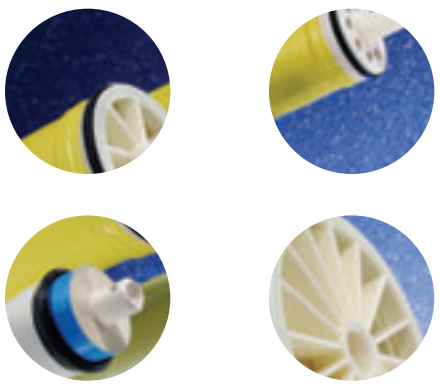
Putting it to the Test

By Steve Rosenberg, Ph.D.

Downtime due to membrane cleaning or replacement is one of the greatest expenses in water treatment systems. Biological and inorganic fouling are challenges that have the potential to unnecessarily cut short the lifespan of a membrane and increase downtime.



Membrane testing helps troubleshoot problems, reduce downtime

While low-fouling or fouling-resistant membranes help impede the growth of biological matter, even the best membranes can suffer damage from other factors. When unknown causes are affecting reverse osmosis (RO) or ultrafiltration (UF) membranes, an element test can help locate the root of the problem and keep a water purification system running smoothly.

Two such tests for membranes are the electron spectroscopy for chemical analysis (ESCA) test and inductive coupled plasma (ICP) emission spectroscopy. The ESCA test identifies impurities that are bound to the membrane surface and is useful to detect sources of oxidation. Because the composition of the membrane is known, what remains on the surface of the membrane can reveal what has caused oxidation—for example, chlorine and bromine. The ICP is another test that helps identify inorganic fouling by pinpointing specific metals on the membrane surface.

Uncovering the Cause

A recent case of beneficial membrane testing occurred in northern China at the Tai Steel Plant. Extensive membrane testing was needed to ascertain why the RO membranes had considerable fouling, requiring clean-in-place (CIP) operations two to three times per month.

The plant reuses internal wastewater for the boiler make-up of the power plant and for the steel production process. The internal wastewater contained a high metals content and required an intense pretreatment program with multimedia filters and UF as major components. The permeate then traveled through a two-pass RO system and mixed-bed ion exchange. In addition to high metal content, the raw wastewater also had high turbidity and organics.

An initial autopsy analysis showed scaling and biological fouling. Nonoxidative dibromo nitrilopropionamide was used to control the fouling but did not alleviate the problem efficiently. Water samples were taken from different locations of the RO system for further analysis.

The water samples were streaked onto tryptic soy agar and sabouraud dextrose agar. The contamination level could be identified by the number of microorganism colonies on the agar plate after 72 hours. The results showed that biological contaminants were removed after disinfection, coagulaton and flocculation; however, the results also showed that biological contamination appeared again in the permeate of the RO system.

A water sample from the antiscalant tank was collected in order to implement a biological contamination analysis. The biological analysis clearly showed approximately 10E+6 colony forming unit microbes in the antiscalant water sample. The testing identified that the microbes in the RO system were coming from the antiscalant tank. A technical support and development group therefore suggested that the antiscalant tank be cleaned and disinfected entirely and periodically.

In addition to biological analysis, an ICP test was conducted to see if metals were present on the membrane surface. The tests showed high levels of aluminum, calcium and iron, as well as lower levels of magnesium and silicon (Figure 1).

The high level of aluminum pointed to a problem in the coagulation and flocculation component during pretreatment, where polyaluminum chloride (PAC) dosing occurs before UF. Elemental analysis confirmed that the PAC was responsible and the level of dosing was reduced so that aluminum would no longer pass through the UF membranes. With the changes that were made as a result of membrane testing, the system needed CIP operations only once per month.

Testing & Troubleshooting

Membrane tests can be a great aid in bringing water treatment systems up to optimum performance. Reducing the number of CIP operations and extending the life of the membrane will help improve a system's function today and lower operating costs in the long run. With tests such as the ESCA and ICP, problems in RO or UF systems need not remain a mystery. *wqp*

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Figure 1. Inductively Coupled Plasma Emission Spectroscopy Report

Al	Ba	Ca	Cu	Fe	Mg	Mn	Ni	P	K	Na	Sr	Zn	Si
208	1.12	468	0.98	28	16	4.1	1.6	2.7	7	237	1.9	1.5	19

Note: ICP is for determining the specific metal on RO membrane surface.
***All metals reported in mg/m²

Interpreting Individual Metal Levels for Membrane Reports (mg/m²)

Element	Normal Level	Trigger of Concern	Typical Causes
Ca	<1	20-40	Calcium carbonate or calcium sulfate precipitation
Si	1-2	>3-5	Silt, silicates, SiO_2 precipitation
Al	<1	>1	Particulates or colloids, alum or PAC
Fe	<1	>1	Particulates or colloids, iron oxides
Mg	–	>5	