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# Experience with seawater reverse osmosis SW30XFR-400/34i membrane at large desalination plant in United Arab Emirates

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**ABSTRACT**

A common difficulty with water purification processes using reverse osmosis membranes is biofouling, a phenomenon in which bacteria grow within the apparatus, sometimes as biofilm inside the membrane element. Biofouling reduces the membrane permeability and generates a larger than desirable pressure drop across the membrane, which could also eventually mechanically compromise the membrane element integrity. In industrial scale systems, it is not possible to completely remove the grown biofilm from within the reverse osmosis membrane, even using harsh cleaning conditions. This paper highlights the performance of the FilmTec™ SW30XFR-400/34, the new generation seawater fouling resistant membrane elements. The elements were operated using Red Sea seawater, known for its high biofouling potential. The operational results highlighted the improvement obtained when replacing the heritage FilmTec™ SW30HRLE-400 with the improved SW30XFR-400/34. The results complied over more than 2 y of operation demonstrate that the pressure drop was reduced up to 40% while keeping a stable normalized permeate flow and increased salt rejection.

*Keywords:* Seawater; Reverse osmosis; Fouling resistant; Membrane; Pressure drop; Biofouling

## 1. Introduction

Water purification using reverse osmosis (RO) elements is commonly selected as the most cost-effective strategy to provide high quality water for use in a variety of applications. However, fouling is still one of the major challenges for RO elements, causing an increase in the energy of operation required and frequent shutdowns to clean the system [1].

There are different types of membrane contamination [2]. The most problematic type is biological. Biological fouling is usually associated with an increase in differential pressure (dP) of the first stage pressure vessel [3–5]. The extracellular polymeric substances (EPS) films are particularly difficult to clean. Both system dP increase and drop in permeability increase the energy of operation but also lead to frequent cleanings to regain element performance. In total, fouling affects energy consumption, element lifetime, water productivity and cost of water produced [6]. It continues to be a significant cause of membrane failure as shown in Fig. 1.

Biofouling is generally the leading issue triggering cleaning in industrial wastewater treatment plants. Although guidelines recommend cleaning the system pressure drop increases by 15%, some plants postpone cleaning until much higher pressure drop values [7]. If it is not managed properly,

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this could not only ultimately reduce membrane lifetime, but also decrease permeate water quality and system uptime as shown in Fig. 2.

FilmTec™ SW30XFR-400/34 is a fouling-resistant seawater reverse osmosis (SWRO) element specifically designed to handle biofouling in SWRO desalination plants. This is achieved thanks to its fouling-resistant design, its durable membrane chemistry and its low pressure drop design.

The product specifications of the new seawater fouling resistant membrane element, together with its previous generation, the FilmTec™ SW30HRLE-400, can be found in Table 1.

## 2. Methods

### *2.1. Field trials with Red Sea seawater*

The operation was carried out in a large desalination plant located in United Arab Emirates (UAE), with a capacity up to 12,600 $m^3/d$ for each of the 8 trains.

A schematic of the plant is shown in Fig. 3. The open intake seawater was pretreated by Dyna sand filter vessel followed by 5-micron cartridge filtration. For each RO vessel, 7 elements were installed. Feed flow to each RO vessel was 10.5 $m^3/h$ and the recovery was set to 38%, providing an average permeate flux of 14.5 $L/m^2h$.

It is worth mentioning that the membranes used were FilmTec™ SW30XFR-400/34, that were replacing SW30HRLE-400i that were previously installed. Consequently, the results of the FilmTec™ SW30XFR-400/34 will be compared to previous operational results obtained by SW30HRLE-400i, using the same installation, but during different period.

## 3. Results and discussion

### *3.1. Red Sea seawater field trial*

The new seawater fouling resistant membrane element was able to offer up to 40% lower pressure drop than its

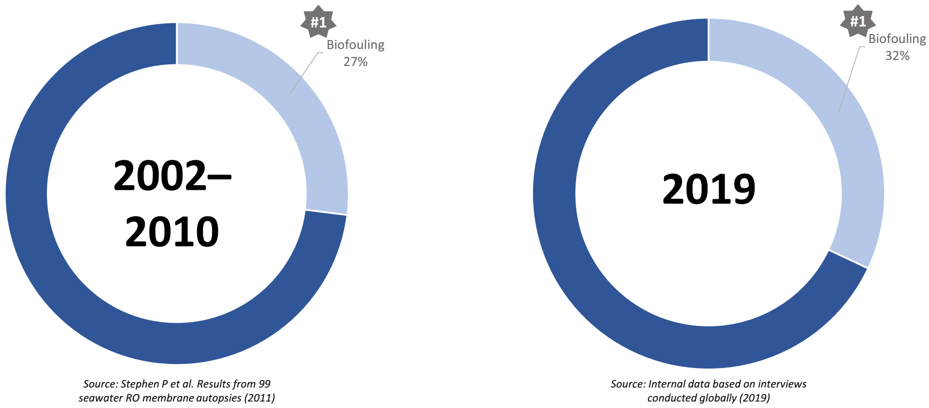


Fig. 1. Prevalence of biofouling as root cause on membrane failure.

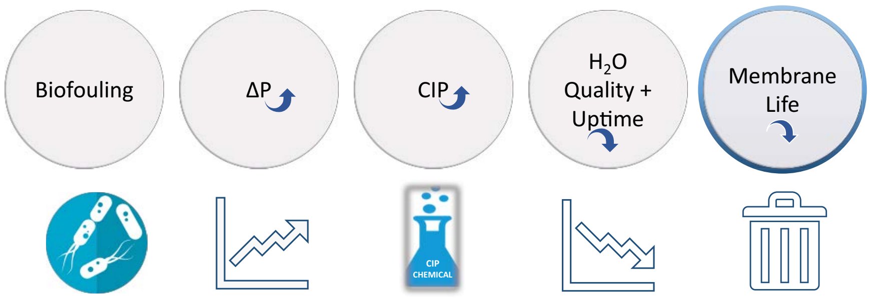


Fig. 2. Biofouling cycle.

Table 1
FilmTec™ seawater fouling resistant reverse osmosis element specifications[a]

| Product | Active area ($ft^2$) | Permeate flow (gpd) | Stabilized salt rejection |
|---|---|---|---|
| FilmTec™ SW30XFR-400/34 | 400 | 7,500 | 99.8% |
| FilmTec™ SW30HRLE-400 | 400 | 7,500 | 99.8% |

[a]Permeate flow and salt (NaCl) rejection is based on the following standard test conditions: 32,000 ppm NaCl, 55 bar, 25°C, pH 8 and 8% recovery.

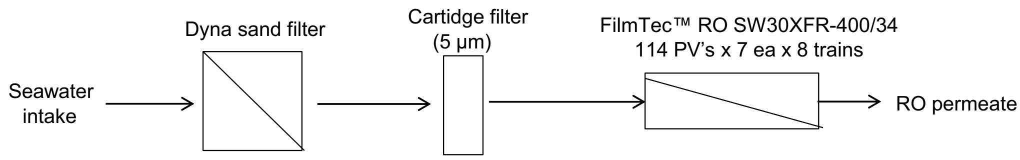


Fig. 3. Scheme of desalination plant.

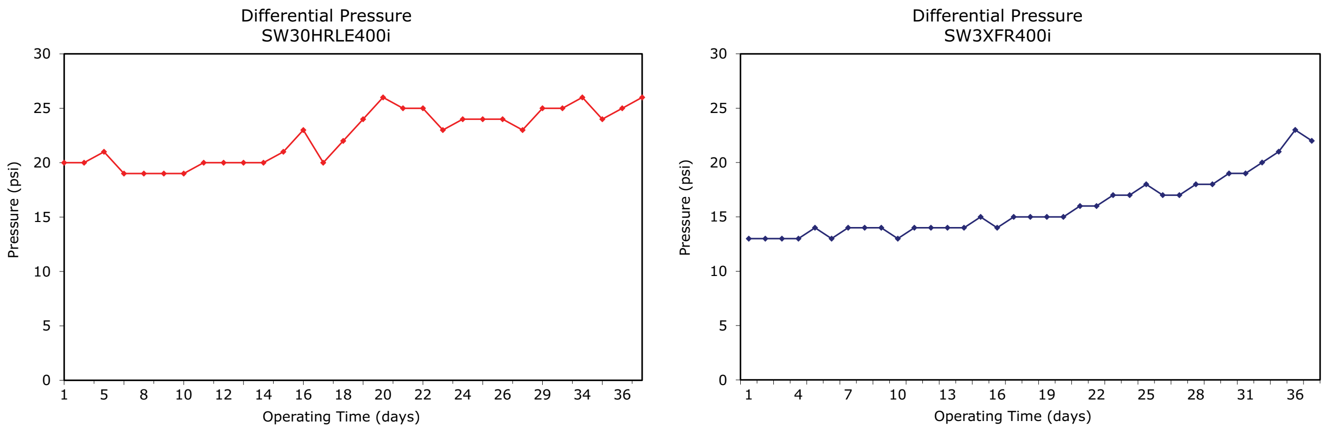


Fig. 4. Pressure drop comparison of new FilmTec™ SW30XFR-400/34 membrane (right) vs. the previous generation SW30HRLE-400 (left).

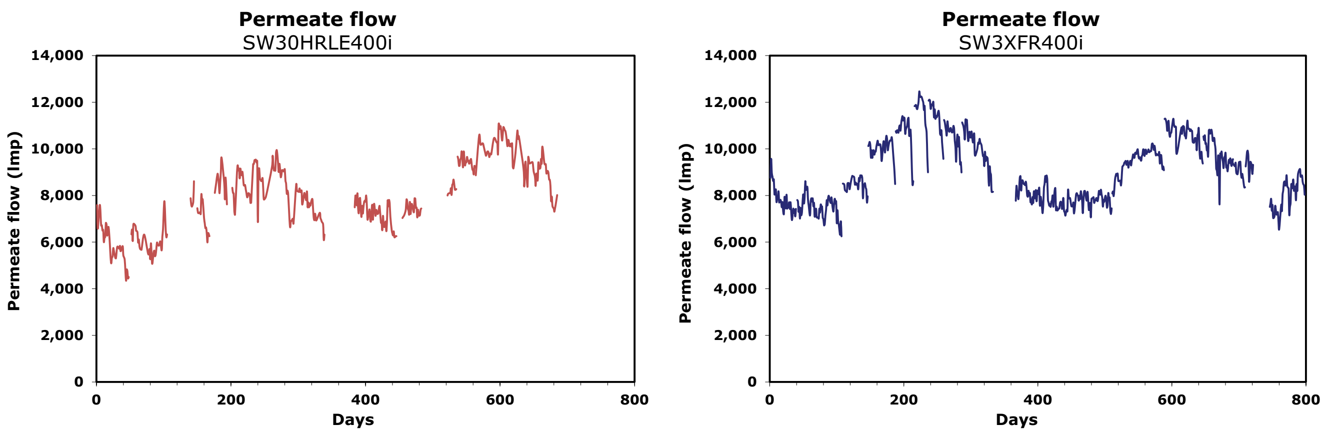


Fig. 5. Permeate flow evolution over time of FilmTec™ SW30XFR-400/34 (right) vs SW30HRLE-400 (left).

previous generation, as can be seen in Fig. 4. This results in several benefits during operation, such as a more reliable system, more uptime, reduced RO fouling and reduced number of cleanings in place (CIP).

Stabilized permeate flow is compared in Fig. 5, where the seawater fouling resistant membrane, FilmTec™ SW30XFR-400/34, yielded significantly higher permeate flow than the FilmTec™ SW30HRLE-400. Additionally, both membrane elements presented a stable normalized permeate flow after more than 2 y with several CIP. This can be extrapolated into lower cost of ownership for the system.

Stabilized salt passage is compared in Fig. 6, where the seawater fouling resistant membrane element, was able to get much lower salt passage than FilmTec™ SW30HRLE-400i. The SW30XFR-400/34 elements produce a more stable and reliable water quality.

## 4. Conclusions

The FilmTec™ seawater fouling resistant membrane, FilmTec™ SW30XFR-400/34, displayed an improvement compared to the standard FilmTec™ SW30HRLE-400 in a SWRO desalination plant. This membrane was able to offer 40% reduction in pressure drop with a stable performance in terms of normalized permeate flow and higher salt rejection. Additionally, it shows robustness in long-term operation and resistance to chemical cleanings (CIPs).

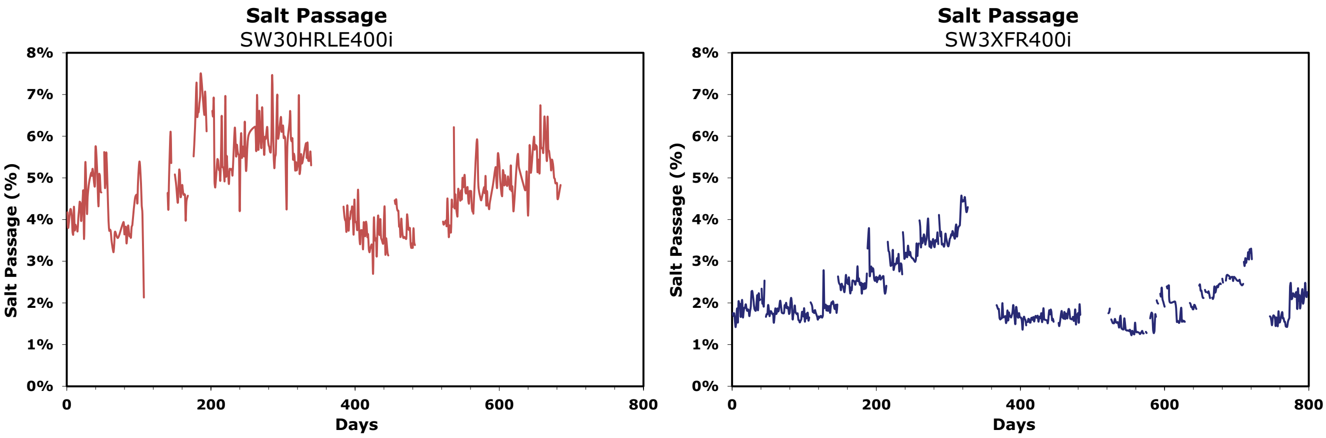


Fig. 6. Salt passage evolution of FilmTec™ SW30XFR-400/34 (right) vs SW30HRLE-400 (left).

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