

Pretreatment Sulfate Scale

The following are general recommendations for controlling sulfate scale in systems using reverse osmosis (RO) and nanofiltration (NF) elements. For additional information on pretreatment or cleaning elements, please see MANN+HUMMEL Water & Fluid Solutions' Pretreatment and Cleaning Guides or contact MANN+HUMMEL Water & Fluid Solutions Technical Service.

INTRODUCTION

Scaling is when sparingly soluble salts precipitate and deposit on the surface of a membrane element. The solubility of barium, calcium and strontium is low and may lead to scale formation on the membrane surface where the salts are most concentrated. This typically affects the elements in the last stage first and then gradually affects the stages upstream.

Barium sulfate (BaSO₄) is the most insoluble of all the alkaline-earth sulfates. When present in water, it may precipitate and act as a catalyst for calcium and strontium sulfate scaling. Typically, barium can be found in well waters, with typical concentrations less than 0.05 ppm to 0.2 ppm. However, in most natural waters, barium is present at a level that may cause barium sulfate scaling. The critical feed concentration of barium may be as low as 0.015 ppm in seawaters, 0.005 ppm in brackish waters or even 0.002 ppm if sulfuric acid is dosed to brackish waters.

Early detection of sulfate scaling is essential to prevent possible damage on the membrane surface. A number of factors can affect the rate of scale formation including temperature and pH control, as well as the use of antiscalants.

If the scaling potential for barium, calcium and/or strontium sulfates is high, some common methods to control scaling potential include:

- The use of a scale inhibitor or antiscalant is the most common method to reduce sulfate scale
- Decreasing the calcium and alkalinity concentrations in the feed solution by means of lime or lime-soda ash softening to lower pH_s (the pH of saturation). Decreasing the calcium (Ca²⁺) concentration will allow the system to operate at higher recovery with respect to CaSO₄ scaling.
- Adjusting operational parameters including pH, system recovery, temperature and incorporating a permeate flush.

PRETREATMENT

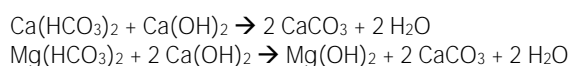
Scale Inhibitor or Antiscalant

The use of a scale inhibitor or antiscalant is the most common method to reduce sulfate scaling potential. A high quality scale inhibitor or antiscalant for sulfate scale may be helpful to use in the feed stream prior to the membrane system. For extremely high barium, calcium and/or strontium sulfate applications, the dosage rate may be predetermined by the chemical manufacturer.

MANN+HUMMEL Water & Fluid Solutions offers several antiscalants that battle sulfate species and helps protect and enhance the operation of RO and NF systems by controlling sulfate scale as well as other mineral scale. These antiscalants may significantly increase the allowable system recovery. For more information, please see product spec sheets at www.microdyn-nadir.com/trisep or contact MANN+HUMMEL Water & Fluid Solutions Technical Service.

Lime Softening

In most raw water sources, hardness is present as calcium and magnesium bicarbonate (sometimes referred to as carbonate hardness or temporary hardness). Lime softening can be used to remove carbonate hardness by adding hydrated lime, Ca(OH)₂:



Noncarbonate calcium hardness (hardness that is present as a sulfate or chloride salt, referred to as noncarbonated or permanent hardness), on the other hand, may be reduced by a combination of lime and sodium carbonate (soda ash), along with coagulant and flocculent chemicals to promote a precipitation reaction. The lime-soda ash process can also be used to reduce high silica concentrations. When sodium aluminate and ferric chloride are added, the precipitate includes calcium carbonate and a complex with silica acid, aluminum oxide and iron.

Lime softening may be performed at different temperature ranges to increase the solubility of calcium, magnesium and silica. Cold lime softening is performed at ambient temperatures, warm lime softening is performed in the temperature range of 49 – 60°C (120 – 140°F) and hot process softening is performed at temperatures of 108 – 116°C (227 – 240°F).

OPERATIONAL CONSIDERATIONS

pH

Barium, calcium and/or strontium sulfate scale may occur if there is an over-feed of sulfuric acid in the system's pH adjustment process.

Typically, sulfuric acid (H₂SO₄) is used to perform a system pH adjustment as it is easier to handle and in many countries, more readily available than hydrochloric acid (HCl). However, when using sulfuric acid, additional sulfate is added to the feed stream and may potentially cause sulfate scaling. If sulfate scaling is a concern, it is highly recommended to use HCl as the preferred acid for pH adjusting. HCl is typically available as a 30 to 37% solution and is sometimes referred to as muriatic acid.

Recovery

The system's recovery may be lowered. At a lower operating recovery, the concentration of barium, calcium and/or strontium sulfate in the concentrate decreases and lowers scaling potential.

Temperature

Lower temperatures reduce the solubility of sulfate scale. The solubility of sparingly soluble salts increases with higher TDS levels. This is due to the increased interference by other ions in the process of scale formation.

Permeate Flush

The membrane elements should be flushed for a minimum of 3 minutes with permeate water each time that the membrane system shuts down. This will flush out the highly concentrated water in the tail-end of the system which will prohibit precipitation during this stagnant flow period.

CLEANING PROCEDURE

A customized cleaning procedure may be implemented on a scheduled maintenance basis. This will ensure removal of precipitated sulfate.

Please refer to MANN+HUMMEL Water & Fluid Solutions' **Membrane Cleaning Guide – Water Application Elements** (TSG-C-001) for cleaning recommendations using low pH cleaners TriClean™ 210 or TriClean™ 310 to battle sulfate.

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