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# REAL-TIME MEMBRANE FOULING MONITORING - *A CASE HISTORY*

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The Port Hueneme Water Agency (PHWA) has been operating a municipal drinking water treatment plant designed to be a Brackish Water Reclamation Demonstration Facility. The facility consists of 3 separate side-by-side full scale systems or trains, each representing a major membrane separation process: nanofiltration (NF), reverse osmosis (RO) and electro dialysis reversal (EDR). Both the NF and RO trains use semi-permeable spiral-wound thin-film polyamide membranes, manufactured by Dow Filmtec®, that selectively allow water to pass but not most dissolved salt ions.

*The Nanofiltration Train at Port Hueneme Brackish Water Reclamation Demonstration Facility*

In order to monitor the plant's operation, PHWA relies on a combination of IntelleutionFix® data and reports generated by the facility's SCADA data acquisition system. Membrane system performance is being monitored daily using Dow Filmtec®'s ROSA® software program and a set data normalization procedure. Plant operators inputted the flow set points and water quality analysis data into the original ROSA® configuration. They used the expected fouling factor of 1.0 and the set points for flows

as published by Filmtec®. Each day, the operators take the average analog values for flows, pressures, and conductivities, and enter them in an Excel® spreadsheet with 'macros' back to the ROSA® configuration file. That gave them the ability to request trending graphs of normalized flow, differential pressure, salt passage, and salt rejection . Of these, the normalized flows and differential pressure graphs in particular are utilized to monitor the system's health. Daily and monthly performance reports generated by PL-Web™, are available to the public on-line.

Design and operating data from RO Train A and NF Train A were recently provided by PHWA for evaluation using a new, early-warning membrane performance and fouling monitoring technology and software system known as **MASAR®** ( *Membrane Analysis System and Automated Reporter*), developed recently by MASAR Technologies, Inc. of Tucson, Arizona. A unique parameter, known as the **Fouling Monitor™**, or **FM,** is measured and used by **MASAR®** software to monitor the membrane systems performance of RO, NF, UF and MF water purification plants. The industry-standard normalization method (ASTM D-4516-00, "*Standard Practice for Standardizing Reverse Osmosis Performance Data"*) has been utilized by all membrane manufacturers and water plant operators to produce a long-term flux decline performance trend by comparing the normalized product flux and quality performance to design projections under the same conditions. The **FM**, on the other hand, is based on detecting and quantitatively measuring membrane fouling or scaling as soon as it starts to develop in the system in real-time, eliminating the need for long-term, ambiguous trending analysis.

The **MASAR®** performance evaluation focused on 3 distinct periods of interest:

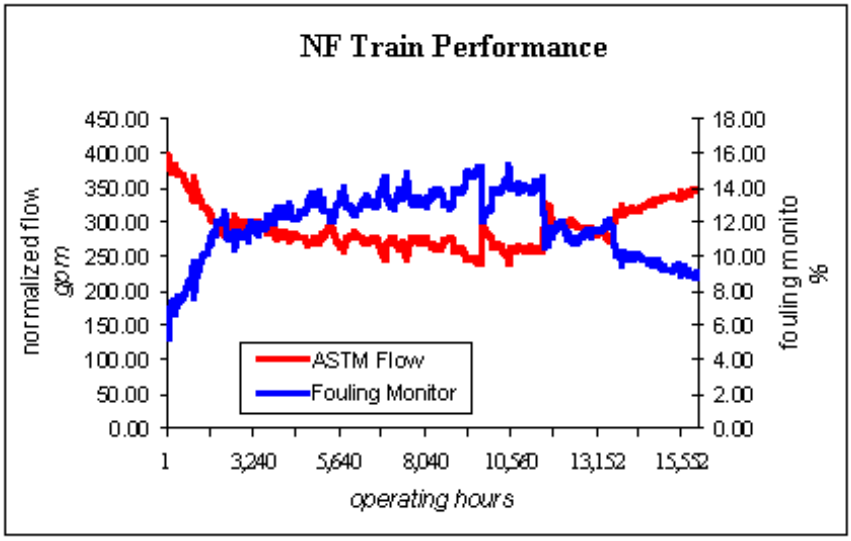
1. From start-up to end of 1999 (the first 10,000 hours) before any process or operational changes were implemented.
2. From January 2000 to Memorial Day in May 2000, when a new anti-scalant was in use as part of the plant's pre-treatment system.
3. From June 2000 till the end of the period, when disinfection, by chloramination of the raw water, was maintained through the processes.

**Summary of Results**

The following table summarizes the average calculated **FM** values for each period:

| TRAIN | Nov. 98–Dec. 99 | Jan.-May 2000 | May-Sept. 2000 | ALL |
|---|---|---|---|---|
| Operating hours | 1 | 9,648-10,008 | 13,440-13,464 | 1-16,008 |
| NF-A | 12.3% | 12.6% | 9.7% | **11.9%** |
| RO-A | 3.1% | 3.6% | 1.2% | **2.9%** |

Graph 1 shows the changes in **FM** as well as ASTM-normalized product flow performance for the nanofiltration train, while Graph 2 shows the same for the RO train during the entire period, including the periods when different operational changes were implemented.

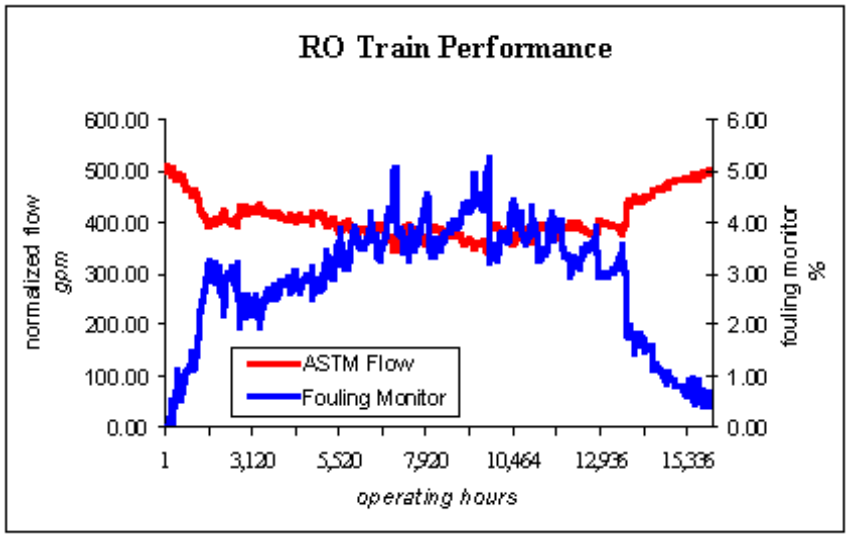



*Graph 1*

As indicated by the changes in the **FM** values, the nanofiltration system (Train NF-A) showed a sustained state of fouling (Average **FM** = 12.3%) for the period from start-up in November 1998 to the end of 1999 when the anti-scalant was changed. As soon as chloramination was implemented (*at 13,464 hours*), a relatively slow improvement in the fouling status of NF-A as measured by the **FM** is observed, but not better than 1.7 the start-up levels of 5% (about 70% deterioration). On the other hand, the ASTM–normalized flow performance trend for the same period shows a steady and significant improvement in the normalized flux to within 12% of start-up levels!

The RO system evaluation exhibited a different effect. RO-A, like NF-A, was showing a steady state of fouling from startup up to the end of 1999, but at a much lower **FM** rate than the NF Train (Avg. **FM** = 2.3% for RO-A vs. 4.8% for NF-A). The change in anti-scalant produced little or no effect on the overall performance of the RO Train. As soon as chloramination was implemented to address the biofouling problem, a significant improvement in the RO system performance became evident. By September 2000, the **FM** was restored to almost the same levels as that seen at startup with the new membranes (**FM** = 0.5%). In this case, the ASTM normalized flow shows a corresponding improvement (unlike the case for the NF Train).

The difference in actual performance between the RO and NF trains as shown by the **MASAR**® evaluation results is truly remarkable. Both trains had suffered from biofouling, promoting the change to chloramination as a more effective way of disinfection. This change produced an excellent improvement in the RO train operation but not that of NF train. The plant had earlier discovered that the NF membrane elements also suffered from a manufacturing defect that resulted in the continuing deterioration of their performance as truly indicated by the **MASAR**® evaluation, while the plant's daily monitoring procedures as described above, just like ASTM D-4516-00 standard normalization method, failed to pick up the NF membranes' real behavior and indicated a totally different trend!




*Graph 2*

Had the plant been using **MASAR**®'s **Fouling Monitor**™, it would have given the operators a true and early indication of its membrane systems performance and fouling status. Corrective measures would have then been implemented immediately after investigating the sources of deterioration such as biofouling an element defects. The new **MASAR**® technology has proven it can be very valuable tool to closely monitor and optimize the operation, performance and cost-effectiveness of water membrane filtration plants**,** and determining the actual effect of any changes in design, process or operational conditions.

***To request a free trial of the Silent Alarm software for your membrane desalination plant, click here:*** http://www.masar.com/software/trial.html

## BIOGRAPHY

**Joseph Richardson** has been operating the City of Port Hueneme's Brackish Water Reclamation Demonstration Facility for the past 4 years as a Water Treatment Operator II. He holds an AA in Electronics and an AS in Water Technology, and is a licensed operator by California State Dept of Health. Mr. Richardson also supervised and operated the water distribution and treatment facilities for the City of Ventura for 9 years, and as Instructor at Ventura College's Water Technology Dept. for 15 years. He also worked in various water plant operation positions at Mobil Oil and Southern California Edison.

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