Case History

Site Information
Location: Canary Islands, Spain
Purpose: Evaluate performance of $i\text{LEC}^\text{TM}$ elements
Date of Installation: March 2003
Comparative Performance: FILMTEC™ elements with $i\text{LEC}$ technology were easier to install, with no leakage, better permeate quality, less backpressure.

Introduction
Lanzarote is the furthest east of the seven major Canary Islands, situated about 60 miles (100 km) off the coast of Africa. This popular tourist destination relies largely on reverse osmosis (RO) conversion of seawater to support its tourist, domestic and agricultural activities. The RO operations on Lanzarote are owned and operated by Insular de Aguas de Lanzarote S.A. (Inalsa). Inalsa provides water production, distribution, and recycling services, as well as wastewater treatment, to more than 40,000 customers. Bottled water has been produced by Inalsa since 1990 and is marketed under the label Agua Chafariz.

An ongoing problem with Inalsa's RO elements involved leakage at the o-rings of element interconnectors, resulting in an average failure rate of three vessels per train per month at the Lanzarote III plant. With four trains in operation at the plant, the time dedicated to correcting o-ring leaks was approximately 18 manhours per month.

FILMTEC™ elements with $i\text{LEC}^\text{TM}$ technology are designed to eliminate this problem by replacing the sliding couplers with a single, stationary seal. A field test of 12 elements with $i\text{LEC}$ technology was conducted in the Lanzarote III plant to determine the effect of this new element design on permeate quality, energy consumption, and ease of installation and removal.

i\text{LEC}^\text{TM} Technology
Makes Seawater Desalination Processing Easier, Less Expensive
Leakage Problems at Lanzarote III

Daily measurement of the permeate conductivity from each vessel in the plant was used to identify leakage problems as they occurred. Vessels with particularly high conductivity were opened and unloaded. If no interconnector problems were found, the elements were tested individually. Between one and five vessels per month per train were found to have leaking interconnectors. Vessels with elevated but acceptable conductivity, which may have small or developing leaks, were monitored for signs of further deterioration.

Scheduled shutdowns were used to correct interconnector problems, so there was no lost production. However, exchanging elements in a vessel with interconnector problems was typically a three-person job that required approximately 30 minutes. Given an average failure rate of three vessels per month, and considering all four trains at Lanzarote III, the time dedicated to correcting o-ring leaks was approximately 18 manhours per month.

The five-year net present value (NPV) of this expenditure, given a $25-per-hour labor cost and a 10 percent discount rate, is $21,000. If the plant were operating at capacity and subject to monetary losses during shutdown, the penalty would be far higher. Cost of materials represents another added expense because problem interconnectors are replaced with a custom-machined Inalsa sliding coupler that incorporates three o-rings at each end.

Benefits of iLEC™ Technology

iLEC™ technology eliminates the need for multiple sliding seals between adjacent membrane elements, reducing the number of sealing surfaces per connection to a single, axially compressed o-ring. The result is a seal that is lubricant- and maintenance-free.

Long-term permeate quality is improved through prevention of o-ring leaks that occur as o-rings gradually become worn and abraded. In contrast to standard interconnectors, the possibility that o-rings will be pinched or damaged during installation, requiring the “debugging” of leaks upon start-up, is also eliminated.

iLEC™ technology also removes the permeate-side flow restriction associated with the small flow diameter of conventional interconnectors, reducing energy costs. Figure 1 contrasts cross-section views of the small flow diameter and multiple sliding seals of the conventional interconnector with the larger diameter and fixed seal of the product using iLEC™ technology.

Elements using iLEC technology are installed in minutes with a level of effort comparable to that associated with standard interconnectors. Special snap and alignment features provide tactile, audible, and visual feedback to inform the installer that a positive connection has been made between adjacent elements. Optional tools are available to make the handling of elements even easier (Figure 2).
Plant Design
FILMTEC™ SW30HR-380 elements with iLEC™ technology were installed into two vessels at Lanzarote III, a plant that produces 20,000 m³/d (5 million gpd) of permeate at a concentration of 430 ppm from four reverse osmosis trains. The vessels for this trial were located in the first and second stages of Train 4, a two-stage, 60 by 48 array of 8-inch pressure vessels. Each vessel holds six elements, which currently range in age from four to 12 years. The seawater feed is extracted from beach wells and pretreated using sand followed by cartridge filtration. The feed water contains 38,500 ppm TDS (total dissolved solids) and is adjusted to pH 7 using bisulfite.

Upon start-up of this evaluation, the train operated with a Stage 1 recovery of 34 percent and an overall recovery of 46 percent. The train produced approximately 255 m³/h (1.6 million gpd) of permeate. The feed pressures for Stages 1 and 2 were 64.0 bar (929 psi) and 62.8 bar (912 psi), respectively. The temperature was 21°C (70°F).

In both of the test vessels, interlocking vessel adapters, like those shown in Figure 3, replaced the standard adapters provided by the vessel manufacturer. These eliminated two more sliding connections, just inside the leading and trailing elements in each vessel, and reduced the permeate flow restriction at the vessel permeate port.

Plant Performance
The FILMTEC™ SW30HR-380 elements with iLEC™ technology commenced operation on March 12, 2003. Upon start-up, the vessel using iLEC technology in Stage 1 produced permeate containing 95 ppm TDS at an average flux of 20 L/m²h (11.8 gfd), while the vessel using iLEC technology in Stage 2 produced a permeate with 270 ppm TDS at an average flux of 7.3 L/m²h (4.6 gfd). Sustained performance at this level requires standard-test rejection of 99.85 percent and perfect sealing between elements.

To verify leak-free operation, a conductivity probing of elements with and without iLEC technology at Lanzarote III was conducted. The profiles shown in Figure 4 contrast a leak-free vessel using elements with iLEC technology with a neighboring vessel containing standard elements. A leaking o-ring between elements 1 and 2 in the standard vessel produced an obvious spike in conductivity and a degradation in permeate quality for that vessel.

Figure 3: Interlocking vessel adapters eliminate other potential leakage points within the vessel.

Figure 4: A comparison of conductivity probe data for side-by-side vessels in Stage 1 of Train 4.
Eliminating the standard couplers and vessel adapters provided a small boost in energy efficiency. The flow restriction of the couplers and adapters was measured inside a vessel in Stage 1. The backpressure imposed by the couplers and adapter, measured at the end of the vessel opposite the permeate port, was approximately 0.2 bar (3 psi). The corresponding result for the vessel using iLEC™ technology in Stage 1 was just 0.09 bar (1.3 psi).

Operating personnel at Lanzarote III were observed and questioned as they handled elements with iLEC technology for the first time. The time required for installation of the elements with iLEC technology was just three minutes per vessel, consistent with that required for loading standard elements. Regardless of the element type, a far greater period of up to 30 minutes was required to open and later close the same vessels.

Operating personnel rated the iLEC technology elements easier to install and “less work” than standard elements, in part because there was no need to handle interconnectors. Other comments from operating personnel included:

- Elements were easy to install, even without the strap wrench and element pulling tool.
- There should be no increase in the number of individuals, typically two to four, required for element installation and removal.
- Interlocking vessel adapters were readily attached to the first and last elements in both vessels using iLEC technology.
- The snapping action of the iLEC technology was easily detected, giving a good indication of a successful connection even in the noisy plant environment. Operators responded with “no doubt” when asked whether elements just installed were properly coupled together.

Conclusions
FILMTEC™ SW30HR-380 elements with iLEC™ technology were successfully installed in the Inalsa Lanzarote III reverse osmosis plant. Installation was easily accomplished with no need to search for leaks upon start-up. More than one year after installation, the vessels using iLEC technology are still leak-free, overall quality of the product water is improved, and permeate backpressure is reduced.

For More Information
For more information about iLEC™ technology

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