Introduction

This technical note is designed to assist system operators in identifying foulants and selecting suitable cleaning regimes to restore the system performance. Photographs of the foulants on membrane surfaces are provided as well as tips for actions to take to minimise future fouling.

History and Plant Assessment

To identify membrane fouling it is first important to determine what parameters have changed and by how much. This is best determined by reviewing plant data and any previous cleaning records. The nature of the feedwater and effectiveness of the pre-treatment are also useful indicators of the possible nature of the fouling.

If there is no cleaning history it is often useful to open a pressure vessel and look for clues on the outside of the membranes. If there is enough foulant on the outside of the membrane element, a small sample of the material can be tested to determine the possible foulant and what procedures should be used to clean the membranes. The membranes can also be weighed to determine the amount of foulant in the membrane elements.

The following foulant identification guide can also be used to identify the fouling that has occurred. Fouling may be a combination of types and some degree of biofouling is often present.

Plant Symptoms	*Likely Fouling*
Visible slime on the feed side of the membrane or cartridge filter and feed piping *High pressure differential in first array or lead elements, or telescoping*	*Biological*
Scale extruding out of down stream end of last membranes in the system *All the scale dissolves when introduced to a dilute solution of hydrochloric acid* *Poor salt rejection and low flow on individual membrane test data* *Possible high pressure differential on individual membrane test data* *Individual membrane weight is 45 pounds (20 kg) or greater (8"x40" element)* *Failure of antiscalant or acid addition*	*Calcium Carbonate*
As above but the material does not dissolve in dilute solution of hydrochloric acid	*Sulphate scaling*
Discoloration of membranes *Poor salt rejection and low flow on individual membrane test data* *Possible high pressure differential on first array or individual membrane test data* *High iron or manganese values reported in feedwater*	*Iron or Manganese Fouling*
Discoloration of membranes *Low flow and/or possible high pressure differential* *No elevated iron or manganese level in feed*	*Organic Fouling*
High pressure differential on elements, possibly telescoping *Surface water feed supply to system or high turbidity in feed water* *Discoloration on membranes*	*Silt or Clay*

Cleaning and Prevention

Biological Fouling

If biological fouling is suspected the following cleaning regime will improve the plant performance.

- Add RoCide DB20 biocide to low pH cleaner (RoClean L403 or P303)
- Follow with high pH clean using RoClean P111 at the maximum allowable temperature – (for severe fouling consider P112)

This membrane sample was taken from a single 8" x 40" membrane. The first 20" of the membrane and vexar (feedspacer) wase plugged with biological slime, the last 20" of vexar and membrane was clear. This is a good example of how biological fouling typically occurs in the front end of a system and sometimes only effects the first one or two membranes.

Preventing Biofouling

The following steps should be considered to prevent future biofouling.

- Clean and sanitize pretreatment equipment and piping.
- Monitor bacterial levels throughout system and apply biocide as necessary to control population (this may be intermittent or continuous).

Scaling

When system scaling is suspected it is necessary to determine if it is only calcium carbonate or could be a mixture of carbonate and sulphates. This can be quickly determined by doing the calcium carbonate 'quick test' detailed below.

Calcium Carbonate Quick Test

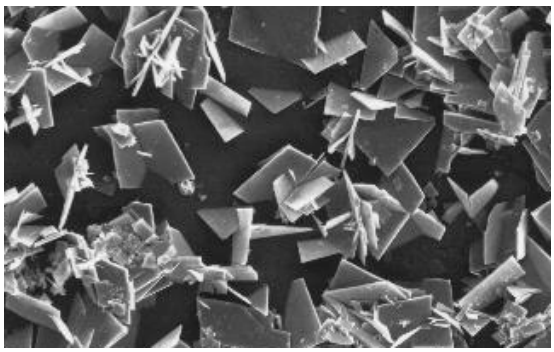
In a glass beaker, mix up a small solution containing ½ DI Water and ½ Hydrochloric acid (36%). Drop a small sample of the foulant into the solution. If the foulant contains Calcium Carbonate, the solution will bubble. Keep adding acid until the bubbling stops or the scale has disappeared.

If material is still present in the beaker once the bubbling stops, the foulant contains more than Calcium Carbonate.

The following cleaning regime will remove carbonate and sulphate scales.

- If some material dissolved in the dilute solution of hydrochloric acid, then a low pH clean with RoClean L403 should be conducted first.
- If no material dissolved in the dilute solution of hydrochloric acid, then the low pH clean can be skipped and only a clean with the RoClean L811 will need to be conducted.
- In all cases heat the cleaning solutions.

It should be noted that scale crystals can scratch the membrane surface either during plant operation or during cleaning. Gentle circulation and long periods of soaking should be used to minimise any possible damage during cleaning of heavily scaled membranes.



Barium Sulfate scale on a membrane, pressure vessel or pipe will feel like fine grit sandpaper. This abrasiveness can cause damage to a membrane surface during operation. When a system is started and stopped, the vexar (feedspacer) material will shift slightly. This shifting can cause the barium sulfate scale to scratch the membrane surface and cause permanent damage.

Preventing Scaling

- Conduct a complete and accurate water analysis.
- Verify proper antiscalant is in use.
- Properly dose antiscalant and check dosage with drawdown assembly.
- Verify recovery rates by measuring feed and concentrate conductivities.

Iron and Manganese Fouling

The following cleaning regime will remove iron and manganese fouling:

- Low pH Clean with RoClean P703
- Consider following low pH clean with RoClean P111 or L211
- Heat solution

Iron in water can be found as ferrous or ferric. Ferrous iron is dissolved iron in the water that has not precipitated. If you can keep the iron from becoming introduced to air, you can keep it from turning into ferric iron. Ferric iron is iron that has been oxidized. Essentially, it has been turned to rust.

Ferric iron can be removed from a membrane with RoClean P703

Preventing Iron and Manganese Fouling

- Conduct a complete and accurate water analysis.
- Prevent oxidation of any ferric iron present after precipitation.
- Remove Iron and Manganese using a Green Sand Filter regenerated with Potassium Permanganate.
- Remove Iron by oxidising the water and remove the iron or manganese with a multi media filter.

Organic fouling:

Organic fouling can be removed by:

- Low pH clean with either RoClean P303 or L403
- Follow low pH clean with RoClean P111 (for severe case consider RoClean P112 or RoClean P911)

A low pH clean followed by the high pH is very effective in dealing with organic fouling. The low pH cleaner helps to break the bridge between the organics and the membrane. The high pH solution is then able to lift the foulant from the membrane surface. This is why when you clean you will sometimes only see a color change when using the high pH cleaner. Do not be misled, the low pH is a necessary and effective part of this cleaning regime.

The top picture is an example of controlled cell test cleaning conducted by Avista to test various cleaning combinations. This laboratory testing is also used to develop specially formulated cleaners for particularly difficult applications.

Preventing Organic Fouling

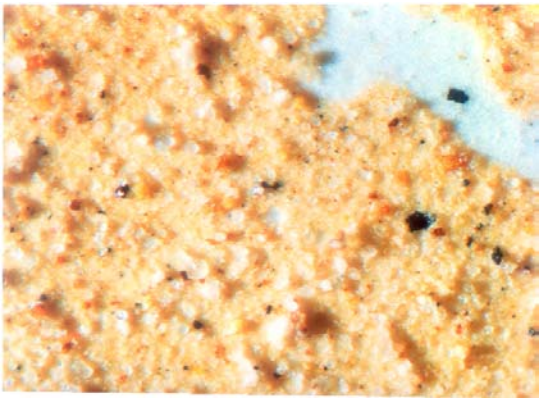
- Remove them from the feed with multi media filtration and coagulant addition.
- Metal salts blended with a polymer are usually the most effective coagulant for high organic waters.

Colloidal fouling:

Colloidal fouling can be removed using:

- Low pH clean with either RoClean P303 or L403
- Low pH clean should be followed by a high pH clean with RoClean L211
- Consider reverse flow and air sparging
- Heat cleaning solution

Flow rates and good cleaning chemistry become the important factors in cleaning colloidally fouled membranes. The RoClean L211 has dispersants that help to push particles away from each other and away from the membrane surface.



Preventing Silt, Colloidal Fouling

- Conduct SDI (Silt Density Index) testing along with turbidity testing to determine colloidal fouling potential.
- Conduct laboratory testing to determine fouling potential as well as filterablilty of the water.
- Inspect SDI pads under microscope to identify the colloidal material.
- Use properly designed multi media filtration.
- Consider the use of a coagulant to assist the multi media filter.
- Use clairfiers or other filtraton equipment for high turbidity waters.

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