Reverse Osmosis Membrane

Technical Service Bulletin 104

Membrane Element Start-up/Shutdown Procedures

The first time NanoH2O RO elements are placed in service and during normal operational start-up and shutdown, certain precautions MUST be observed to help ensure stable long-term performance from the elements. Below are the normal procedures and precautions for initial start-up and subsequent operation.

Feedwater Requirements

- **Free Chlorine**

Qfx membrane elements show some resistance to short-term chlorine (hypochlorite) exposure. The free chlorine tolerance of the membrane is < 0.1 ppm. Continuous exposure, however, may damage the membrane and should be avoided. Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, NanoH2O recommends removing residual free chlorine by pretreatment prior to membrane exposure.

> CAUTION
>
> Confirm that feedwater introduced to the membrane elements contains no more than 0.1 ppm of free chlorine. Membrane element damage resulting from operation beyond this limit is irreversible and will void the NanoH2O product or performance warranty.

- **Turbidity**

Confirm that RO feedwater turbidity and fouling potential, as measured by a 15-minute silt density index (SDI15), are within the limits specified on the Qfx product data sheet or in the NanoH2O product or performance warranty. Please refer to "Silt Density Index Procedure (SDI15) - TSB 107" for more information. During system start-up, spikes of high turbidity water may pass through the pretreatment system until the pretreatment system stabilizes. These spikes will result in membrane fouling that decreases permeate flow and requires operation at higher pressures to compensate for the decreased flow.

> CAUTION
>
> Membrane elements that have been fouled will suspend and may void (if the foulants cannot be completely removed by chemical cleaning) any product or performance warranty issued by NanoH2O related to permeate flow and/or operating pressure.

- **Temperature**

Confirm that RO feedwater temperature is within the limits specified on the NanoH2O product data sheet. Operation at temperatures exceeding 45°C (113°F) under the high pressure conditions required for SWRO can result in the weakening and compression of the porous polysulfone layer supporting the thin-film membrane. This compression can result in compaction that permanently reduces the permeate flow through the membrane. Please contact a NanoH2O sales representative or technical support team member if you are considering system operation with feedwater temperatures that exceed these limits.

> CAUTION
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> Impaired membrane permeability caused by high temperature compaction will void any product or performance warranty issued by NanoH2O related to permeate flow and/or operating pressure.

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Technical Service Bulletin 104

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- **Other Feedwater Conditions**

Prior to introducing the feedwater to the membrane elements, confirm that all other feedwater composition, properties and limiting conditions are in full compliance.

> CAUTION
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> Failure to comply with limiting conditions may void any product or performance warranty issued by NanoH2O.

Initial Start-up Requirements

- **Pre-Flushing**

Prior to installing the membrane element(s), the system or train MUST be flushed to remove any debris in the pressure vessel ("Membrane Element Flushing - TSB 109").

- **Element Loading**

Confirm that the NanoH2O elements were correctly loaded and that all O-rings and brine seals were properly installed. Confirm that the elements in each pressure vessel were properly shimmed to remove excess slack in the pressure vessel ("Vessel Shimming Procedures - TSB 103")

- **Vent Entrained Air**

Initiate a low pressure flush at 1 - 1.4 bars (15 - 20 psig) to ensure that all air is purged from the membrane elements and pressure vessels prior to the next step. The low pressure flush should be performed with the permeate valves open to drain, the concentrate control valve (the valve that controls the ratio of concentrate flow to permeate flow) fully open, and with a soft-start mechanism or variable speed drive.

- **Membrane Flushing**

Remove membrane preservatives. The membrane elements are shipped after being immersed in a 0.5 wt% sodium metabisulfite solution and drained. In order to remove the preservative, It is recommended to perform a flushing step at the flow rate of 7-9 m3/h per 8 inch PV, applying the lowest possible pressure to achieve this flow, what typically occurs at a feed pressure of 4 bar with a dP of 1.5-2 bar for a 6-7 elements PV.

Ramp up the pressure to achieve normal operation ("Membrane Element Operating Precautions-TSB 106").

The permeate produced for the first 10 minutes of plant operation should be discharged to waste. To ensure the highest quality permeate stream, discard the permeate for the first 1 hour of operation after the initial start-up. Furthermore, prolonged flushing may be necessary depending on the application and required water quality.

> CAUTION
>
> Failure to remove entrained air can result in mechanical damage to the membrane elements due to high hydraulic forces resulting from water hammer.

Notes:
When flushing a membrane element, the permeate valves should be open to drain and the concentrate control valves should also be fully open to avoid damaging the membrane elements. For any flushing operation to be effective, the volume used for flushing should exceed the liquid hold-up volume of the membrane elements. For standard 8-inch x 40-inch elements, assume the hold-up volume is 37.85 liters (10 gallons) for each membrane element. For standard 4-inch x 40-inch elements, assume the hold-up volume is 11.35 liters (3 gallons) for each membrane element. To ensure the highest quality permeate stream, discard the first hour's worth of permeate after initial start-up.

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Technical Service Bulletin 104

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Operating Requirements – System Start-up

· Concentrate Control Valve Operation

Prior to train or system start-up, confirm that the concentrate control valve is in the fully open position.

> CAUTION
>
> NEVER start up a train or system with the concentrate control valve fully or partially closed. After feedwater is introduced to the train or system with the concentrate control valve fully open, slowly close the valve until the desired recovery is achieved. Starting a train or system with the concentrate control valve fully or partially closed can over-pressurize the system, damage the membrane elements, burst piping and create a safety hazard. Train or system permeate recovery should NEVER exceed the maximum safe permeate recovery as recommended by NanoH2O or by its Q+ Projection Software.

· Control Rate of Pressurization During Start-up

No train or system should be brought online (pressurized) at a rate faster than 0.7 bar (10 psig) per second.

> CAUTION
>
> Rapid pressurization of a train or system can cause mechanical damage to the membrane elements. Such damage can include: cracking of the outer fiberglass shell, failure of the anti-telescoping device and membrane telescoping. Mechanical damage to membrane elements caused by overly rapid pressurization or over-pressurization will void any product or performance warranty.

Operating Requirements – System or Train Shutdown

· Element Flush

Following the system or train shutdown, it is REQUIRED to flush the membrane elements with RO feedwater to remove the high concentrations of salts. Never shut down the RO system or train without immediately flushing the high TDS (Total Dissolved Solids) concentration from the membrane elements.

> CAUTION
>
> Failure to remove the high TDS concentration of the hold-up volume in the membrane elements may result in damage to the elements.

Notes:
When flushing a membrane element, the permeate valves should be open to drain and the concentrate control valves should also be fully open to avoid damaging the membrane elements. For any flushing operation to be effective, the volume used for flushing should exceed the liquid hold-up volume of the membrane elements. For standard 8-inch x 40-inch elements, assume the hold-up volume is 37.85 liters (10 gallons) for each membrane element. For standard 4-inch x 40-inch elements, assume the hold-up volume is 11.35 liters (3 gallons) for each membrane element. To ensure the highest quality permeate stream, discard the first hour's worth of permeate after initial start-up.