



FILMTEC™ Membranes

FILMTEC HR Seawater Elements Resist Fouling, Cut TDS and Costs

Site Information

Location:

Fuerteventura, Canary Islands, Spain

Size:

1500 m³/d

Purpose:

Reduce TDS in high-fouling RO system

Time in Operation:

7 years

Comparative Performance:

- Permeate TDS reduced by 30%; flow increased by 50%.
- Cost savings in installation, operations, and chemicals.



An aerial view of the Gran Tarajal reverse osmosis desalination plant. Installation of FILMTEC™ SW30HR-320 elements reduced permeate total dissolved solids (TDS) by 30% and increased flow by 50% while reducing costs. (Photo courtesy of Consorcio de Abastecimiento de Aguas a Fuerteventura)

Introduction

Gran Tarajal is one of the largest towns on the island of Fuerteventura, Canary Islands. Like many seaside communities, natural sources of drinking water are scarce, so Gran Tarajal relies on a local reverse osmosis (RO) plant to convert sea water to drinking water. Unfortunately, the raw water quality is very poor, with high colloids and microbes. The total bacteria count (TBC) varies from 300 colony forming units (CFU)/mL to TNTC (too numerous to count). The silt density index SDI₍₁₅₎ of the feed water after pretreatment varies between 2.4 and 4.6. About 30% of the operating time it is higher than 3.8.

The Gran Tarajal RO plant wanted to improve the quality of the permeate from the 610 to 630 ppm total dissolved solids (TDS) obtained with conventional sea water elements to 400 or less because the water would be blended with higher TDS waters. To accomplish this, an RO element with a salt rejection of more than 99.6% would be needed. The plant preferred FILMTEC™ elements because they needed a tough membrane, and the previously installed conventional elements withstood on average one cleaning per month during the 5 years they were in operation. The plant was also interested in elements that would have good resistance to high differential pressure since the pressure vessels used in the plant contain seven elements each.

FILMTEC SW30HR-320 elements were installed in the plant and began operation in July 1997. Performance of the new elements was compared to both new installed conventional elements and the existing conventional elements.

FILMTEC™ Seawater High Rejection Elements

FILMTEC™ SW30HR-320 is a high productivity, very high rejection element designed to lower component economics. This element is very effective in treating high-fouling feed water. Features include:

- FILMTEC SW30HR-320 can effectively be used in permeate staged sea water desalination systems without impairing the performance of the downstream stage.
- FILMTEC SW30HR-320 features a 34-mil feed spacer, alleviating the impact of fouling on pressure drop across a vessel and enhancing cleaning capability.
- FILMTEC SW30HR-320 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 reduces element variability, increases reliability, and maximizes element efficiency, lowering cost of operation.

Plant Operation

The plant has a capacity of 1500 m³/d. Pretreatment consists of acidification, chlorination, two-stage sand filtration, dechlorination, and cartridge filtration. After pretreatment, the RO feed is pumped by a high-pressure pump with fast ramp starting characteristics (16 s from 3 to 65 bar) into a system consisting of 24 pressure vessels containing seven elements each. The poor quality of the feed combined with the short starting ramp of the high-pressure pump produces high mechanical stress on elements installed with the conventional spacer, which can result in mechanical damage to membrane elements. Because of the poor quality feed and high differential pressure, frequency of cleaning increased from once every 7 weeks to once every 10 to 15 days.

Some pressure vessels were loaded with FILMTEC SW30HR-320 elements and one was loaded with new conventional elements for comparison. The entire plant was carefully cleaned and the new operation started.

Plant Performance

Table 1 compares the operating parameters of the new sea water high-rejection elements with new and old conventional elements.

Table 1. Key operating parameters averaged for one pressure vessel with seven elements.

Operating parameters	New FILMTEC SW30HR-320			New installed conventional elements			Old conventional elements	
	Start-up	1 year	2 years	Start-up	1 year	2 years	Start-up ^a	1 year
Operating time								
Norm. feed press, ^b bar	66.0	66.3	66.6	66.0	66.3	66.6	66.0	66.3
Norm. permeate flow/PV, m ³ /h	4.52	3.46	3.2	3.6	2.45	2.16	2.18	1.77
Recovery, ^c %	44.1	42.6	41.8	42.0	41.8	41.8	41.6	40.8
Feed TDS, mg/L	37760	38100	37800	37760	38100	37800	37760	38100
Permeate TDS, mg/L	178	126	262	239	302	346	382	484
Norm. permeate flow/element, L/h	952	712	660	754	499	464	460	374
Norm. permeate flow/element, gpd	6030	4510	4180	4780	3160	2940	2920	2370
Temperature, °C	22	21	22	22	21	22	22	21
Norm. salt rejection SR, %	99.7	99.8	99.65	99.38	99.26	99.2	99.15	99.08
Hydraulic fouling factor (FF)	1.21	0.84	0.81	1.18	0.76	0.68	0.72	0.69
Specific energy absorption, ^d kWh/m ³	3.68	3.78	3.82	3.78	3.89	3.97	3.98	4.18
Pressure differential feed brine DP, bar	1.0	0.9	1.1	1.0	1.4	1.7	1.6	2.3
Stabilized hydraulic fouling factory ^e (FF _{ST})	1.02			0.99			NA	

^a At start-up, the old conventional elements left in the plant averaged 1.8 years (650 h) of operation.

^b Corrected for SW30HR-320 with ROSA factor corresponding to the permeate back pressure used at that specific operating time.

^c Determined by CL⁻ concentration analysis.

^d High-pressure pump and booster.

^e FF_{ST} measured once the fast decay of transient permeate flow was finished. This was about 500 h (20 days) after start-up.

Plant Performance,
cont.

Values in Table 1 are normalized because the plant had to continue operating with a partial load of the old elements. Start-up data were collected 78 h after start-up. One-year data were collected 354 days after start-up and 88 h after alkaline cleaning. Two-year data were collected 739 days after start-up and 59 h after alkaline cleaning. No two-year data are shown for the old conventional elements because they had been replaced with new high-rejection elements by then.

The fouling characteristics of the new membrane were excellent. With the same amount of fouling potential in the feed flow to both types of element, the new and the conventional element, the loss of capacity for FILMTEC™ SW30HR-320 elements was 17% in the first year of operation and 20.5% in two years of operation. The conventional element lost 23.5% in the first year and 31.3% in two years. The flow lost by the FILMTEC SW30HR-320 elements was 35% (more than one third) less than the conventional, which is remarkable.

The new HR elements met the requirements for permeate TDS with a value of 262 mg/L at 2 years after start-up. New conventional elements showed a TDS level of 346 mg/L. Salt passage for the new HR elements after 2 years decreased by 55%.

Cleaning
Performance

Table 2 shows the cleaning performance of the FILMTEC SW30HR-320. Plant cleaning consisted of two alkaline cleaning cycles of 2 hours each at pH 12.3 for conventional elements and only one cycle for FILMTEC SW30HR-320.

The flow increase and the differential pressure reduction of the FILMTEC SW30HR-320 elements was about 50% better than for the conventional element. The combined result of better fouling and cleaning performance doubled the time between cleanings for the FILMTEC SW30HR-320 elements.

Table 2. Comparative cleaning performance of FILMTEC SW30HR-320 elements vs. conventional elements after 770 h of operation.

Performance parameters	FILMTEC SW30HR-320			Conventional elements		
	Before cleaning	After plant cleaning	After lab cleaning	Before cleaning	After plant cleaning	After lab cleaning
Norm. permeate flow, gpd	3865	4535	4598	3508	3825	3930
Flow increase, %	—	17.3	19	—	9	12
Salt rejection SR, %	99.6	99.75	99.70	99.08	99.15	99.20
Diff. pressure feed brine DP, bar	1.2	1.0	0.9	1.7	1.5	1.45
DP reduction, %	—	17	25	—	12	14.5

System had undergone 285 days of operation under fouling conditions. SDI₁₅ = 4.4 on average and 5 cleanings.

Plant Economics

FILMTEC SW30HR-320 showed savings of 12% in the cost of installation and up to 4.4% in total operating costs due to reduced power usage. There was also up to 4% reduction in chemical costs for cleaning and plant downtime.

Conclusions

FILMTEC™ SW30HR-320 elements, with the 34-mil feed spacer, demonstrated an excellent level of performance in this plant, operating under severe fouling conditions typical of an open sea surface intake. Compared to conventional sea water elements, FILMTEC SW30HR-320 elements demonstrated 50% increase in permeate flow, 30% decrease in permeate TDS, and 55% decrease in salt passage. After cleaning, flow increase and differential pressure reduction was about 50% better than with conventional elements. Cost savings included 12% in installation costs, 4.4% in operating costs, and 4% in chemical costs.

FILMTEC SW30HR-320 elements enable the economic use of RO membranes in larger sea water purification applications where such usage was previously not considered economically viable. This product is an excellent choice for new installations and plant retrofits.

FILMTEC Membranes

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