Technical Service Bulletin

July 2025 TSB 608.02

Storage and Cleaning Guidelines for PRO-XS Membrane Elements

This bulletin provides guidelines for storing and chemical cleaning Hydranautics' Composite Polyamide **PRO-XS** series of nanofiltration membrane elements.

Note: Before undertaking any storage and cleaning operation, consult local legislation regulations regarding related chemical usage and disposal.

1. General Storage Guidelines

Scope

The general storage procedures included in this bulletin are as follows:

1. Short-term storage of **PRO-XS** membrane elements in place in pressure tubes.
2. Long-term storage of **PRO-XS** membrane elements in place in pressure tubes.
3. Transport and storage of **PRO-XS** membrane elements before start-up of an NF system.

Note: The composite polyamide type of NF membrane elements may not be exposed to chlorinated water under any circumstances. Any such exposure will cause irreparable damage to the membrane. Absolute care must be taken following any disinfection of piping or equipment or the preparation of cleaning or storage solutions to ensure that no trace of chlorine is present in feedwater to membrane elements. If there is any doubt about the presence of chlorine, perform chemical testing to make sure. Neutralize any chlorine residual with a sodium bisulfite solution, and ensure adequate contact time to accomplish complete dechlorination.

Short-Term Storage

Short-term storage is for periods where a membrane plant must remain out of operation for more than five days, but fewer than thirty days, with the **PRO-XS** elements in place. Prepare each **PRO-XS** train as follows:

1. Flush the **PRO-XS** section with RO permeate water or NF permeate water or feedwater (if clean water source is not available) while simultaneously venting any gas from the system. If possible, flushing with NF or RO permeate water instead of feedwater has added benefits, and may help remove build up of foulants (reference TSB 107).

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2. When the pressure tubes are filled, close the appropriate valves to prevent air from entering the system.

3. Reflush as described above at 5-day intervals.

Long-Term Storage

Long-term storage is for periods where an **PRO-XS** plant must remain out of operation for more than thirty days with the **PRO-XS** elements in place. Prepare each **PRO-XS** train as follows:

1. Clean the PRO-XS membrane elements in place.

2. Flush the PRO-XS section with an approved chemical solution depending on the following environmental conditions.

   Prepare a solution of an approved biocide prepared from NF or ROpermeate.

   The recommended biocide chemcials for PRO-XS1 element are: **SBS**. For PRO-XS2 and PRO-XS3 elements three chemicals are allowed: **SBS, Isothiazolin** and **Safeguard™ 100** (Avista brand).

   When using **SBS** for preservation, a concentration of 0.5%-1% is recommended. It should be noted that the preparing solvent can take salty solution. It is recommended for a salinity level between 100-35,000 mg/L range. In this case, operators can use NF permeate as the prepare solvent for the preservation solution. If the pH of the preservation solution is below 5, pH needs to be adjusted to 5 at the preparation stage to assure above pH 3 storage condition. The preservation solution needs to be flushed into the pressure vessel and make sure all emements are fully soaked in the vessel.

   Isothiazolin is highly effective for train preservation to control biological growth in off-line trains for extended periods. The recommended long term preservation dose is 500-1000 ppm.

   Safeguard™ 100 effective dosing concentration is 2% as recommended by the chemical manufacturer.

3. When the PRO-XS section is filled with this solution (make sure that it is completely filled), close the valves to retain the solution in the PRO-XS section.

4. Repeat Steps 2 and 3 with fresh solution every thirty days if the temperature is below 80°F (27°C), or every fifteen days if the temperature is above 80°F (27°C).

5. When the PRO-XS system is ready to be returned to service, flush the system for approximately one hour using low-pressure feedwater with the product dump valve open to drain; then flush it at high pressure for 5 to 10 minutes with the product dump valve open to drain. Before returning the PRO-XS system to service, check for any residual biocide in the product.

Transport and Storage Prior To Installation

The recommended shelf life of PRO-XS membranes is 18 months.

When **PRO-XS1,2,3** elements are stored prior to installation, they should be protected from direct sunlight and stored in a cool, dry place with an ambient temperature range of 41°F to 95 °F (5°C to 35°C). During the period of transit between the factory and the plant site, the elements should not be exposed to temperatures below 41°F (5°C) nor above 95°F (35°C).

When **PRO-XS5** elements are stored prior to installation, they should be protected from direct sunlight and stored in a cool, dry place with an ambient temperature range of 41°F to 95°F (5°C to 35°C). During the period of transit between the factory and the plant site, the elements should not be exposed to temperatures below 41°F (5°C) nor above 113°F (45°C).

Necessary transportation and storage temperature control need to be considered to assure the comfomity of the above instructions. The incomformity of the transportation and storage temperature limits may lead to deteriated membrane performance.

New elements are enclosed in a sealed polyethylene bag containing a storage preservative solution, and then packaged in a cardboard box. Please check on product specification sheet for specific preservation chemical being used for package and related guidelines regarding initial flushing and waste disposal. Large shipments may come packaged in crates strapped to pallets containing 25 single elements. When storing the pallets of elements, they may be stacked 2 high. Pallets should not exceed 2 high.

Length of Storage

Hydranautics will only accept unused elements for return for credit no later than 90 days after purchase, per the guidelines in TSB 116 Returned Goods Authorization (RGA)

Procedure. Though Hydranautics acceptance for unused elements is limited to 90 days, elements could be stored for an extended period of time and still perform as expected. If the storage conditions listed within this bulletin are followed and the vacuum in the bag is maintained, it may be possible to successfully store **PRO-XS** elements for up to eighteen months.

Installation of elements which are stored for long periods may result in lower flow rates or higher operating pressures than expected. In such instances, cleaning the elements using a caustic solution, as outlined in TSB 107 (Solution 7), may improve flux.

Hydranautics Storage Bags (for customers requesting spares)

HYD P/N: 83060.5000 (7"x48") for 4"x40" elements
HYD P/N: 83060.9000 (14"x55") for 8"x40" elements

2. Cleaning Guidelines

Basic cleaning prodedures of **PRO-XS** products follow TSB 107. All the PRO-XS elements are LD configured elements, so cleaning flow conditions should follow LD elements' instruction in Table 6b of TSB107. Cleaning pH and temperature limits should follow Table 5b of TSB107.

If you are using a proprietary chemical, make sure the chemical has been qualified for use with your Hydranautics membrane by the chemical supplier. The chemical supplier's instructions should not be in conflict with Hydranautics recommended cleaning parameters and limits listed in this Technical Service Bulletin.

- If you are using generic chemicals, make sure the chemical has been qualified for use with your Hydranautics membrane in this Technical Service Bulletin. All the listed generic cleaning chemicals in Table 3 of TSB107 are allowed to be used to clean PRO-XS elements.
  Potential flow loss may be observed for the use of anionic surfactants on PRO-XS1 element. However, such flow reduction is only observed when DI water is used directly in the filtration after the cleaning exposure. For regular filtration on feed water with certain salinity levels (above 65 mM ionic strength solution), permeate flow should not be negatively impacted after using anionic cleaners. If membrane permeate flow rate worsens after using anionic cleaner, try using 65 mM above salty solution to rinse the system and recovery the flow loss, which can be either 3,800 mg/L NaCl or 2,000 mg/L $MgSO_4$ solution.
- Use the least harsh cleaning regimen to get the job done. This includes the cleaning parameters of pH, temperature, and contact time. This will optimize the useful life of the membrane.

- Clean at the recommended target temperatures to optimize cleaning efficiency and membrane life.
- Use the minimal amount of chemical contact time to optimize membrane life.
- Be prudent in the adjustment of pH at the low and high pH range to extend the useful life of the membrane. A “gentle” pH range is 3 to 10, while the harshest is 1 to 11.5.
- Oil and biologically fouled membranes should not use a low pH clean-up first as the oil and biological matter will congeal.
- Cleaning and flushing flows should usually be in the same direction as the normal feed flow to avoid potential telescoping and element damage. In certain cases, where heavy feed end fouling has occurred, reverse flow cleaning may be more effective in removing the foulant. In these cases, please see TSB 125 “Reverse Direction Cleaning of RO Membrane Elements” and follow all recommended guidelines to prevent element damage.
- When cleaning a multi-stage NF, the most effective cleaning is one stage at a time so cleaning flow velocities can be optimized and foulants from upstream stages don’t have to pass through down-stream stages.
- Flushing out detergents with higher pH permeate can reduce foaming problems.
- Verify that proper disposal requirements for the cleaning solution are followed.
- If your system has been fouled biologically, you may want to consider the extra step of introducing a sanitizing biocide chemical before and after a successful cleaning. Biocides can be introduced before and immediately after cleaning, periodically (e.g. once a week), or continuously during service. You must be sure that the biocide is compatible with the membrane, does not create any health risks, is effective in controlling biological activity, and is not cost prohibitive.
- For safety reasons, make sure all hoses and piping can handle the temperatures, pressures and pH’s encountered during a cleaning.
- For safety reasons, always add chemicals slowly to an agitated batch of make-up water.
- For safety reason, always wear safety glasses and protective gear when working with chemicals.
- For safety reasons, don’t mix acids with caustics. Thoroughly rinse the 1st cleaning solution from the NF system before introducing the next solution.

For PRO-XS treating high fouling waters, the pH, temperature, and contact times are typically used for each cleaning based on the assumption that cleanings do not exceed one cleaning every 30 days. Each time after high pH clean, it is recommended to run an acid clean or acid rinse to neutralize pH. Since high pH clean opens membrane polymer structure, which can lead to increased salt passage. After pH neutralization procedure, membrane rejection performance will be recovered.

PRO-XS Membrane Element Cleaning and Flushing Procedures

The NF membrane elements can be cleaned in place in the pressure tubes 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. NF cleaning procedures may vary dependent on the situation. The time required to clean a stage can take from 4 to 6 hours total. It is recommended to take data for NF performance normalization just before and immediately after the cleaning to evaluate the efficiency of cleaning. It may also be beneficial to start the NF rack after first cleaning step (alkaline or acid) and collect data for normalization to evaluate efficiency of each cleaning step separately.

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

Note: The permeate valves should ALWAYS remain open when cleaning or flushing the elements. If the permeate valve is closed, the pressure on the permeate line will equalize to the feed pressure. This is likely greater than the concentrate pressure, which will result in the permeate pressure being greater than on the feed side of the tail element. This may result in membrane delamination and performance failure.

1. Perform a low pressure flush at 60 psi (4 bar) or less of the pressure tubes by pumping clean water from the cleaning tank (or equivalent source) through the pressure tubes to drain for several minutes to displace any feed/brine solution from membranes. Flush water should be clean water of RO permeate or DI quality and be free of hardness, transition metals, and chlorine.

2. Mix a fresh batch of the selected cleaning solution in the cleaning tank. The dilution water should be clean water of RO permeate or DI quality and be free of hardness, transition metals, and chlorine. The temperature and pH should be adjusted to their target levels. Check and record also the conductivity, turbidity and Iron concentration of freshly prepared cleaning solution.

3. Circulate the cleaning solution through the pressure tubes for no more than 2 hours. At the start of circulation, send the displaced water to drain so you don't dilute the cleaning chemical and then divert up to 20% of the most highly fouled cleaning solution to drain before returning the cleaning solution back to the NF Cleaning Tank. For the first 5 minutes, slowly throttle the flow rate to 1/3 of the maximum cleaning flow rate. This is to minimize the potential plugging of the feed path with a large amount of dislodged foulant. For the second 5 minutes, increase the flow rate to 2/3 of the maximum cleaning flow rate, and then increase the flow rate to the maximum cleaning flow rate. If required, readjust the pH back to the target when it changes more than 0.3 pH units. Temperature of cleaning solution should be controlled and kept at maximum allowed value during the whole cleaning cycle for best cleaning efficiency. After each circulation step, check the conductivity, turbidity and Iron content of cleaning solution. If these will increase significantly compared to the initial startup values, the cleaning solution shall be drained and new solution prepared to continue with cleaning to improve cleaning efficiency.

4. A soak and recirculation sequence is recommended during cleaning. The soak time can be from 1 to 2 hours depending on the manufacturer's and/or chemical supplier's recommendations. After soaking, conclude with an additional 1 to 2 hours of circulation.

Caution should be used to maintain the proper temperature and pH during the whole cleaning cycle. Soaking time does increase the chemical exposure time of the membrane.

5. Upon completion of the chemical cleaning steps, a low pressure Cleaning Rinse with clean water (RO permeate or DI quality and free of hardness, transition metals, and chlorine) is required to remove all traces of chemical from the Cleaning Skid and the NF Skid. Drain and flush the cleaning tank; then completely refill the Cleaning Tank with clean water for the Cleaning Rinse. Rinse the pressure tubes by pumping all of the rinse water from the Cleaning Tank through the pressure tubes to drain. A second cleaning can be started at this point, if required.

6. Once the NF system is fully rinsed of cleaning chemical with clean water from the Cleaning Tank, a Final Low Pressure Clean-up Flush can be performed using pretreated feed water. The permeate line should remain open to drain. Feed pressure should be less than 60 psi (4 bar). This final flush continues until the flush water flows clean and is free of any foam or residues of cleaning agents. This usually takes 15 to 60 minutes. The operator can sample the flush water going to the drain for detergent removal and lack of foaming by using a clear flask and shaking it. A conductivity meter can be used to test for removal of cleaning chemicals, such that the flush water to drain is within 10-20% of the feed water conductivity. A pH meter can also be used to compare the flush water to drain to the feed pH.

7. Once all the stages of a train are cleaned, and the chemicals flushed out, the NF can be restarted and placed into a Service Rinse. The permeate should be diverted to drain until it meets the quality requirements of the process (e.g. conductivity, pH, etc.). It is not unusual for it to take from a few hours to a few days for the NF permeate quality to stabilize, especially after high pH cleanings.

It is important to follow these cleaning guidelines to maintain the expected membrane life and warranted values for your application. Again, cleaning more aggressively than recommended above may be required to maintain desired flow, but will result in faster aging of the membrane and will change the length of warranty for permeate quality. In the case that more frequent or more aggressive cleaning is needed, the user should contact the system supplier to review/improve operational practices and better manage the fouling to achieve desired membrane lifetimes.