



FILMTEC Membranes

How to Achieve the Lowest Cost Desalination with FilmTec's New Extra Low-Energy, High-Rejection Seawater Element

Energy usage is the single largest factor in the cost of seawater desalination systems, accounting for 20-30% of the total cost of water. To enable the lowest level of energy usage and reduce the cost of producing potable water from seawater, FilmTec has introduced FILMTEC™ SW30XLE-400*i*, an extra low-energy, high-rejection reverse osmosis (RO) membrane element that offers unprecedented levels of productivity and performance. This Tech Fact bulletin will discuss:

- Energy requirements for seawater desalination.
- Performance characteristics of the FILMTEC SW30XLE-400*i* membrane element.
- How to use the FILMTEC SW30XLE-400*i* element to reduce your energy consumption to levels of 2.0 kWh/m³ or reduce your capital costs by up to 30%.
- Performance data from several field trials.
- The benefits of *iLEC*TM interlocking endcaps.

Energy Usage in Seawater Desalination

Basic thermodynamics explains the inherent energy cost of producing potable water from seawater. For example, it can be simply calculated that for 35,000 mg/L seawater at 40% recovery with a product water of 300 ppm, the minimum energy needed is 1.85 kJ/kg of permeate, which corresponds to a usage of 0.52 kWh/m³.

In the past five years, however, more sophisticated thermodynamic analyses of RO system efficiency have been developed. These analyses use second-law considerations to estimate inefficiencies from concentration differences and from converting one stream into two streams at different thermodynamic states. For example, an energy analysis of a California brackish water RO plant revealed that almost three-quarters of the energy cost was the result of pressure loss across the membrane (feed-to-permeate section). The second largest factor in energy cost was the inefficiency of the pumps, including the use of throttling valves to control flow from pumps. Because membrane manufacturers and system designers have the greatest impact on the pressure loss across the membrane, a key contribution to reducing energy costs must come from membranes with higher flow rates.

Over the past decade, seawater RO membrane elements with flow rates of 6,000 gpd have become the industry standard for desalination. It has only been recently that advances in technology have enabled elements to deliver high rejection with higher flow rates, in turn enabling lower energy costs.

Benefits of the
FILMTEC
SW30XLE-400*i*
Seawater Element

The FILMTEC SW30XLE-400*i* membrane element enables the lowest total cost of seawater desalination in the industry through previously unattainable stabilized high rejection at high flow rates (see Table 1).

FILMTEC SW30XLE-400*i* also 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.

Table 1. Characteristics of the new FILMTEC SW30XLE-400*i* membrane element

Product name	Active area	Flow rate	NaCl rejection	Boron rejection	Maximum pressure	Feed spacer
FILMTEC SW30XLE-400 <i>i</i>	400 ft ² (37.2 m ²)	9,000 gpd (34.1 m ³ /d)	Typical 99.70% Minimum 99.55%	88.0%	1,200 psi (83 bar)	28 mil

The physical property data listed are considered to be typical properties, not specifications.

Standard test condition: NaCl feed of 32,000 mg/L, recovery of 8%, 77°F (25°C), 800 psi (55 bar) and pH 8.

The FILMTEC
SW30XLE-400*i*
Element Offers a
Number of
Important
Performance
Benefits

Increased active area. New developments in FilmTec's element construction have allowed an increase in the active area to 400 ft² without compromising the thickness of the 28 mil spacer. This development allows a significant increase in the productivity of a pressure vessel at constant membrane flux, without compromising fouling risk or element cleanability.

Long-term performance. The FILMTEC SW30XLE-400*i* element relies on a modification of the FT30 membrane chemistry, not bleach or other oxidative treatments, to achieve its higher flow rates. As a result, the element displays stable rejection performance and cleanability over the long term.

Wide utility. The FILMTEC SW30XLE-400*i* element is most useful in mid to lower salinity and temperature ranges, as well as in applications with relaxed permeate quality requirements. Figure 1 demonstrates the element's range by considering a standard plant with FILMTEC SW30XLE-400*i* elements and comparing the permeate quality to the World Health Organization standard of 500 mg/L.

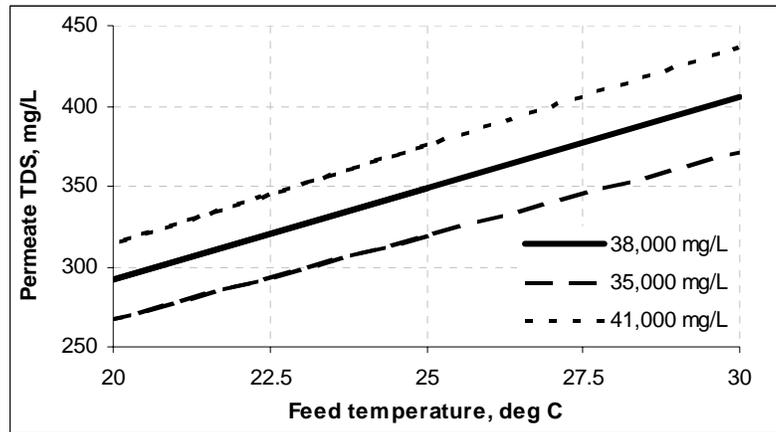
Improved Productivity with *iLEC* Interlocking Endcaps

The FILMTEC SW30XLE-400*i* is fitted with interlocking endcaps allowing users to enjoy these benefits:

- **Reduced permeate pressure drop** – The new endcap design imposes less permeate backpressure, translating to even more energy savings.
- **Long-term seal integrity** – The single, non-sliding seal reduces the number of potential leak sites and eliminates o-ring abrasion.
- **Leak-tight startup performance** – There is no possibility of o-rings being pinched and damaged during installation.
- **Lubricant-free operation** – No lubricants are necessary for full sealing performance between elements.
- **Backward compatibility** – Elements remain compatible with slip-fit connection methods and current pressure vessel designs.
- **Immediate installation feedback** – An audible click and matched alignment markings verify a leak-tight seal is achieved upon installation.
- **Durability** – Tests have shown that the interlocking endcap connection withstands bending, sagging and rough handling from repeated installation cycles.
- **Easy loading and unloading** – Element loading and unloading requires no additional time or personnel.

The FILMTEC SW30XLE-400i Element Offers a Number of Important Performance Benefits (cont.)

Figure 1. Operation range of the FILMTEC SW30XLE-400i element



Plant is assumed to use seven FILMTEC SW30XLE-400i elements per vessel and produce a flux of 15 L/m²h at a recovery of 45%.

At 38,000 mg/L and 25°C, which can be considered an average condition for most seawater plants, the permeate TDS reached is 350 mg/L. In most conditions between 35,000 mg/L and 41,000 mg/L and 20 and 30°C, FILMTEC SW30XLE-400i elements deliver a permeate TDS below 400 mg/L, meeting the permeate requirement for potable water.

Reducing Your Operating Costs and Capital Requirements

Designing systems around FILMTEC SW30XLE-400i membrane elements (as against conventional 6,000 gpd elements) can enable significant reductions in capital expenses, operating expenses or a combination of both, according to the strategy followed and the preferences of system designers and operators.

- **To reduce capital expenses**, designers can take advantage of the membranes' higher productivity to increase capacity using the same number of pressure vessels and membrane elements, or use fewer pressure vessels and membrane elements to achieve the current level of capacity without exceeding pressure requirements of a system based on 6,000 gpd elements.
- **To reduce operating expenses**, the feed pressure can be reduced while using the same number of elements to achieve the same flow rate, thereby resulting in lower energy costs at lower operating flux.
- **To reduce both capital and operating expenses**, water production and recovery can be increased using the same number of membranes, resulting in lower pump and pre-treatment capital and operating costs.

Other options for cost savings.

These are only three of the ways savings can be achieved with the high-flow, extra low-energy FILMTEC SW30XLE-400i elements. Plant designers and operators can employ many other methods to optimize their costs, according to the financial frame conditions (e.g., project duration, replacement rate, energy cost, interest rate) and the design approach (e.g., elements per vessel, average flux, recovery).

How Much Can You Save?

The high-flow, extra low-energy FILMTEC SW30XLE-400*i* membrane element offers the lowest energy use in the industry, allowing for energy consumption levels of 2.0 kWh/m³ or lower. Or, its unprecedented productivity and performance can reduce your capital costs by up to 30%. To learn more about how to take optimal advantage of the FILMTEC SW30XLE-400*i* element's economic benefits in your specific case, consult your Dow representative.

For More Information

More details about the performance and economic advantages of FILMTEC seawater RO membrane elements are available on our website, www.filmtec.com/sw:

- *"Strategies for Using FILMTEC Elements to Lower Your Total Cost of Desalination"*, Form No. 609-00471
- *"Success with FILMTEC SW30HR LE-400 Elements"*, Form No. 609-00473
- *"Solutions from FilmTec – Improve Your Desalination Economics"*, Form No. 609-00475
- *"Solutions from FilmTec – High-Flow, High Rejection Membranes for the Lowest Total Cost of Desalination"*, Form No. 609-00476
- *"How FilmTec's New High-Rejection, Low-Energy Seawater Element Can Reduce Your Desalination Costs"*, Form No. 609-00437

Learn more about the economic and performance benefits of **iLEC** interlocking endcaps:

- *"Say 'Goodbye' to the Weakest Link"*, Form No. 609-00447
- *"How to Improve Permeate Quality Using FilmTec's Interlocking Endcaps"*, Form No. 609-00446
- *"iLEC Interlocking Endcaps Make Sea Water Desalination Processing Easier, Less Expensive"*, Form No. 609-00466
- *"iLEC Interlocking Endcaps Solve Leakage Problems and Improve Energy Efficiency in Semiconductor Plant"*, Form No. 609-00467
- *"iLEC Interlocking Endcaps Withstand Severe Treatment at Reverse Osmosis Facility"*, Form No. 609-00468

FILMTEC Membranes

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