Avista™ | Membrane Autopsy

Membrane Foulant Identification

The Avista™ Membrane Autopsy is one of the most powerful tools available to identify, prevent and correct membrane performance issues to improve system maintenance and operation.

TROUBLESHOOTING MEMBRANE SYSTEMS

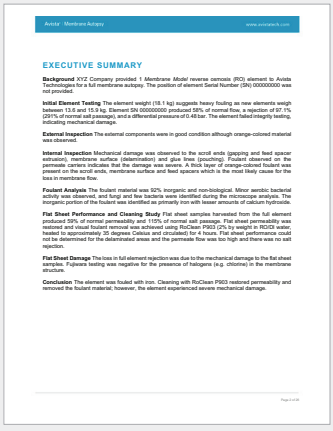
The Avista Membrane Autopsy includes a physical dissection of an element to remove samples and supporting materials for laboratory and foulant analysis. This procedure identifies scaling or fouling problems, determine the proper cleaning regimen, verify system operating conditions and improve system performance.

Avista Chromatic Elemental Imaging℠ (CEI℠) is used to identify the location and relative concentration of elements in a foulant sample to resolve the primary sources of membrane fouling. In the CEI process, a beam of focused electrons is accelerated across the surface of a foulant sample causing each element to emit electrons. The X-ray patterns emitted are specific to every element, enabling each one to be individually identified. CEI then assigns a color to each element and produces a three-dimensional, high resolution image of the foulant sample. Element concentration is indicated by color intensity.

- CEI provides insight into the layering characteristics of foulants deposited on a membrane.
- By analyzing the layers, it is possible to understand the fouling sequence.
- When used in combination with Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS), CEI can reveal the interaction between inorganic, organic, metal oxide and colloidal compounds.

AVISTA MEMBRANE AUTOPSY PROCESS

- Test results are summarized in a final report which includes a concise executive summary
- Results and on-site performance data are used to suggest site-specific methods of improving pretreatment, reducing membrane fouling, and achieving peak system performance
- Full Element Wet Test
- External Inspection
- Internal Visual Exam
- Foulant Analysis
- Organic Analysis
- Identification of Inorganic Foulants



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EXECUTIVE SUMMARY

Background XYZ Company provided 1 *Membrane Model* reverse osmosis (RO) element to Avista Technologies for a full membrane autopsy. The position of element Serial Number (SN) 000000000 was not provided.

Initial Element Testing The element weight (18.1 kg) suggests heavy fouling as new elements weigh between 13.6 and 15.9 kg. Element SN 000000000 produced 58% of normal flow, a rejection of 97.1% (291% of normal salt passage), and a differential pressure of 0.48 bar. The element failed integrity testing, indicating mechanical damage.

External Inspection The external components were in good condition although orange-colored material was observed.

Internal Inspection Mechanical damage was observed to the scroll ends (gapping and feed spacer extrusion), membrane surface (delamination) and glue lines (pouching). Foulant observed on the permeate carriers indicates that the damage was severe. A thick layer of orange-colored foulant was present on the scroll ends, membrane surface and feed spacers which is the most likely cause for the loss in membrane flow.

Foulant Analysis The foulant material was 92% inorganic and non-biological. Minor aerobic bacterial activity was observed, and fungi and few bacteria were identified during the microscope analysis. The inorganic portion of the foulant was identified as primarily iron with lesser amounts of calcium hydroxide.

Flat Sheet Performance and Cleaning Study Flat sheet samples harvested from the full element produced 59% of normal permeability and 115% of normal salt passage. Flat sheet permeability was restored and visual foulant removal was achieved using RoClean P903 (2% by weight in RO/DI water, heated to approximately 35 degrees Celsius and circulated) for 4 hours. Flat sheet performance could not be determined for the delaminated areas and the permeate flow was too high and there was no salt rejection.

Flat Sheet Damage The loss in full element rejection was due to the mechanical damage to the flat sheet samples. Fujiwara testing was negative for the presence of halogens (e.g. chlorine) in the membrane structure.

Conclusion The element was fouled with iron. Cleaning with RoClean P903 restored permeability and removed the foulant material; however, the element experienced severe mechanical damage.

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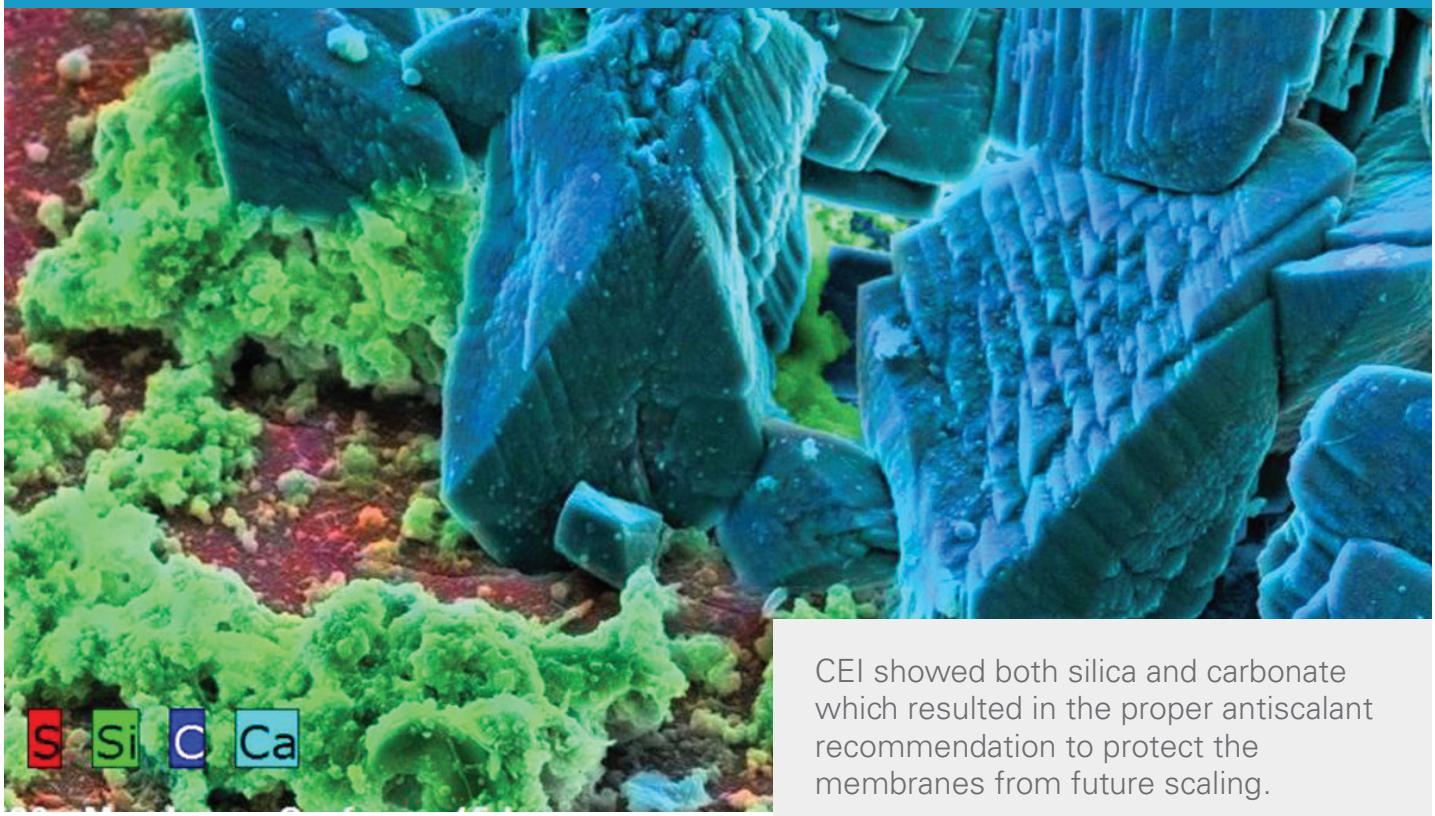
AVISTA MEMBRANE AUTOPSY WITH CEI: UNIQUE ADVANTAGES

- **Troubleshooting:** CEI is unmatched in its ability to successfully determine the primary membrane foulants which can help identify process deficiencies to prevent or minimize future fouling.
- **Product Innovation:** CEI accelerates the development of new antiscalants, cleaners and biocides by replacing the process of trial and error with scientific validation of formulations targeting specific foulants.



CEI showed both silica and carbonate which resulted in the proper antiscalant recommendation to protect the membranes from future scaling.

Additionally, it provided information on a cleaning sequence that removed the calcium carbonate layer first followed by silica scale.

SITUATION

The reverse osmosis (RO) element was received for an Avista membrane autopsy to determine why a second stage RO system had experienced a rapid increase in pressure after only six months of operation.

- The tail element weighed almost 50 pounds (22 kgs) more than a new element, a clear indication of severe scaling.
- The Avista membrane autopsy revealed crystals on the membrane surface.
- CEI identified the crystals as calcium carbonate scale layered on top of silica deposits.

SOLUTION

Based on a review of an original feedwater analysis, the Avista membrane autopsy determined that both calcium carbonate and silica were within the inhibition capabilities of the on-line antiscalant.

- The antiscalant injection rate was correct, and the system recovery was within design parameters.
- A new feedwater analysis was completed and revealed that the silica values had doubled over the summer.
- The higher silica values exceeded the capabilities of the scale inhibitor, which led to the extreme scaling.

Please consult your sales and technical consultant.

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