Technical Service Bulletin

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RO Membrane Foulants and Their Removal from Polyvinyl Derivative (PVD) RO Membrane Elements

This bulletin provides general information about the usual foulants affecting the performance of Hydranautics' PVD Reverse Osmosis (RO) membrane elements and the removal of these foulants. The information in this bulletin applies to 4-inch, 6-inch, 8-inch, and 8.5-inch diameter RO membrane elements.

Note: It is recommended that all RO membrane cleaning operations should be closely coordinated with Hydranautics during the RO membrane element warranty period.

Note: The use of cationic surfactants may result in flux decline.

RO Membrane Element Foulants

During normal operation over a period of time, RO membrane elements are subject to fouling by suspended or sparingly soluble materials that may be present in the feedwater. Common examples of such foulants are calcium carbonate scale, calcium sulfate scale, metal oxides scale, silica coating, and organic or biological deposits.

The nature and rapidity of fouling depends on the condition of the feedwater. Fouling is progressive, and, if not controlled early, will impair the RO membrane element performance in a relatively short time.

Monitoring overall plant performance on a regular basis is an essential step in recognizing when membrane elements are becoming fouled. Performance is affected progressively and in varying degrees, depending on the nature of the foulants. Table 1 provides a summary of the expected effects that common foulants have on performance.

Table 1. RO Membrane Element Foulant Symptoms

FOULANT	GENERAL SYMPTOMS	RESPONSE
1. Calcium Precipitates (carbonates and phosphates, generally found at the concentrate end of the system)	A marked decrease in salt rejection and a moderate increase in ΔP between feed and concentrate. Also, a slight decrease in system production.	Chemically clean the system with Solution 1.
2. Hydrated Oxides (iron, nickel, copper, etc.)	A rapid decrease in salt rejection and a rapid increase in ΔP between feed and concentrate. Also, a rapid decrease in system production.	Chemically clean the system with Solution 1.
3. Organic Deposits	Possible decrease in salt rejection and a gradual increase in ΔP between feed and concentrate. Also, a gradual decrease in system production.	Chemically clean the system with Solution 2.
4. Bacterial Fouling	Possible decrease in salt rejection and a marked increase in ΔP between feed and concentrate. Also, a marked decrease in system production.	Chemically clean the system with Solution 2.

Referenced solutions can be found in Table 2 at the end of this document.

Note: All problems require the cause of the condition to be corrected. Contact Hydranautics for assistance.

Note: Ensure that the pH in any cleaning solution does not fall below 2.0 or increase above 9.0. Otherwise, damage to the RO membrane elements may occur, particularly at elevated temperatures. Use ammonium hydroxide to raise the pH, and sulfuric or hydrochloric acid to lower it.

Foulant Removal

Foulant removal is controlled by cleaning and flushing or by changing the operating conditions. As a general guide, foulant removal is required when any of the following conditions occur:

1. Permeate flow has dropped to 10-15 percent below rated flow at normal pressure.

2. Temperature-corrected feedwater pressure has increased 10-15 percent to maintain rated product water flow.

3. Product water quality has decreased 10-15 percent; salt passage has increased 10-15 percent.

4. The differential pressure across an RO stage has increased noticeably (instrumentation may not be available to monitor this parameter).

The following paragraphs provide a discussion of the common foulants and their removal.

Calcium Carbonate Scale

Calcium carbonate may be deposited from almost any feedwater if there is a failure in the inhibitor addition system or in the acid injection or pH control system that results in a high feedwater pH. An early detection of the resulting calcium carbonate scaling is absolutely essential to prevent the damage that crystals can cause on the active membrane layers. Calcium carbonate scale that has been detected early can be removed by lowering the feedwater pH to between 3.0 and 4.0 for one or two hours. Longer resident accumulations of calcium carbonate scale can be removed by recirculating a citric acid solution of 2-percent strength and a pH of no less than 2.0 through the RO membrane elements.

Metal Oxides Scale

Precipitated hydroxides (e.g., ferric hydroxide) can usually be removed by using the techniques described above for calcium carbonate scale.

Silica Coating

A silica coating not associated with either metal hydroxides or organic matter will usually respond only to very specialized cleaning methods. Contact Hydranautics for instructions related to a specific problem.

Organic Deposits

Organic deposits (e.g., microbiological slimes and molds) are best removed by using Solution 2. To inhibit additional growth, recirculate and soak the membranes with a Hydranautics-approved biocide solution after cleaning. Contact Hydranautics for the biocide best suited for specific conditions.

Cleaning Solutions

The following chemical solutions are recommended for cleaning the RO membrane elements. The appropriate solution to use can be determined by chemical analysis of the fouling material. A detailed examination of the results of the analysis will provide additional clues as to the best method of cleaning. Keeping records of the methods used and results obtained will provide data useful in developing the methods and solutions that work best under the feedwater conditions at hand.

Solution 1 is recommended for inorganic fouling. Solution 2 is recommended for organic fouling. All solutions are to be used at the highest available temperature up to 104°F (40°C) for up to 60 minutes of cleaning. The quantities given are per 100 U.S. gallons (379 liters) of water. Prepare the solutions by proportioning the amount of chemicals to the amount of cleaning water to be used. Use permeate water to mix the solutions. Mix thoroughly.

RO Membrane Element Cleaning and Flushing

The RO membrane elements in place in the pressure tubes are cleaned by recirculating the cleaning solution across the high-pressure side of the membrane at low pressure and relatively high flow. A cleaning unit is needed to do this.

A general procedure for cleaning the RO membrane elements is as follows:

1. Flush the pressure tubes by pumping clean product water from the cleaning tank (or equivalent source) through the pressure tubes to drain for several minutes.

2. Mix a fresh batch of the selected cleaning solution in the cleaning tank, using clean product water.

3. Circulate the cleaning solution through the pressure tubes for approximately one hour or the desired period of time, at a flow rate of 35 to 40 gpm (133 to 151 l/min.) per pressure tube for 8.0 and 8.5-inch pressure tubes, 15 to 20 gpm (57 to 76 l/min.) for 6.0 inch pressure tubes, or 9 to 10 gpm (34 to 38 l/min.) for 4.0-inch pressure tubes.

4. After completion of cleaning, drain and flush the cleaning tank; then fill the cleaning tank with clean product water for rinsing.

5. Rinse the pressure tubes by pumping clean product water from the cleaning tank (or equivalent source) through the pressure tubes to drain for several minutes.

6. After the RO system is rinsed, operate it with the product dump valves open until the product water flows clean and is free of any foam or residues of cleaning agents (usually 15 to 30 minutes).

Table 2. Summary of Recommended Cleaning Solutions

Solution	Ingredient	Quantity per 100 Gallons (379 Liters)	pH Adjustment
1	Citric Acid	17.0 pounds (7.7 kg)	Adjust to pH 4.0 with ammonium hydroxide (NH_4OH)
	RO Permeate	100 gallons (379 liters)	
2	Sodium Laurel Sulfate or Triton X-100	2.2 pounds (1.0 kg) 0.1 gallons (380 ml)	Adjust to pH 8.0 with sodium hydroxide (NaOH) or sulfuric acid (H_2SO_4), as required
	RO Permeate	100 gallons (379 liters)	

Note: The use of cationic surfactants may result in irreversible flux declines. These surfactants should only be used after checking compatibility with PVD or CPA/ESPA membrane elements.

If additional information is needed, please contact the Technical Service Department at:

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