Membrane Cleaning Guide
Food & Dairy: RO & NF Elements

The following are general recommendations for cleaning TurboClean® reverse osmosis (RO) and nanofiltration (NF) elements in food & dairy applications. More detailed procedures for cleaning membrane systems in process applications should be provided by the system supplier or the cleaning chemical supplier.

INTRODUCTION

During operation the surface of a membrane is subject to fouling. Fouling includes the build-up of material, including organics and mineral scale, on the membrane surface. Fouling results in a lower permeate flow rate, an increased pressure drop between the feed and concentrate and/or higher solute passage. Process applications require daily or frequent cleaning(s) as opposed to water systems where the time between cleanings is measured in weeks or months.

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.*
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.

CLEANING PRECAUTIONS

Certain chemicals and cleaning conditions may have an adverse effect on membrane performance. We recommend caution with the following:

- Aggressive alkaline cleanings at high temperature and pH may cause membrane degradation and lead to premature failure. Please follow the recommendations of the system supplier or the cleaning chemical supplier.
- Nitric acid solutions may have an oxidizing effect on the membranes, especially on nanofiltration, and therefore should be used with caution.
- Frequent disinfection with an oxidizing solution (such as hydrogen peroxide blend) more than 1-2 times per week may cause premature membrane oxidation.

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CLEANING METHOD

The cleaning method described below is meant to be a general procedure. Between each step the system must be flushed with high-quality water; please refer to *Water Quality* below for specific requirements.

1. Shut down the system to be cleaned. Be sure to follow all safety procedures for system shutdown.
2. Purge feed stream from the system.
3. Flush system with water. See *Water Quality* for specific requirements.
4. Alkaline wash, maximum of pH 12.0, maximum of 50°C (122°F), 30 minutes.
5. Flush system with water.
6. Acid wash, pH 2.0, maximum of 50°C (122°F), 30 minutes.
7. Flush system with water.
8. Enzyme wash, pH 9.5, maximum of 50°C (122°F), 45 minutes.
9. Flush system with water.
10. Clean water flux readings (see *Checking Cleaning Effectiveness* below).
11. Chemical soak, pH 3.6, no heat, 15 minutes if duration between production and CIP is over 2 hours.*
12. Flush system with water.

*Once per week, substitute a chemical sanitization with a hydrogen peroxide/peracetic acid blend (about 350 ppm active ingredient) at 20°C (68°F) for 15 minutes.

DISINFECTION

In many food & dairy plants, cleaning is followed by a chemical disinfection. The frequency of disinfections is based on plant need, feed quality, and membrane type. The procedure for a chemical disinfection is similar to the cleaning procedure (i.e. dosing and circulating the solution prior to flushing the system with water). It is important that chemical disinfection using peroxide be done only at or below 25°C (77°F) and in acidic conditions. It is also critical that all iron is removed from the membrane surface prior to disinfection. For more information, please refer to MANN+HUMMEL Water & Fluid Solutions' **Membrane Disinfection Guide – Hydrogen Peroxide/Peracetic Acid Mixtures** (TSG-C-006).

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 1 outlines the quality of water suitable for the above cleaning procedure.

TABLE 1. 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

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 1.0 bar (15 psi) per installed element within a vessel. Operate cleaning at as low a pressure as possible in order to clean the membrane most effectively and without pushing foulant into the membrane.

TABLE 2. RECOMMENDED FLOW RATES FOR FLUSHING.

Membrane Diameter	Flow Rate per Vessel	Recommended Pressure	Maximum Pressure Drop
3.8"	1.8 – 2.3 m^3/hr (8 – 10 GPM)	1.5 – 4.0 bar (20 – 60 psi)	3.5 bar (50 psi)
6.3"	3.6 – 4.5 m^3/hr (16 – 20 GPM)	1.5 – 4.0 bar (20 – 60 psi)	3.5 bar (50 psi)
8.0"	7.0 – 9.1 m^3/hr (30 – 40 GPM)	1.5 – 4.0 bar (20 – 60 psi)	3.5 bar (50 psi)
8.3"	7.9 – 10.2 m^3/hr (35 – 45 GPM)	1.5 – 4.0 bar (20 – 60 psi)	3.5 bar (50 psi)

A low flow rate should be used for the pre-soak recirculation. This flow rate would be about 50% less of what is shown in Table 2. A high flow rate should be used for the post-soak recirculation. This flow rate would be about 50% more of what is shown in Table 2.

CHECK CLEANING EFFECTIVENESS

To verify that the cleaning procedure effectively cleaned the membranes, it is common to measure the clean water flux after cleaning. Water flux results can indicate whether surface foulants have been removed or if an additional cleaning step is needed. Clean water flux recorded over time can demonstrate cleaning effectiveness or lead to a cleaning or operating upset.

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