Membrane Cleaning Guide
Cellulose Acetate Elements

The following are general recommendations for cleaning TRISEP® cellulose acetate (CA) elements. MICRODYN-NADIR recognizes that specific Clean in Place (CIP) procedures will vary from system to system based on the unique requirements of individual end users. For additional cleaning instructions, please contact MANN+HUMMEL Water & Fluid Solutions Technical Service.

INTRODUCTION

During operation, the surface of a membrane is subject to fouling by mineral scale, biological matter, colloidal particles, and insoluble organic constituents. The term "fouling" includes the build-up of any type of material on the membrane surface, including mineral scaling. Membrane surface fouling results in lower permeate flow rate, increased pressure drop between the feed and concentrate, and/or higher solute passage.

WHEN TO CLEAN

Elements should be cleaned when one or more of the below have been met:

- Normalized* permeate flow drops 10%
- Normalized salt passage increases 10%
- Normalized pressure drop increases 10 – 15%

*Normalizing performance data is helpful in determining when it is necessary to clean. Sometimes a drop in permeate flow, an increase in salt passage, or an increase in pressure drop is noticed for alternative reasons (i.e. changes in temperature). It is recommended to measure and record permeate flow, salt passage, and pressure drop across each stage in the system because a malfunction in pretreatment, temperature or pressure control, or a change in recovery can result in a change in product water output, salt passage, and pressure drop. If such a problem is observed, these causes should be considered first because the elements may not require cleaning. MANN+HUMMEL Water & Fluid Solutions offers a Normalization Spreadsheet, which can be downloaded from our website.

SAFETY PRECAUTIONS

When using the chemicals indicated below, please follow these accepted safety practices:

1. Always wear eye protection. In the case of handling corrosive chemicals, wear full-face masks and protective clothing. Consult the chemical manufacturer for detailed information about safety, handling, and disposal.
2. When preparing cleaning solutions, ensure that all chemicals are dissolved and well mixed before circulating the solutions to the elements.
3. High-quality water must be used for flushing, cleaning, and disinfecting TRISEP membranes. See *Water Quality*.

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4. Cleaning chemicals will be present on both the permeate and concentrate sides of the membrane immediately after cleaning. Properly flush the system prior to operation with the feed stream and divert permeate to drain for at least 30 minutes or until the water is clear when starting up after cleaning.

LOW PH CLEANING

The following steps are recommended for a low pH cleaning for TRISEP cellulose acetate elements:

1. Clean and fill the solution tank with the proper volume of RO permeate quality water. See *Water Quality*.
2. Allow water to circulate through the pump and into the tank during chemical mixing.
3. Add TriClean™ 310 or TriClean™ 210* cleaning chemical into the tank. Mix thoroughly.
   **Note:* TriClean™ 210 is the powdered form of TriClean™ 310.
4. Mix TriClean™ 211 liquid cleaner into the tank and mix thoroughly.
5. Check pH of solution. The proper range is between 2.0 and 3.0. The solution's pH may be raised by adding sodium hydroxide or lowered by adding additional chemical.
6. A maximum cleaning temperature of 40°C (104°F) is recommended.*
   **Note:* A maximum cleaning temperature of 30°C (86°F) is recommended for SBNF.
7. If multiple stages are present, isolate the first stage to be cleaned. With concentrate and product lines diverted to proper drain, slowly run cleaning solution through the pressure vessels until all the remaining water is out of the vessels and the cleaning solution is coming out of the concentrate line. Shut down the pump and divert the concentrate and product lines to the cleaning solution tank.
8. If the tank volume is too low, mix additional cleaning solution.
9. Start recirculating the cleaning solution through the vessels at the specified flow rate per vessel (see *Flow Rates* below). Recirculate for 1 hour, checking pH periodically. If the pH goes above 4.0, a new solution will have to be mixed.
10. Shut down the pump and allow to static soak for 1 hour while cleaning the additional stages (if present).
11. Follow the same procedure (steps 5 through 8) to clean the remaining stages.
12. After soaking, recirculate each stage for 20 minutes.
13. Rinse the system using the *Post Cleaning Rinse* procedure below.

ORGANIC CLEANING

The following steps are recommended for an organic cleaning for TRISEP® cellulose acetate elements:

1. Clean out the solution tank and add the appropriate volume of RO permeate quality water. See *Water Quality*.
2. Allow water to circulate through the pump and into the tank during chemical mixing.
3. Add a neutral pH cleaning chemical into the tank. Mix thoroughly.
4. Check the pH of the solution. The proper range should be between 7.0 and 7.5. The pH may be raised by adding additional chemical or lowered by adding sulfuric acid.
5. A maximum cleaning temperature of 40°C (104°F) is recommended.
   **Note:* A maximum cleaning temperature of 30°C (86°F) is recommended for SBNF.
6. Displace the water in the vessels by diverting the concentrate and product lines to an appropriate drain and slowly pump the solution into the vessels until it is visible coming from the concentrate line. Shut down the pump and divert the concentrate and product lines back to the cleaning solution tank.
7. Recirculate the solution through the vessels at the appropriate flow and pressure for 30 minutes. See *Flow Rates*.
8. Shut down the pump and allow to static soak for 1 hour.
9. Clean the additional stages in the same manner while the first stage soaks.
10. After soaking, recirculate each stage for 30 minutes
11. Rinse the system using the *Post Cleaning Rinse* procedure below.

POST CLEANING RINSE

The following steps are recommended for a post cleaning rinse for TRISEP CA elements:

1. With the pump in the off position, divert the concentrate and product lines to the appropriate drain.
2. Thoroughly rinse out the solution tank and fill it with RO permeate. See *Water Quality*.
3. Start the pump and begin rinsing the water through the vessels.
4. Rinse for a minimum of 20 minutes.
5. Test the pH of the water in solution tank and then test the pH of the concentrate water.
6. When both the pH readings are similar, rinse one more tank volume of water through the vessels.
7. Rinse the additional stages in the same manner.

8. Shut down the pump and go on to the next cleaning method or if cleaning is complete, refer to *Element Start-Up Rinse* procedure below.

ELEMENT START-UP RINSE

The following steps are recommended prior to element start-up for TRISEP® CA elements:

1. Return the manifolds to their normal operating configuration.
2. Divert the concentrate and product lines to the drain.
3. Start flowing water through the elements at a water pressure close to city water pressure. Do not start the pump.
4. Allow the water to flow through the vessels for a minimum of 15 minutes and until all air is out of the system.
5. Start the pump and adjust the pressures and flows to their normal operating parameters.
6. Flush to the drain for a minimum of 30 minutes.
7. Test the pH or conductivity of the concentrate and product waters and compare to the pre-cleaning readings.
8. When the pH or conductivity is similar to the pre-cleaning readings, shut down the pump and divert the concentrate and product lines back to their normal operating configuration.
9. Safely restart the system

CLEANING TEMPERATURE AND PH LIMITS

Temperature and pH adjustments both have a strong influence on the effectiveness of membrane cleaning. Generally, warmer temperatures and stronger pH adjustments result in better cleaning results. However, various material components within an element are limited in their ability to withstand the combination of temperature and pH. Table 1 below provides guidelines for acceptable pH and temperature limits for TRISEP cellulose acetate membranes.

TABLE 1. TEMPERATURE AND PH LIMITS BY MEMBRANE TYPE.

Membrane Type	Temperature Limit	pH Limit
SB20, SB50, SB90, SBUF	40°C (104°F)	2.0 – 7.5
SBNF	30°C (86°F)	2.0 – 7.5

FLOW RATES

High fluid flow rates improve the effectiveness of cleanings by flushing foulants removed during the process from the membrane system. Recommended flow rates vary based on the diameter of the membrane elements being cleaned. Table 2 summarizes the recommended flow rates and cleaning pressures. Please note that pressure drop during cleaning should not be allowed to exceed 3.5 bar (50 psi) across a pressure vessel or 1 bar (15 psi) per installed element within a vessel.

TABLE 2. SUGGESTED FLOW RATES DURING CLEANING AND RINSING.

Membrane Diameter	Flow Rate per Vessel	Recommended Pressure	Maximum Pressure Drop
2.5”	0.7 – 1.2 m^3/hr (3 – 5 GPM)	1.5 – 3.5 bar (20 – 50 psi)	3.5 bar (50 psi)
4.0”	1.8 – 2.3 m^3/hr (8 – 10 GPM)	1.5 – 3.5 bar (20 – 50 psi)	3.5 bar (50 psi)
8.0”	7.0 – 9.1 m^3/hr (30 – 40 GPM)	1.5 – 3.5 bar (20 – 50 psi)	3.5 bar (50 psi)
8.3”	7.9 – 10.2 m^3/hr (35 – 45 GPM)	1.5 – 3.5 bar (20 – 50 psi)	3.5 bar (50 psi)

WATER QUALITY

The quality of water used for CIP is important in order to avoid unwanted deposits on the membrane. RO quality water is recommended for flushing, cleaning, and disinfecting of TRISEP® membranes, but prefiltered water may be used. Table 3 outlines the quality of water suitable for the above cleaning procedure.

TABLE 3. CIP WATER QUALITY RECOMMENDATIONS.

Solute	Recommended Limit
Iron (Fe)	< 0.05 mg/L
Manganese (Mn)	< 0.02 mg/L
Aluminum (Al)	< 0.05 mg/L
Silica (SiO_2)	< 5.0 mg/L
Total Hardness as $CaCO_3$	< 50 mg/L as $CaCO_3$
Total Alkalinity as $CaCO_3$	< 50 mg/L as $CaCO_3$
Chlorine	0 mg/L
Turbidity	< 0.5 NTU
Silt	< 1 SDI

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