



## New 3D TRASAR® Membrane Technology increases plant efficiency and reduces operational risks in potable water production

### ENVIRONMENTAL RESULTS

Reduction in fresh water demand of over 41000 m<sup>3</sup> (6.25%) per year through improved water use efficiency

Additional reduction in water use eliminated annual wastewater volume of over 41000 m<sup>3</sup> (>25%)

Reduction in energy demand for production equivalent to 9.31% per year based upon kWh/m<sup>3</sup>

Overall annualised 15.5% reduction in treatment programme consumables

All data verified by the customer



### ECONOMIC RESULTS

Conservation of precious groundwater aquifer water resources in a water-stressed area

Annualised savings in disposal costs of €3580

Annualised savings in energy costs of €2670

Annualised savings of over €2500  
Overall annualised reduction in the Total Cost of Operation of €8750

### Introduction

FASCA, a company based in southern Europe, is focused on delivering integrated water management solutions. The company operates several Reverse Osmosis (RO) plants in the region that are used to produce and distribute potable water. Nalco technology has been used to successfully treat these RO plants since their start-up some years ago, and some of the RO trains currently use Nalco RO TRASAR technology for process monitoring and control.

This first-generation TRASAR® technology has been shown to be extremely reliable and is valued by the customer because the monitoring and control offered helps to consistently maintain plant performance and reduce operational costs. From the moment

they were commissioned, the RO TRASAR units demonstrated their value by detecting dosing pump failures and highlighting any incorrect dosage levels, allowing rapid correction and subsequent optimisation of treatment application, system protection and efficiency. The technology helped the customer avoid severe scaling problems and the unplanned cleaning or membrane replacement costs that would inevitably result. As a result of this long-term track record of success and experience with the TRASAR technology programme, the customer was very eager to receive the next-generation technology as it became available. Nalco subsequently launched this technology advance under the name of 3D TRASAR Membrane Technology, and this customer was one of the first recipients of the new programme.

## Background

The customer selected one of its potable water production plants to receive the new technology. The plant selected is made up of a Reverse Osmosis plant with two trains, each producing 125 m<sup>3</sup>/h of permeate. The feed water is well water, which has very stable water quality and temperature. As a result of the excellent feed water quality and the protection provided by the original Nalco RO TRASAR technology, including advanced antiscalant chemistries, it has never been necessary to clean the membranes in the system.

Each RO train includes:

- 1 media filter
- 1 cartridge filter
- 1 high pressure pump
- RO system, 2 stages (14:7) with six membranes of various types per vessel
- Nalco PermaTreat<sup>®</sup> technology is applied to each train

Due to the pattern of water demand, only one train runs at a time, running for eighteen hours per day. The trains are rotated every week.

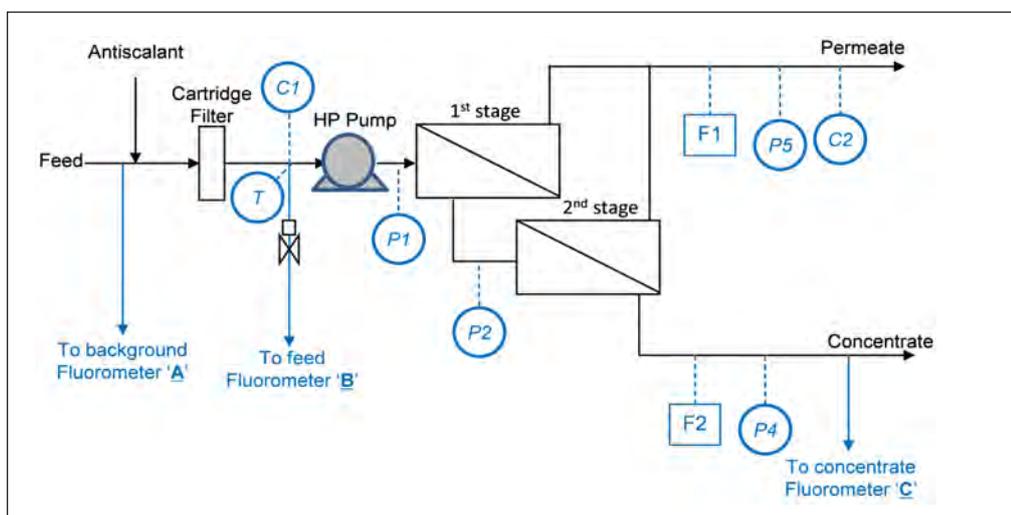
## Implementation

The installation of 3D TRASAR Membrane Technology at the site included the full suite of monitoring and control capabilities. Initially, control of the existing antiscalant programme was maintained using the existing RO TRASAR system. The new 3D TRASAR system was run in parallel but not yet with control

of the antiscalant. This allowed values from both the RO TRASAR and 3D TRASAR systems to be compared and accuracy and reliability to be demonstrated. To define the operating limits of a cooling water system when using a new programme strategy, Nalco typically uses 3D TRASAR Optimiser technology, a sophisticated process optimisation tool which identifies the advanced comprehensive treatment management programme necessary to protect a system from scale, corrosion, and microbiological fouling. As a result of this analysis, a new treatment regime was proposed, using the 3D TRASAR system. This moved away from the traditional programme, to one based upon automated real-time control of system parameters, and containing advanced chemistry to deliver comprehensive control of both corrosion and scale, and a unique polymer to deliver advanced corrosion protection. The use of the polymer also ensured good dispersancy and protection of all types of metallurgy that were present in the system.

The samples and signals from sensors needed for monitoring, control and normalisation calculations for the 3D TRASAR system are shown in Figure 1.

- Fluorometers A, B and C measure the fluorescence values of the untreated feedwater (background), treated feedwater and concentrate.
- C1 feed conductivity and temperature values are obtained from 3D TRASAR probes. C2 permeate conductivity is taken from an existing customer sensor.



**Figure 1** – Schematic showing the layout of data-gathering points used to control the antiscalant programme

- P1, P2, P4 pressure values are taken from existing customer sensors. There is no sensor for P5 permeate pressure, needed for normalisation, but this is a constant value (0.3 bar).
- F1 permeate flow and F2 concentrate flows are taken from existing customer sensors.

The following additional signals are also received by the customer's control unit:

- Pressure values (pre- and post-sand filters)
- Pressure value (post-cartridge filters)
- pH and ORP from fluorometer B
- Concentrate conductivity from fluorometer C

In order to send all of these data to the 3D TRASAR unit, a splitter box was prepared to split the signals from the Programmable Logic Controller (PLC) (as shown in Figure 2).



**Figure 2** – Splitter box used to manage signals between the RO trains and the 3D TRASAR unit.

The 3D TRASAR unit was connected to the internet via a Nalco Global Gateway (NGG) to record and analyse data, and to run the Nalco 'UNO' normalisation tool.

## Description

### 3D TRASAR Technology

3D TRASAR Technology management programmes are used in many different types of water preparation and management system to deliver on-demand control and optimisation of water chemistry, continuously protecting the systems from scale formation and fouling, ensuring optimised operational efficiency and continuity of production.

- Protection of systems avoids premature and costly replacement of non-renewable materials
- Scale and fouling control maximises operational efficiency and reduces costs

- Better water resource management minimises the demand for costly renewable resources, and safeguards public water supplies

3D TRASAR Technology is used by thousands of corporations around the world to:

- Secure improvements in their environmental and economic performance
- Optimise system efficiency
- Help them to meet their sustainability goals, specifically in the areas of water and energy use reduction

3D TRASAR technology control systems take account of the inherent variability in system water conditions, maintaining protection from scale and fouling by predicting problems and intervening before they occur. The programme controls system chemistry, dosing on-demand and minimising the amount of materials added to the system, thereby reducing costs without prejudicing system integrity.

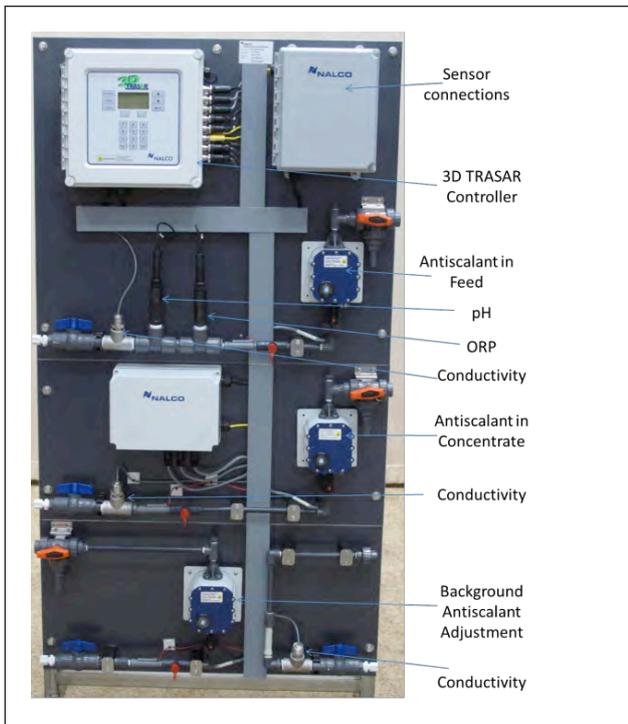
### 3D TRASAR Membrane Technology

This technology is the new generation of the Nalco RO TRASAR platform for the performance management of membrane systems. 3D TRASAR Membrane technology allows monitoring and control of antiscalant programmes and monitoring of key parameters for the membrane system: flows, pressures, feed water temperature and conductivities. This information is collected by the 3D TRASAR Control unit from plant sensors and sent to the centralised Nalco 3D TRASAR website via Nalco Global Gateway (NGG) to be normalised and trended. Customers are able to access this information on their own specific web page. Furthermore, the Nalco 360 Service team checks this data on a regular basis and makes recommendations about the continuous optimisation and improvement of plant operations.

The 3D TRASAR unit collects data from membrane systems through:

- TRASAR chemistry, ORP, pH and conductivity sensors on the unit
- Signals from the existing sensors through PLCs or signal splitters
- Signals from new sensors that are added if needed

The basic hardware package includes everything necessary to monitor and control the antiscalant programme in a multi-train system: 3 fluorimeters to measure the background fluorescence and the antiscalant in the feed and the concentrate; pH; ORP and conductivity probes and a platform for analogue inputs from plant sensors. A typical configuration is shown in Figure 3.



**Figure 3** – 3D TRASAR Membrane Technology: typical control unit configuration

The system can be customised for each system or customer need, and hardware can include more fluorimeters (6), ORP and pH probes, PID (4), analogue inputs (20) and connectivity to a PLC.

## Results

At this customer site, the 3D TRASAR unit ran in monitoring mode only for the first few weeks. During this period, the baseline operational status was determined by recording the normal system dynamics, and the data were checked for any upsets. The main initial advantage of using the new technology became quickly apparent through the availability of a much wider array of information on system performance than previously available.

The 3D TRASAR data showed that the Reverse Osmosis system was operating with a very high degree of stability, with no fouling or other operational issues affecting plant performance. Data for normalised differential pressure across the system for the first 7 weeks of the monitoring period are shown in Figure 4 below.

The differential pressure was found to be higher across the first stage due to previous fouling by iron oxide particles from a previous episode of corrosion of a high pressure pump. The second stage membranes had a higher surface area and were almost new giving a resultant lower differential pressure.



**Figure 4** – Graph showing Differential Pressure (DP) across two stages of the RO system.

Figure 5 shows data for the normalised permeate flow during the initial monitoring period. The 3D TRASAR unit and the NGG demonstrated their ability to receive, send and analyse all of the data necessary to provide reports publishing normalised data.

### Normalised data report

Key performance parameters are influenced by water temperature, pressure and feed water Total Dissolved Solids (TDS). Normalisation is the way to compensate for the effect of these variables and standardise data, allowing comparisons and to see trends of the actual performance of the RO system. The capability of the 3D TRASAR unit to generate normalised data reports means the customer has easy access to actual plant performance. Currently, normalised data reports have to be prepared manually. The Nalco system continuously and automatically provides critical information about plant performance, saving time and resources that can now be used elsewhere.

An additional advantage of the 3D TRASAR Membrane technology includes the ability to check plant recovery rates using readings from the values of TRASAR chemistry detected in both the feed and concentrate. Figure 6 shows a comparison between the percentage plant recovery determined by using the 3D TRASAR Membrane technology, and also by flow.

The peaks shown on the graph are due to shutdown and start-up periods. In this case the graph plots from both sources of data are largely superimposed, indicating that the 3D TRASAR Membrane technology provides an important double-check on the traditional flow measurement. In other plants, flow meters may not be as reliable, and therefore the Nalco programme offers the only way of accurately identifying the correct recovery.

Once the baseline of plant performance had been determined by running the 3D TRASAR system in monitoring mode for approximately seven weeks, the control of the antiscalant programme was switched over from the original RO TRASAR system to the new 3D TRASAR system. The antiscalant dosage set-point remained the same as before, at 3 ppm, with a low failsafe limit of 2 ppm. The system was then allowed to run in control mode for one month.

During the period of control mode operation, the accuracy of the dosage of antiscalant was increased as a result of the ability of the 3D TRASAR system to monitor background fluorescence in real-time. This allowed dosages to be calculated relative to the background, thus eliminating unnecessary extra antiscalant addition. Under the original RO TRASAR control regime, the customer had had to increase the set-point to 3.2 ppm in order to maintain the required 3 ppm dosage due to the constant input of background fluorescence during configuration. The advantage of having an online background fluores-

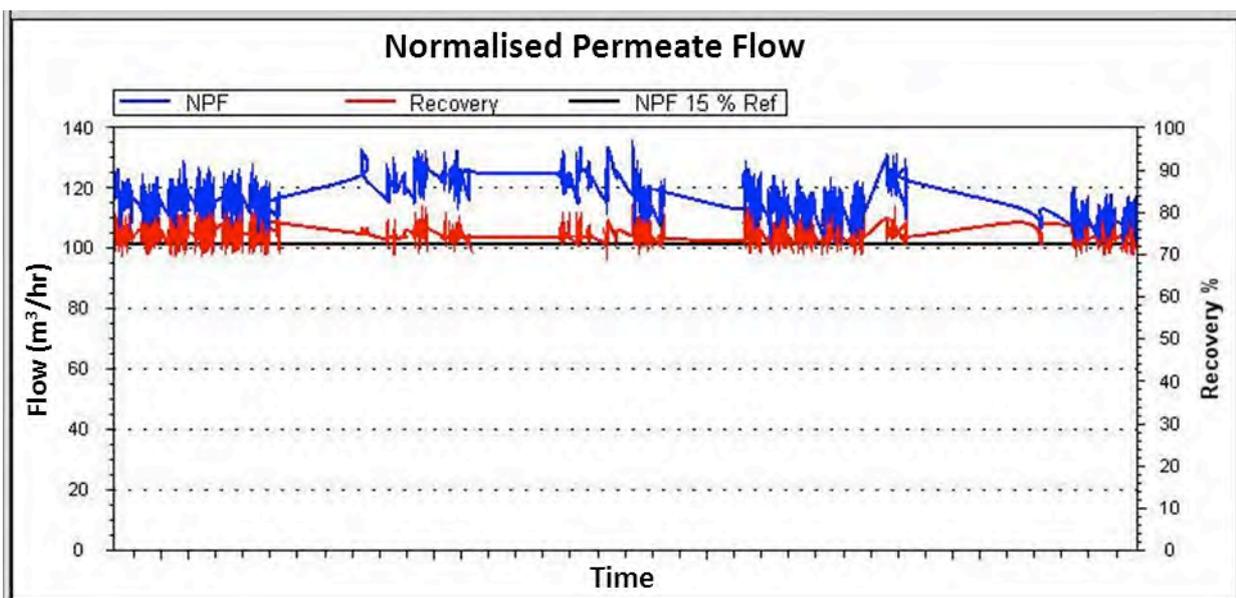
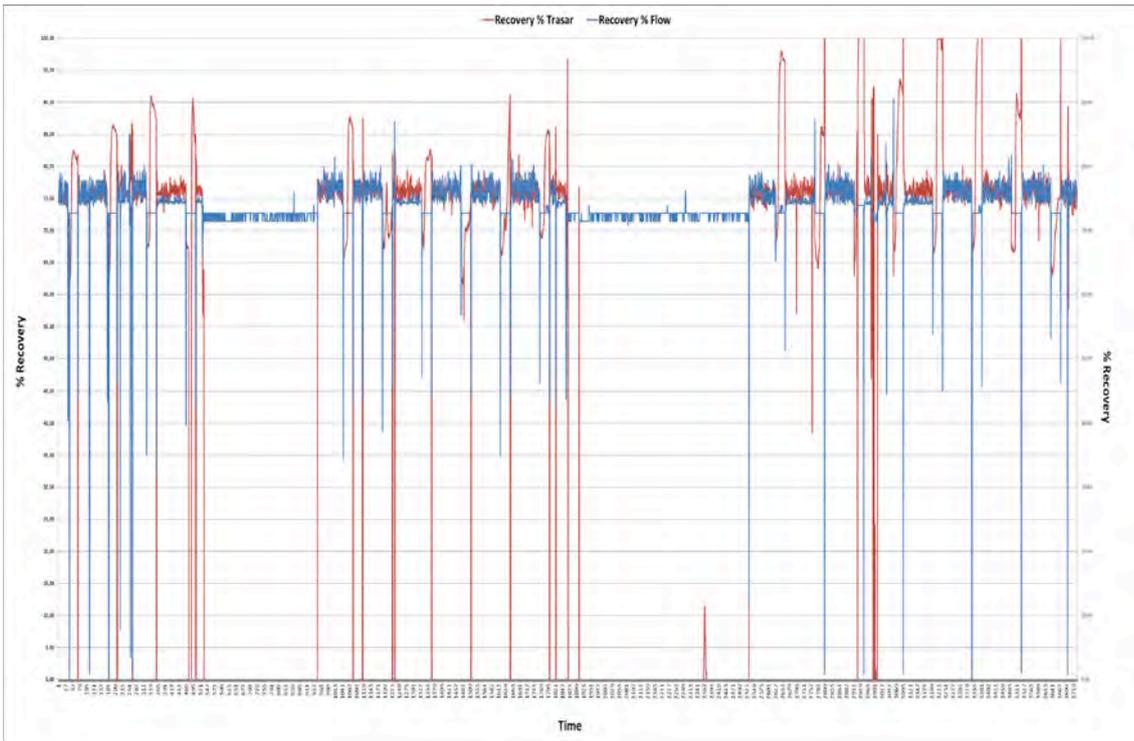


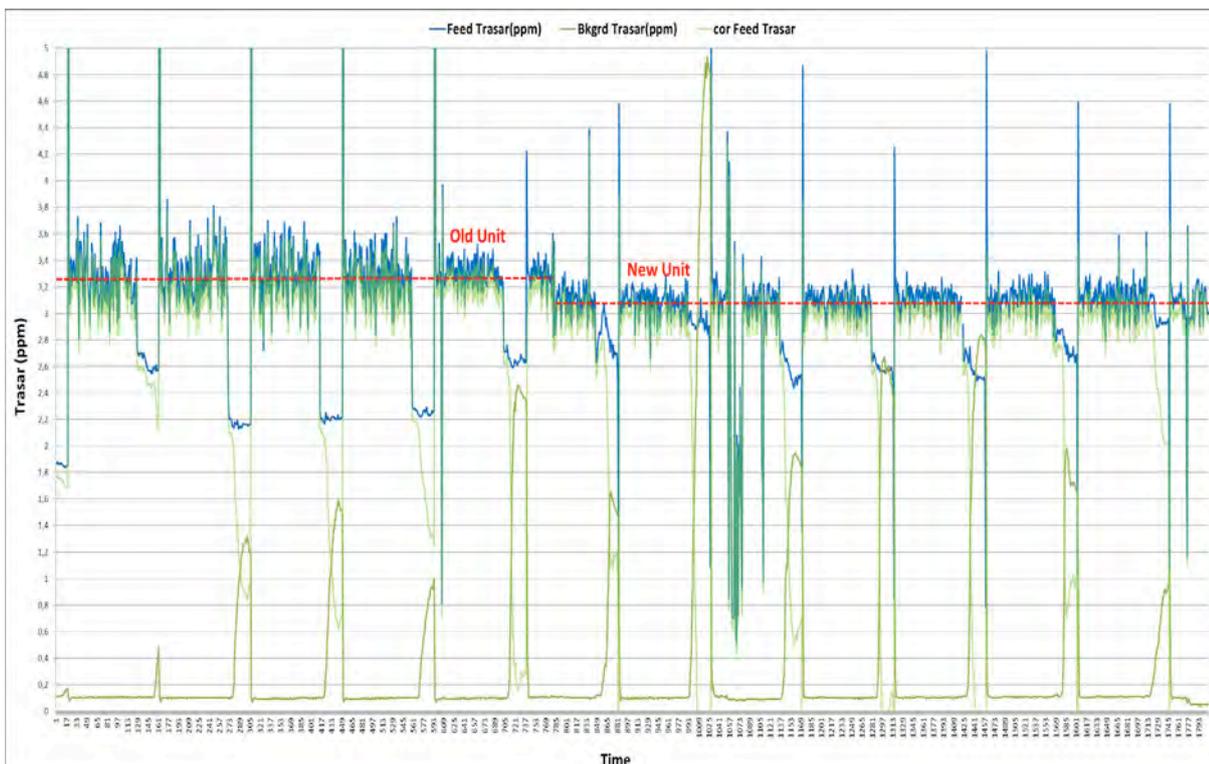
Figure 5 – Normalised Permeate flow data for the first five weeks of initial monitoring on the RO system.



**Figure 6** – Comparison of recovery rates as determined by 3D TRASAR technology detection, and by flow measurement.

cence reading was that this background fluorescence value was measured and compensated for, continuously providing a more accurate dosage (as shown in Figure 7 below).

As soon as the 3D TRASAR unit was confirmed as running well in control mode, it was decided to use the monitoring and normalisation capabilities of the unit to increase the percentage plant recovery to check for potential operational cost savings. It was agreed with the customer that the plant recovery



**Figure 7** – Reduction in antiscalant dosing through compensation for background fluorescence by the 3D TRASAR Membrane Technology (new unit).

would be increased from the original 75% to run at 77% recovery for five days and, if successful, to run for an additional five days at 80% recovery. During both periods data were to be normalised to control plant performance and detect any issues at early stage.

The plant was set to run at higher recovery rates, but would still continue to produce the same permeate flow. The main potential savings would be delivered by lowering both the cost of the concentrate flow discharge, and the energy costs due to lower energy costs (kWh/m<sup>3</sup>). Overall, the expected potential cost savings included:

- Feed water flow reduction (conservation of the groundwater aquifer water resources in a water-stressed area).

- Feed water pumping costs and energy
- Overall programme operational costs (even maintaining the same dosage the feed water treatment cost would be 6% lower at 80% recovery).

Figures 8 & 9 demonstrate the normalised permeate flow data for the periods of plant operation at 77% and 80% recovery respectively.

One of the customer's key concerns was to control the nitrate level in the permeate water. However, even during the two higher recovery periods, there was only a 9 µS/cm increase in permeate conductivity. The nitrate concentration remained within the required limits and an even a better salt passage was confirmed (see Figure 10).

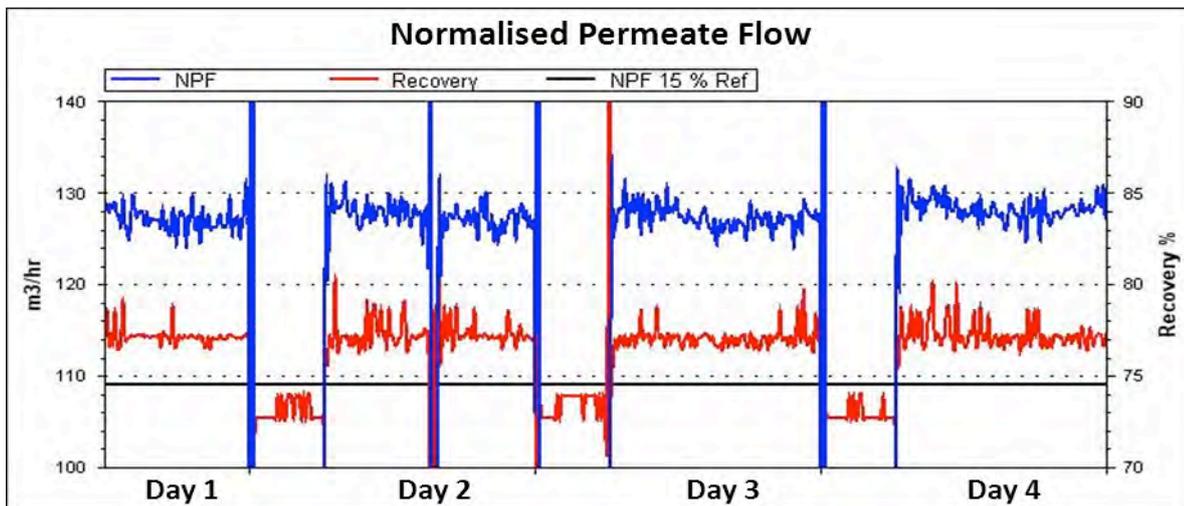


Figure 8 – Normalised Permeate flow data at 77% recovery for the first four days when using 3D TRASAR control

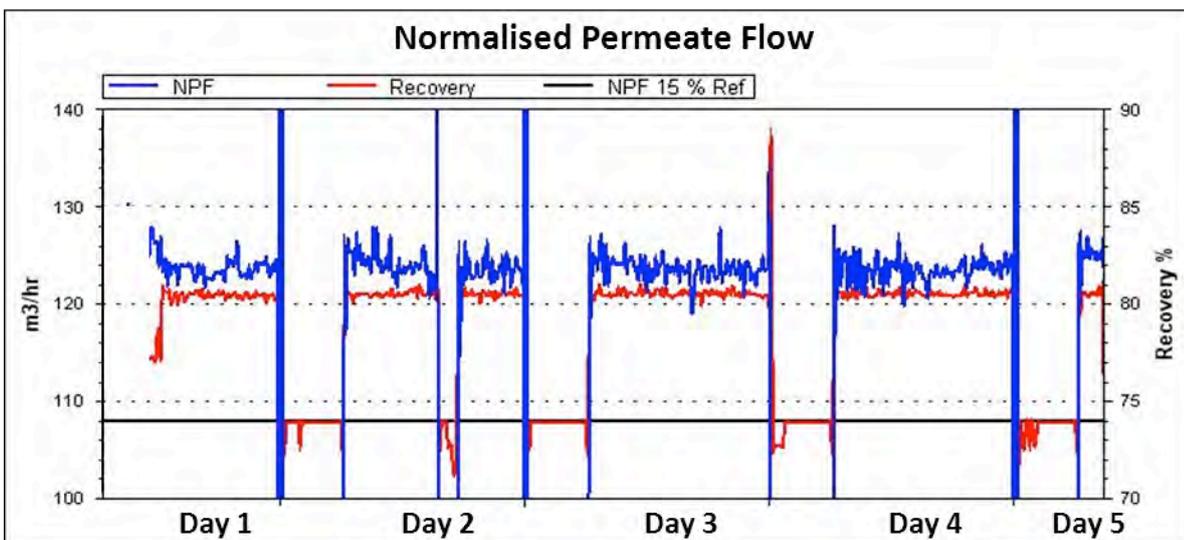


Figure 9 – Normalised Permeate flow data at 80% recovery for the first four days when using 3D TRASAR control

After 5 days working at the highest recovery, Train 1 was shut down and production rotated to Train 2. After the successful evaluation of the plant at higher recovery rates, the plant was reset to its baseline 75% recovery to ensure that optimised normal operation could be restored.

## Summary

The implementation of innovative and progressively enhanced TRASAR technology at this customer plant has continuously demonstrated the capability to deliver specific benefits. These have historically included:

- Consistent operation of the Reverse Osmosis plant, avoiding problems from scaling and the related costs of membrane cleaning or replacement.
- Progressive reduction in the treatment programme component delivering reductions in cost, lowering the number of deliveries, and reducing the associated impacts of transportation upon fuel use, emissions, and the local community.

The following additional benefits have now been demonstrated after the implementation of the new 3D TRASAR Membrane technology:

- Enhanced dosage control
- Increased dosage accuracy
- Online data collection and analysis

- Customer access to reports publishing normalised data
- Reduced environmental impact due to lower feed water needs and lower concentrate rejection
- No impact on the final water quality

Reduction in the overall Total Cost of Operation by €8750 per year has been delivered, and has been verified by the customer, including:

- Reduction in feedwater demand by 41667 m<sup>3</sup>/year (6.25%)
- Reduction in water rejection and disposal of 41667 m<sup>3</sup>/year (>25%), saving €3580 per year
- Reduction in energy demand by 9.31% per year based on kWh/m<sup>3</sup>, saving €2670 per year
- Reduction in treatment programme consumables of 15.5% due to lower requirements at 80% recovery (lower feed water to treat), saving up to €2500 per year

## Conclusion

Results obtained with the new 3D TRASAR Membrane technology were again able to demonstrate that this is an even more powerful diagnostic, monitoring and control programme, representing a significant advance over earlier technology. It can be used to achieve measurable economic savings, improve performance, control, and give peace of mind to the operators of Reverse Osmosis systems.

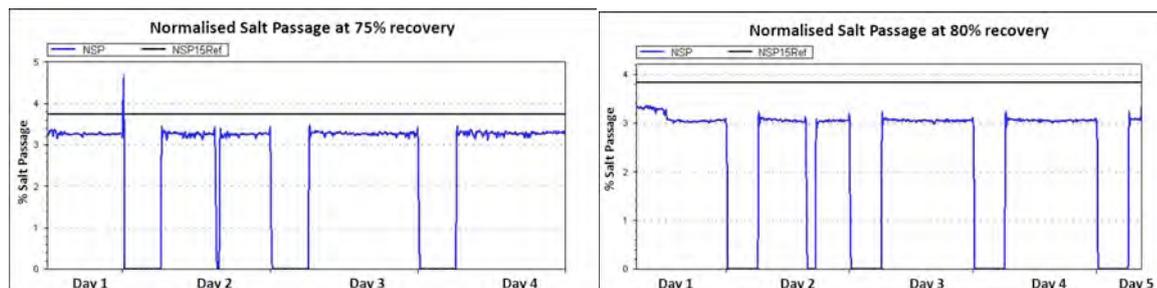


Figure 10 – Percentage salt passage at 75% and 80% recovery

Nalco reports Environmental Return on Investment (eROI) values to customers to account for contributions in delivering both environmental performance and financial payback.

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