Troubleshooting
Low Permeability

The following are general guidelines for troubleshooting TRISEP® elements with low permeability.

INTRODUCTION

Low permeability, or low flow, is usually the result of an increased resistance to water flow through the membrane. This symptom is most often the result of the accumulated build-up of material from fouling and scaling on the membrane surface. Other less common causes could include pretreatment issues or operational issues. Depending on the system design, this issue may manifest as either a loss of normalized permeate flow or an increase in required feed pressure.

BIOFOULING

Explanation & Root Cause

Biofouling is primarily caused by the combination of a biologically active feed water and improper pretreatment. Biofouling of the membranes is indicated by the following changes in the operating parameters:

- Permeate flow decreases when operated at constant feed pressure and recovery.
- Recovery decreases when operated at a constant feed pressure.
- Feed pressure has to be increased if the permeate flow is to be maintained at a target permeate flow rate and constant recovery. This typically increases fouling potential and makes it more difficult to clean later.
- Differential pressure increases. Since pressure drop across the pressure vessels can be such a sensitive indicator of fouling, it is strongly recommended to install pressure gauges to allow monitoring differential pressure within each stage in a system.
- Solute passage increases when fouling occurs.
- High counts of microorganisms in water samples taken from the feed, concentrate or permeate streams indicates the presence of biofouling.
- Biofilms typically feel slippery to the touch and often have a bad smell. If burned over a small flame, burnt biofilm smells similar to that of burnt hair.

Preventative / Corrective Measure

If biofouling is present, the following corrective measures are suggested:

- Clean and sanitize the entire system, including pretreatment and elements. Please see MANN+HUMMEL Water & Fluid Solutions' Membrane Cleaning Guides for **Water Application Elements** (TSG-C-001), **Food & Dairy: RO & NF Elements** (TSG-C-003), **Food & Dairy: UF & MF Elements** (TSG-C-004), **Cellulose Acetate Elements** (TSG-C-005), and/or **Food & Dairy: TurboClean® Extreme (XT) Elements** (TSG-C-007) for cleaning procedures. An incomplete cleaning and disinfection of the system can result in rapid re-contamination.
- Biofouling is often combatted with a high pH soak and rinse. Please see the above cleaning procedures or contact MANN+HUMMEL Water & Fluid Solutions Technical Service for details.
- Optimize the pretreatment system to cope with the fouling potential of the raw feed water.
- Install fouling-resistant membrane elements. Please contact MANN+HUMMEL Water & Fluid Solutions Technical Service for more information.

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COLLOIDAL FOULING

Explanation & Root Cause

To identify colloidal fouling:

- Review recorded feed water SDI's and analyze residue from SDI filter pads.
- Analyze accumulations on prefilter cartridges.
- Analyze deposits on feed scroll end of first stage lead elements.

Preventative / Corrective Measure

The corrective measures for colloidal fouling are:

- Clean the elements depending on the foulant type.
- Adjust, correct and/or modify the pretreatment.

COMPACTION / INTRUSION

Explanation & Root Cause

Low permeate flow and improved salt rejection may be due to membrane compaction or intrusion.

Compaction refers to the physical compression of the membrane itself due to very high applied pressures. Compaction causes the membrane itself to lose efficiency and results in a decrease in flux and salt passage.

Intrusion, on the other hand, is the when the membrane gets firmly pushed into the channels of the permeate carrier under excessive pressures and temperatures, essentially blocking flow. Intrusion causes high pressure drop on the permeate side of the membrane, causing the element as a whole to lose efficiency. This will result in low permeate flow. For more information on intrusion, please refer to **Troubleshooting – Intrusion** (TSG-T-009).

Preventative / Corrective Measure

To correct for compaction and/or intrusion, it is recommended to replace all damaged elements with new ones, preferably elements capable of handling high temperatures and pressures, or add new elements to the system to compensate for the flux decline. If new elements are installed together with used elements, the new elements should be distributed evenly into parallel positions and loaded into the tail positions of a system to prevent them from operating at too high of a flux. Loading vessels exclusively with new elements in parallel with other vessels containing exclusively used elements causes an uneven flow distribution and recovery of the individual vessels.

Another way to correct for compaction and/or intrusion is to change the operating parameters. If possible, adjust the operating temperatures and pressures to prevent compaction and/or intrusion.

INCOMPLETE WETTING / DRYING OUT

Explanation & Root Cause

After membrane elements are tested, they are flushed with a preservative solution and then packaged. This preservative solution protects the element's performance by keeping the pores of the polysulfone layer wet. The polysulfone layer is inherently hydrophobic, so when this is allowed to dry out, the membrane tends to lose flow. When this occurs, the membrane can be re-wetted as described below.

Preventative/Corrective Measure

When receiving membrane elements, the packaging should be inspected to ensure that no leaking has occurred as a result of mishandling during shipping. After new elements have been removed from their packaging, the amount of time the elements are exposed to open air should be minimized (a few hours maximum). Similarly, special care should be taken for elements that are removed from a system for warranty purposes to ensure the elements do no dry out.

If an element has dried out, the loss in water permeability may be irreversible. However, the elements may be able to be re-wetted as described in **Element Storage Guide – Storage & Re-wetting** (TSG-O-010).

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METAL OXIDE FOULING

Explanation & Root Cause

Metal oxide fouling occurs predominantly in the first stage and can easily be localized when permeate flow meters have been installed in each array separately. Common sources of metal oxide fouling are:

- Iron or aluminum in feed water.
- Hydrogen sulfide with air in feed water results in metal sulfides and/or elemental sulfur.
- Corrosion of piping, vessels or components upstream of membrane elements.

To identify metal oxide fouling:

- Analyze the feed water for iron and aluminum.
- Check system components for evidence of corrosion. Iron fouling can easily be identified from the element's appearance (usually the element is covered in red particles).

Preventative/Corrective Measure

The corrective measures for metal oxide fouling are:

- Clean the membrane elements.
- Adjust, correct and/or modify the pretreatment.
- Retrofit piping or system components with appropriate materials.

ORGANIC FOULING

Explanation & Root Cause

The adsorption of organic matter in the feed water on the membrane surface can result in flux loss, especially in the first stage. This adsorption layer can act as an additional barrier for dissolved salts, resulting in a lower salt passage. Organics with a high molecular mass and with hydrophobic or cationic groups such as oil traces or cationic polyelectrolytes (which are sometimes used in pretreatment) can produce such an effect and are very difficult to remove from the membrane surface.

To identify organic fouling, check or analyze:

- Deposits from filter cartridges and SDI filter pads.
- The incoming water for oil, grease and other organic contaminants.
- Pretreatment coagulants and filter aids, especially cationic polyelectrolytes.
- Cleaning detergents and surfactants.

Preventative/Corrective Measure

If organic fouling is occurring, the following corrective measures are suggested:

- Clean for organics.
- Use correct pretreatment. Use minimal coagulant dosages and monitor feed water changes to avoid overdosing.
- Modify pretreatment (i.e. oil/water separators).

SCALING

Explanation & Root Cause

Scaling originates from the precipitation and deposition of sparingly soluble salts onto the membrane. It typically occurs when a brackish water system is operated at high recovery without the proper pretreatment and usually starts in the last stage and then gradually moves to the upstream stages. Feed waters containing high concentrations of calcium, bicarbonate and/or sulfate can scale a membrane system within hours whereas scaling with barium or fluoride occurs slowly because of the low concentrations involved.

To identify scaling:

- Check the feed water analysis for the scaling potential at the specified system recovery.
- Analyze the concentrate for levels of calcium, barium, strontium, sulfate, fluoride, silicate, pH and Langelier Saturation Index. Try to calculate the mass balance for those salts (analyzing feed water and permeate).

- Inspect the concentrate side of the system for scaling. Scaling is hard and rough to the touch – like sand paper and is difficult to wipe off.
- Weigh a tail element as scaled elements are typically heavier.
- Autopsy a tail element and analyze the membrane for scaling. The crystalline structure of the deposits can be observed under a microscope. A foaming reaction with acid indicates carbonate scaling. The type of scaling can be identified by a chemical analysis.

Preventative/Corrective Measure

The corrective measures for scaling include:

- Cleaning the membranes with acid and/or an alkaline solution. An analysis of the spent solution may help to verify the cleaning effectiveness.
- Optimize cleaning depending on scaling salts present.
- Carbonate scaling: lower pH, adjust antiscalant dosage.
- Sulfate scaling: lower recovery, adjust type of antiscalant and dosage.
- Fluoride scaling: lower recovery, adjust type of antiscalant or dosage.

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