction are compliant with FDA indirect food contact requirements and are suitable for use in food processing applications.

Product Specifications

Product	Part number	Design active area – ft^2 (m^2)	Outer Casing
DOW™ Food and Dairy RO-8038	302219	370 (34.4)	Outer shell
DOW RO-390-FF	116314	390 (36.2)	Mesh wrap
DOW RO-3840/30-FF	196310	81 (7.5)	Mesh wrap
DOW RO-3838/30-FF	80588	79 (7.4)	Mesh wrap
DOW RO-3938/30-FF	117259	85 (7.8)	Mesh wrap
DOW NF-390-FF	146074	390 (36.2)	Mesh wrap
DOW NF-3840/30-FF	319116	81 (7.5)	Mesh wrap
DOW NF-3838/30-FF	316942	79 (7.4)	Mesh wrap

Figure 1



	Dimensions – inches (mm)		
Product type	A	B	C
DOW™ Food and Dairy RO-8038[1]	38.00 (965.0)	1.125 (28.58)	7.9 (200)
DOW RO-390-FF & NF-390-FF[2]	40.00 (1,016)	1.125 (28.58)	7.9 (200)
DOW RO-3840/30-FF & NF-3840/30-FF	38.75 (984.3)	0.83 (21.1)	3.8 (96)
DOW RO-3838/30-FF & NF-3838/30-FF[3]	38.00 (965.0)	0.83 (21.1)	3.8 (96)
DOW RO-3938/30-FF[4]	38.00 (965.0)	0.83 (21.1)	3.9 (99)

1. DOW Food and Dairy RO-8038 are designed to fit Schedule 40, 8 inch stainless pipe (nominal 7.98 inch ID).
2. RO / NF-390-FF are designed in a 8040 style with 1 inch exposed product water tube instead of a flush cut end on each side.
3. RO / NF-3838/30-FF and RO / NF-3840/30-FF elements are designed to fit 14 gauge stainless tubing (nominal 3.83 inch ID).
4. RO-3938/30-FF is designed to fit older APV housings (nominal 101 mm ID).

Operating Limits

- Maximum operating pressure: 800 psi (54.8 bar)
- Maximum operating temperature[a]: 122°F (50°C)
- Free chlorine tolerance[c]: Non-detectable
- Hydrogen peroxide usage limit:
  - Continuous operation: 20 ppm
  - Short-term cleaning (@ 77°F/25°C maximum): 1,000 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).
[b] Refer to Cleaning Guidelines in technical bulletin 609-00077.
[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Cleaning Limits for pH Range and Temperature

Element type	Max. Temp 50ºC (122ºF) pH Range	Max. Temp 45ºC (113ºF) pH Range	Max. Temp 35ºC (95ºF) pH Range	Max. Temp 25ºC (77ºF) pH Range
RO	3 - 10	2 - 11	1.5 - 11.5	1 - 12
NF	3 - 10	2 - 10.5	1.5 - 11.5	1.5 - 11.5

Design Guidelines

Product	Max. recirculation cross-flow – gpm (m^3/h)	Max. element $\Delta P^{\dagger}$ – psi (bar)
DOW™ Food and Dairy RO-8038	80 (18.2)	13 (0.9)
DOW RO-390 & NF-390	80 (18.2)	13 (0.9)
DOW RO-3840 & NF-3840	30 (6.8)	15 (1.0)
DOW RO-3838 & NF-3838	30 (6.8)	15 (1.0)
DOW RO-3938	30 (6.8)	15 (1.0)

† Maximum pressure drop across entire vessel is 60 psi (4.1 bar).

Important Information

New RO spiral elements normally are cleaned prior to initial use. The cleaning procedure should be based on the application for which the elements are to be used. If cleaning with formulated agents is not available, an alkaline wash with a wetting agent is recommended prior to initial use.

Please refer to technical bulletin 609-00077, DOW™ Food Processing and Sanitary Element Cleaning Guide, for more information on cleaning.

Operation Guidelines

Avoid any abrupt pressure or cross flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Before initiating cross-flow at high permeate flux conditions (e.g., start-up with high-temperature water), the set operating pressure should be maintained for 5-10 minutes.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.

General Information

- Keep elements moist at all times after initial wetting.
- If operating specifications given in this Product Information bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during system shutdowns, it is recommended that DOW™ Food and Processing elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 60 psi (4.1 bar).
- Avoid permeate-side backpressure at all times.

DOW™ Food and Dairy Membranes

Notice: The use of this product in and of itself does not necessarily guarantee the removal of cysts and pathogens from water. Effective cyst and pathogen reduction is dependent on the complete system design and on the operation and maintenance of the system.

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FILMTEC™ Membranes

FILMTEC Heat Sanitizable RO Elements

Features

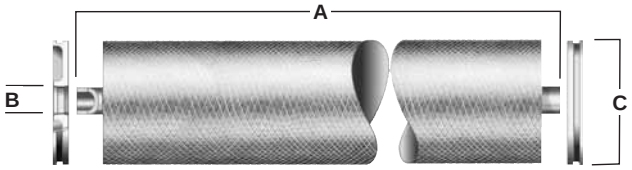
FILMTEC™ HSRO heat sanitizable reverse osmosis membrane elements deliver outstanding quality water with the added capability to withstand sanitization with hot water. HSRO elements, manufactured on advanced automated equipment, have the highest active membrane area in the industry. This high area allows system designs with either lower operating flux or cost savings from fewer membrane elements. The full-fit configuration minimizes stagnant areas and is optimal for applications requiring a sanitary design. All components comply with FDA standards.

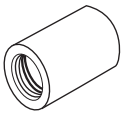
Product Specifications

Product	Part Number	Active Area ft^2 (m^2)	Applied Pressure psig (bar)	Permeate Flow Rate gpd (m^3/d)	Stabilized Salt Rejection (%)
HSRO-4040-FF	98592	90 (8.4)	150 (10.3)	1,900 (7.2)	99.5
HSRO-390-FF	170701	390 (36)	150 (10.3)	9,000 (34)	99.5

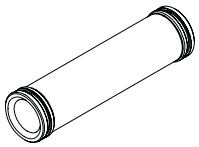
1. HSRO-4040-FF was previously named SG30-85-HS. HSRO-390-FF was previously named SG30-390-HS.
2. Permeate flow and salt rejection based on the following test conditions: 2,000 ppm NaCl, pressure specified above, 77°F (25°C) and 15% recovery.
3. Elements must be conditioned prior to start-up. A one-time flux loss will occur during stabilization. Listed values apply after performance stabilization.
4. Permeate flows for individual elements may vary +/-20%.
5. For the purpose of improvement, specifications may be updated periodically.

Figure 1





FilmTec supplies two end caps (part number 102109) with each HSRO-4040-FF element. FilmTec sells coupler part number 89048 for use in multiple element housings. Each coupler includes two 2-210 EPR o-rings (part number 89255).



FilmTec supplies two end caps (part number 113199) and one coupler (part number 255289) with each HSRO-390-FF element. Each coupler includes two 3-912 EPR o-rings (part number 151705).

Product	Dimensions – Inches (mm) A	B	C
HSRO-4040-FF	40.0 (1,016)	0.75 OD (19.0)	3.9 (99)
HSRO-390-FF	40.0 (1,016)	1.13 ID (28.6)	7.9 (200)

1. Refer to FilmTec Design Guidelines for multiple-element systems.
2. HSRO-4040-FF fits nominal 4 inch I.D. pressure vessels. HSRO-390-FF fits nominal 8 inch I.D. pressure vessels.

1 inch = 25.4 mm

Operating Limits

- Membrane Type: Polyamide Thin-Film Composite
- Maximum Operating Temperature[a]: 113°F (45°C)
- Maximum Sanitization Temperature (@ 25 psig): 185°F (85°C)
- Maximum Operating Pressure: 600 psig (41 bar)
- Maximum Pressure Drop: 15 psig (1.0 bar)
- pH Range, Continuous Operation[a]: 2 - 11
- pH Range, Short-Term Cleaning[b]: 1 - 12
- Maximum Feed Silt Density Index: SDI 5
- Free Chlorine Tolerance[c]: < 0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-22010 for more information.

Important Information

New HSRO heat sanitizable spiral elements must be pre-conditioned prior to initial use by exposure to hot water. An appropriate conditioning procedure consists of the following:

- Flush to drain with suitable quality water at low pressure and low permeate flow rate.
- Recycle warm water (45°C or less) at very low pressure (< 25 psig trans-membrane pressure with a maximum feed pressure of 45 psig (3 bar)).
- Introduce hot water to the system to increase temperature to 80°C (176°F).
- Keep trans-membrane pressure below 25 psig (1.7 bar) when warm or hot water (45°C or higher) is being fed to the membranes.
- Maintain temperature for 60-90 minutes.
- Allow system to cool to 45°C or below.
- Flush to drain with suitable water quality at very low pressure (< 25 psig trans-membrane pressure with maximum feed pressure of 45 psig (3 bar)).

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating points should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 60 psi (4.1 bar).
- Avoid static permeate-backpressure at all times.

Suitable quality water must be used during all pre-conditioning steps. This water is chlorine-free, non scaling/fouling water. RO permeate is preferred, but prefiltered feedwater may be used.

This step is needed to ensure that the element components have cooled to below 45°C.

Regulatory Note

These membranes may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

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FILMTEC Membranes

RO Elements for Sanitary Applications

Features

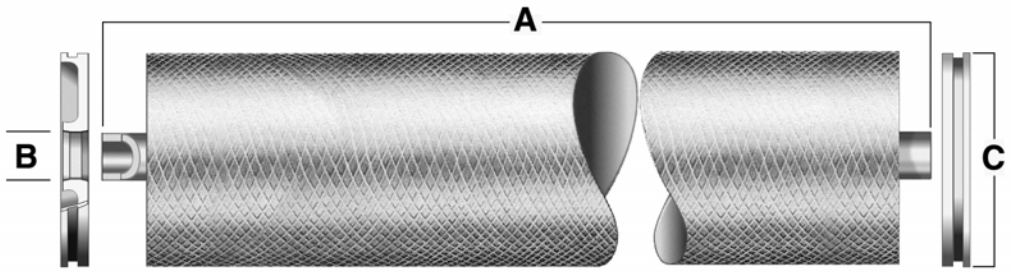
FILMTEC™ RO reverse osmosis membrane elements deliver high flux and outstanding quality water for applications requiring sanitary grade membrane elements. The full-fit configuration minimizes stagnant areas and is optimal for applications requiring a sanitary design. All components comply with FDA standards.

Product Specifications

Product	Part Number	Active Surface Area ft^2 (m^2)	Stabilized Permeate Flow Rate gpd (m^3/d)	Typical Stabilized Salt Rejection (%)
RO-4040-FF	84286	85 (7.9)	2,400 (9.1)	99.5
RO-390-FF	116314 / 100608	390 (36)	10,800 (40.9)	99.5

1. RO-4040-FF was previously named BW30-4040-LW.
2. RO-390-FF replaces BW30-380-LW and BW30-8040-LW.
3. Permeate flow and salt rejection based on standard conditions: 2,000 ppm NaCl, 225 psi (16 bar), 77°F (25°C), pH 8 and 15% recovery.
4. Minimum stabilized salt rejection is 98.0%.

Figure 1



	Dimensions – Inches (mm)		
Product	A	B	C
RO-4040-FF	40.0 (1,016)	0.75 OD (19)	3.9 (99)
RO-390-FF	40.0 (1,016)	1.125 ID (28.58)	7.9 (200)

1 inch = 25.4 mm

Operating Limits

• Membrane Type	Thin-Film Composite
• Maximum Operating Temperature	113°F (45°C)
• Maximum Operating Pressure	600 psi (41 bar)
• Maximum Differential Pressure	15 psi (1.0 bar)
• Maximum Feed Turbidity	1 NTU
• Free Chlorine Tolerance	Below Detectable Limits
• pH Range, Continuous Operation	3 – 10
• pH Range, Short-Term Cleaning (30 min.)*	1 – 12
• Maximum Feed Silt Density Index (SDI)	5

* Refer to Cleaning Guidelines in specification sheet 609-23010.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-00298) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 60 psi (4.1 bar).
- Avoid permeate-side backpressure at all times.

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FILMTEC™ Membranes

8" Semiconductor Grade Reverse Osmosis Elements

Features

Ultrapure water specifications and analytical measurement capabilities have advanced to meet the exacting needs of microprocessor, semiconductor and other silicon based device manufacturers.

FILMTEC™ SG30-400/34*i* and SG30LE-440*i* reverse osmosis elements have been developed to meet the requirements of higher overall rejection, higher rejection of lower molecular weight organic compounds and silica and an accelerated TOC rinse down profile. These high surface area elements allow for system design with fewer elements and a lower applied operating pressure, thus optimizing amortization of capital costs while lowering operating cost.

Both elements now come with the unique *iLEC*™ interlocking endcaps that reduce system operating costs, reduce the risk of o-ring leaks and the generation of small particles that lead to poor water quality, and eliminate the need for lubricants. See form No. 609-00446 for more information on the benefits of *iLEC* interlocking endcaps.

SG30-400/34*i* is intended primarily for polishing use in traditional UPW systems designed for higher pressure operation. It features a 34 mil spacer to lessen the impact of fouling and pressure drop across a vessel, increasing running time between cleaning and enhancing cleaning effectiveness.

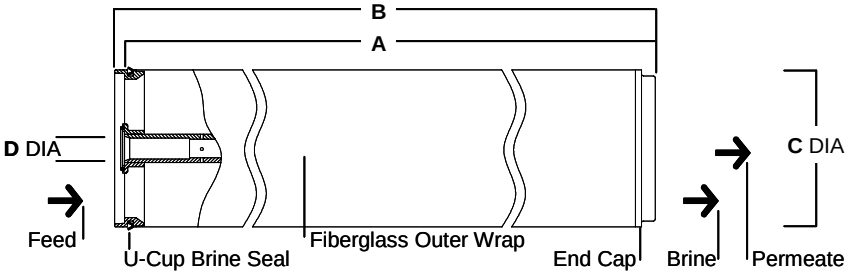
SG30LE-440*i* is intended primarily for polishing use in newer UPW equipment where the benefits of lower capital cost and lower energy consumption add value.

Product Specifications

Product	Part Number	Active Area ft^2 (m^2)	Permeate Flow Rate gpd (m^3/d)
SG30-400/34*i*	272569	400 (37)	10,200[1] (38.6)
SG30LE-440*i*	272573	440 (41)	10,000[2] (38)

1. Pure water flow based on the following conditions: 225 psi (1.55 MPa), 77°F (25°C) and 15% recovery.
2. Pure water flow based on the following conditions: 107 psi (0.74 MPa), 77°F (25°C) and 15% recovery.
3. Flow rates for individual elements may vary but will be not more than 15% below the value shown.
4. Product specifications may vary slightly as improvements are implemented.
5. Typical stabilized salt rejection (Cl^-) for individual element is 99.5% under the test conditions of 2,000 ppm NaCl, 225 psi (1.55 MPa) for SG30-400/34*i* and 150 psi (1.03 MPa) for SG30LE-440*i*, 77°F (25°C), pH 8 and 15% recovery. At lower TDS (<5 ppm), ion rejections are decreased depending on ionic strength, pH and ionic species.

Figure 1



Product	Maximum Feed Flow Rate gpm (m^3/h)	Typical Recovery Rate (%)	Dimensions – Inches (mm) A	B	C	D
SG30-400/34*i*	85 (19)	15	40.0 (1,016)	40.5 (1,029)	7.9 (201)	1.125 ID (29)
SG30LE-440*i*	85 (19)	15	40.0 (1,016)	40.5 (1,029)	7.9 (201)	1.125 ID (29)

1. Typical recovery rate shown is for a single element. Recovery rate is calculated by dividing permeate flow rate by feed flow rate. 1 inch = 25.4 mm
2. Refer to FilmTec Design Guidelines for multiple-element systems.
3. SG30-400/34*i* and SG30LE-440*i* elements fit nominal 8.0-inch (203 mm) I.D. pressure vessel.
4. SG30LE-440*i* now has an industry standard 1.125-inch I.D. permeate tube. If required, SG30LE-440*i* can be connected in series with the old SG30LE-430 (1.5-inch I.D. tube) using interconnector part number 196309.

Operating Limits

• Membrane Type	Polyamide Thin-Film Composite
• Maximum Operating Temperature	113°F (45°C)
• Maximum Operating Pressure	600 psig (4.1 MPa)
• Maximum Differential Pressure	15 psig (0.1 MPa)
• pH Range, Continuous Operation[a]	2 - 11
• pH Range, Short-Term Cleaning (30 min.)[b]	1 - 13
• Maximum Feed Silt Density Index	SDI 5
• Free Chlorine Tolerance[c]	< 0.1 ppm

[a] Maximum temperature for continuous operation above pH 10 is 95°F (35°C).

[b] Refer to Cleaning Guidelines in specification sheet 609-23010.

[c] Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, FilmTec recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to technical bulletin 609-02034 for more information.

Organic Rejection Data

Rejection data for organic species are tabulated below.

Table 1. Typical organic compounds rejection

Organic compound	MW	Rejection (%) SG30-400/34*i*[1]	Rejection (%) SG30LE-440*i*[2]
Methanol	32	14	13
Ethanol	46	50	40
Acetone	58	68	48
Isopropanol	60	95	92

Test conditions: 1. Feed concentration 10 ppm, 214 psi (1.47 MPa), 25°C, pH 7 and 15% recovery.
2. Feed concentration 10 ppm, 107 psi (0.74 MPa), 25°C, pH 7 and 15% recovery.

Important Information

Proper start-up of reverse osmosis water treatment systems is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper start-up sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

Before initiating system start-up procedures, membrane pretreatment, loading of the membrane elements, instrument calibration and other system checks should be completed.

Please refer to the application information literature entitled “Start-Up Sequence” (Form No. 609-02077) for more information.

Operation Guidelines

Avoid any abrupt pressure or cross-flow variations on the spiral elements during start-up, shutdown, cleaning or other sequences to prevent possible membrane damage. During start-up, a gradual change from a standstill to operating state is recommended as follows:

- Feed pressure should be increased gradually over a 30-60 second time frame.
- Cross-flow velocity at set operating point should be achieved gradually over 15-20 seconds.
- Permeate obtained from first hour of operation should be discarded.

General Information

- Keep elements moist at all times after initial wetting.
- If operating limits and guidelines given in this bulletin are not strictly followed, the limited warranty will be null and void.
- To prevent biological growth during prolonged system shutdowns, it is recommended that membrane elements be immersed in a preservative solution.
- The customer is fully responsible for the effects of incompatible chemicals and lubricants on elements.
- Maximum pressure drop across an entire pressure vessel (housing) is 50 psi (0.34 MPa).
- Avoid static permeate-side backpressure at all times.

Notice: The use of this product in and of itself does not necessarily guarantee the removal of cysts and pathogens from water. Effective cyst and pathogen reduction is dependent on the complete system design and on the operation and maintenance of the system.

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