Water Equipment Technologies

# ES Series

## Reverse Osmosis Water Treatment System

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

# IMPORTANT USER INFORMATION

**PLEASE DO NOT DISCARD**

**THIS MANUAL CONTAINS IMPORTANT INFORMATION WHICH SPECIFICALLY APPLIES TO THIS UNIT. THIS INFORMATION MAY BE NEEDED AS REFERENCE DURING ANY FUTURE SERVICING OF THE SYSTEM.**

## DISCLAIMER AND LIMITATIONS

This manual discloses proprietary information of WET. This information is provided for the purpose of operating and maintaining its RO systems, and may not be used for any other purpose.

It is recommended that this manual be read and understood before performing installation, operation, and maintenance of the RO system. The equipment warranty may be voided if instructions are not followed correctly. The information provided may not cover all possible variations of detail in relation to equipment use. Please contact the WET Service Department for any technical questions that are not specifically answered in this manual.
The Seller reserves the right to make enhancements or changes that may not be included in the manual. Therefore, it is understood that the material presented here is subject to change without notice and is for informational purposes only.

This manual is believed to be complete and accurate at the time of publication. However, WET assumes no responsibility for the technical content of the manufacturer literature. Due to the inability to verify all vendor-provided materials, WET assumes no responsibility for any errors and shall not be liable for damages in connection with the use of this manual.


## INITIAL INSPECTION AND HANDLING

**On receipt of the RO unit, note any damage on appropriate shipping documents. File damage claims with carrier immediately (not WET).**

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**RO MODEL**_____

**INSTALLED BY**_____

**TELEPHONE**_____

**INITIAL STARTUP DATE**_____

## SAFETY NOTES – READ AND UNDERSTAND BEFORE PROCEEDING

**WARNING**

| | | | |
|---|---|---|---|
| √ | High Voltage Electricity | √ | Spinning Parts |
| √ | High Pressure Components | √ | Pressurized Water |
| √ | Noise | | |

Failure to follow good safety practices and the instructions included in this manual may result in damage to the unit, its surroundings, personal injury or death.

Please take all possible precautions when working on or around this unit.

### Pressure

Reverse Osmosis units operate by forcing water at high pressure against a semi-permeable membrane. The higher the TDS (Total Dissolved Solids) of the feedwater, the higher the pressure required to produce acceptable amounts of purified water. Fresh water typically requires up to 150 psig to suitably overcome osmotic pressure. Even a small leak at elevated pressures can be dangerous.

### Electricity

Electricity and water DO NOT MIX. Every effort is made to insure that the electrical equipment on our systems is resistant to water intrusion. Once installed, the system is subject to many factors beyond our control.

- The reject water of this RO unit is a concentrated solution with high electrical conductivity. Spills should be immediately cleaned. Leaks of any kind should be repaired as soon as possible.
- Check all electrical components on a regular basis to insure that water-resistant seals are still in place and functional.
- DO NOT DRILL HOLES IN THE TOP SURFACE OF ANY ELECTRICAL BOXES.

### Chemicals

- Exposure to the highly concentrated reject water, especially at the high pressures of an operating RO unit, can cause injury or permanent damage to the eyes, skin, and mucous membranes.
- Exposure to the chemicals used in cleaning, disinfection, and preservation is dangerous and may cause permanent damage.
- Test all hoses and connections before using any cleaning system to clean or preserve the membranes. Do NOT allow worn hoses or fittings to be used.
- Avoid contact with chemicals by wearing eye and skin protection equipment. Avoid breathing chemical fumes.

Safety Check Item 

Don't Do This 

Special Attention 

# Table of Contents



## Drawings



## Appendix

# System Description

## Theory of Operation

Feed water is supplied to the RO unit through a inlet valve. Next, the feed water passes through a pre-filter for removal of suspended particles 5 microns or larger.

The filtered water enters a high-pressure pump where the water pressure is increased to RO operating levels and is directed into the 1st stage RO membrane assembly. Inside the membrane assembly, a portion of the feed water, referred to as product or permeate, passes through a membrane barrier that rejects suspended and dissolved solids. The remaining portion of feed water, referred to as reject or concentrate, carries concentrated contaminants out of the membrane assembly. This reject water is sent to the 2nd stage RO membrane assembly, which extracts additional product water.

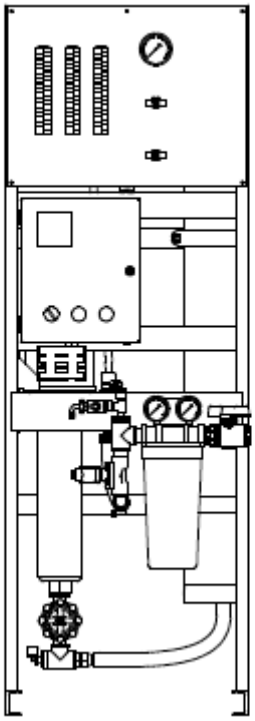
The reject water, upon leaving the 2nd stage RO membrane assembly, is regulated by a Reject valve, and is monitored by a flow indicator, before leaving the system to waste.

The combined product water from both the first and second stage RO membranes is monitored by a conductivity sensor and analytical instrument to determine the Total Dissolved Solids content of the product water.

Recovery, an important operating parameter, is the ratio of the product water to the feed water flow. See the System Specifications section of this manual for details.

The ES Series of RO systems will produce high quality water from either municipal or well water supplies. The reverse osmosis process uses a semi-permeable spiral wound membrane to separate and remove dissolved solids, organics, pyrogens, submicron colloidal matter, and bacteria from water. The feed water is pressurized to approximately 130 PSI forcing the water molecules through the minute pores as purified water. Impurities in the water are generally too large to pass through the pores and they are concentrated in the "reject" stream and flushed to the drain. The RO membranes are capable of removing 90 - 99% of Total Dissolved Solids (TDS), and up to 99% of organics, pyrogens and bacteria that may be in the feed water.

# ES Series Layout



# ES Series Standard Features

## ES Series Standard Features

- Thin Film Composite Membranes
- Industrial Painted Frames
- Stainless Steel Pump
- Heavy Duty FRP Pressure Vessels
- 5 Micron Sediment Pre-filter
- Manual Feed Water Shutoff Valve
- Product Water Check Valve
- Panel Mounted Instruments & Lights
- Automatic Inlet Valve
- Low Pressure Pump Shutoff
- Product, Reject & Recirculation Flow Indicators
- Feed & Product Water Sample Ports
- Poly Tubing & Fittings on Product Line
- Heavy Duty Concentrate & recirculation Control Valve
- Pretreatment Lockout
- Pre and Post Flush
- Factory Performance Tested

The ES Series of RO Systems is designed for light commercial use. Simplicity of design and the use of industry standard components provide for reliable operation and easy serviceability. With over 20 years experience in design and manufacture of water treatment solutions, the ES Series RO System has provided dependable, cost-efficient water production to thousands of customers and end users around the world.

# Recommended Operating Limits

The model number of your unit designates the system's daily production capacity. For example, a model ES-600 will produce 600 gallons of water per day plus or minus 15%. This production is based on a feed water temperature of 77 degrees F (25 degrees C), Total Dissolved Solids of 1000 ppm or less, turbidity of less than 1 NTU and a Silt Density Index (SDI) of less than 5. Higher or lower water temperature will increase or decrease the product water output. Higher TDS levels will decrease output production.

Complete equipment and operating specifications for the ES Series RO systems is included in the Appendix.

| Recommended RO Operating Limits | |
|---|---|
| Water Pressure | 40 to 90 PSI (275 to 620 kPa) |
| Total Dissolved Solids (TDS) | 1000 PPM (mg/l) |
| Temperature | 40° to 85° F (4.4° to 29.4° C) |
| pH | 2 to 11 |
| Hardness | 51 PPM (3 grains per gallon) |
| Iron | 0.2 PPM (mg/l) |
| Chlorine | 0.0 PPM (zero) |
| Turbidity | 1 NTU max. |
| SDI | 5 max. |

# Installation

## RO Unit Piping

**Chlorine MUST be removed from the feedwater if present. Chlorine will damage thin film composite membranes and void the warranty. If activated carbon is used to remove chlorine, the carbon MUST be rinsed to drain before the RO unit is operated.**

### RO Installation Requirements

1. The RO system and its components should be installed indoors whenever possible.
2. The system must be protected from freezing at all times. If shipped to warm climate (ambient over 70°F) inspect for bacteria.
3. The site should allow for adequate ventilation in order to relieve heat buildup which can cause weakening of fitting and plumbing connections.
4. The feed pressure should be at least 20 psi and no greater than 90 psi.
5. All pumps must be aligned to manufacturer's specifications prior to initial pump startup.
6. The RO system will produce a sound level of approximately 80-90 decibels. The system should be installed in a location where these sound levels will not be an issue.
7. Suitable drainage capable of removing the free discharge of the supply source. Drain connections must be suitable for the disposal of concentrated saline, acid/alkaline chemicals, and membrane preservatives or disinfectants.

### Piping Assembly

Connect the feed, product, and reject lines to the RO unit using non-corrosive hose, pipe, or tubing. Tubing for the product and reject connections are supplied with the unit.

The feed connection is located near the pre-filter cartridge housing. The product and reject connections are located behind the instrument panel at the flowmeter connection. Refer to the system layout drawings in the Appendix of this manual for the proper connection sizes.

**For drain connections the use of an air gap to prevent possible back flow into the RO unit is recommended.**

# Electrical

## Electrical Assembly

The RO controls are contained in an RO Control Panel mounted on the front of the skid. The Control Panel houses the relays, timers, and pilot devices (lights and selector switches) required for operation of the RO system.

Use copper conductor for grounding equal to the circuit conductors supplying power to this system.

Electrical installation should be done by a qualified electrician to avoid personal and/or possible damage to the RO unit.

Verify the correct voltage for your system by referring to the “MANFACTURED BY” name plate and NOT the motor plate.

Plug in the RO system using the 3-prong plug in a standard 115 VAC outlet or 220 VAC outlet as required. If the RO unit is equipped with a 3-phase motor, connect 3-phase power to the motor starter and check for proper rotation.

Terminals #1 and #5 (see electrical diagram provided in the Appendix) are provided for automatic on-off operation with a product tank level switch for non-pressurized systems or a pressure switch for pressurized systems. For manual operation, place a jumper between terminals #1 & #5.

**Do NOT run injector tubing and electrical wiring in the same conduit.**

# Initial Startup

## Procedure

Successful long-term performance of the RO system depends on proper operation and maintenance of the system. Proper startup is essential to prepare the membranes for operating service and to prevent membrane damage due to overfeeding or hydraulic shock. Following the proper startup sequence also helps ensure that system operating parameters conform to design specifications so that system water quality and productivity goals can be achieved.

**It is recommended to perform a full feed water analysis immediately prior to startup to establish initial feed water contamination levels.**

### Initial Startup Procedure

1. Disconnect the product water line at the service connection (not flowmeter). Direct the line to a drain to discard the product water during the first hour of operation.

**This RO system is shipped with a disinfectant compound (sodium metabisulfite) in the membranes. Before using any water from the RO, operate the system for ONE HOUR with all water going to drain.**

2. Start the feedwater supply.

3. Open the reject valve completely.

4. Start the RO system using the control power toggle switch on the Control Panel.

5. Adjust the reject valve until the flows match those indicated in the ES Series System Specifications (see Appendix). If the unit is equipped with a recirculation loop, the recirculation valve may require adjustment also.

6. Operate the RO for ONE HOUR with all product water going to drain.

7. Shut down the RO using the toggle switch. Reconnect the product water line. The RO is ready for normal operation.

**Do not exceed 190 PSI pump pressure (Models ES-450 and ES-600) and 225 PSI on Models ES-1000 to ES-9000.**

# Operation

## Startup

1. With feedwater supply being delivered to the RO system, open the *Reject* valve, then start the system using the *On-Off* switch.
2. Adjust the reject valve until the product flow reaches the proper flow rate. (See *System Specifications*) As the valve is closing the product flow will increase, the reject flow will fall, and the pump pressure will rise.

**DO NOT exceed the recommended product flow rate or fall below the minimum reject flow rate shown in the System Specifications for your unit or membrane fouling could occur very rapidly.**

3. After the proper flows have been set and an adequate amount of water has been pumped to drain, record all flows, pressures, TDS levels and water temperature (See RO Daily Log Sheet in Appendix). This initial start-up information is very important when determining the system's performance over time. For accurate TDS readings, let the RO system run for at least 15 minutes.

## Shutdown

The ES system can be turned off **manually** with the *On-Off* switch.

In normal operation, the unit will automatically shut off when the storage tank is full or at a desired pressure. After any normal shutdown, the RO system will enter a short post-flush cycle (see next page for details)

- ✓ To prevent biological growth during system shutdowns (one week or longer) the membranes must be immersed in a preservative solution (Item #753).
- ✓ If sanitization is required, the system must be in use for at least six hours before formaldehyde can be used. If the membranes are exposed to formaldehyde before being in use for this period of time, severe damage will result. Other disinfecting solutions such as hydrogen peroxide can be used. For further information, contact your local representative.

# Pre and Post-Flush

**Shutdown of the RO unit by loss of mains power prevents post-flush of the system and may cause fouling or corrosion. If an emergency shutdown is necessary, restart the system as soon as practical.**

The pre-flush floods the membranes and the RO pump suction, removing trapped air in the lines. The RO pump will start and the automatic flush valve will close at the end of the pre-flush cycle.

The post-flush washes reject concentrate from the entire system to prevent mineral deposits, scaling or sludge buildup. Post-flush prolongs the life of the membranes, valves, fittings and other components of the system.

When the RO is shut down normally, using the toggle switch (or by an optional product tank pressure switch or level device), the RO pump will stop, then the Inlet valve will open for a predetermined time to allow filtered feedwater to flush the system at low flow and pressure, before the post-flush cycle times out and the valve closes.

If an emergency shutdown is required, restart the system as soon as practical. At minimum, allow a pre and post-flush event before the system is shut off for any length of time (This can be done by starting the system for a brief period to allow the pre-flush cycle to complete, then immediately powering off the system, causing a post-flush cycle to occur.)

# System Maintenance

## Overview

| Component | Preventive Maintenance Activity | Remarks |
|---|---|---|
| **RO Membranes** | Clean the membranes when the normalized water output rate drops by 10%, salt content in the product water rises noticeably, or the differential pressure increases by 15% from the reference conditions. | See Cleaning section and OEM literature for details. |
| **Pumps** | Check pump clamp | ES-450, ES-600 only (Monthly) |
| | Check shaft coupling setscrew | ES-1000 through ES-9000 (Monthly) |
| **Pre-Filters** | Check ΔP. If ΔP drops, open filter housing and inspect cartridges for damage / blockage. If the difference between the filter inlet and outlet pressures (Δp) reaches 10 PSI, replace the filters. | Replace the cartridges with 5 micron rated filters. Replace the cartridges 4 times per year, regardless of pressure drops, to minimize bacterial growth. |
| **Pressure Vessels** | Check the pressure vessel head assemblies for leakage. | Replace the pressure vessel head seals if leaking occurs. |
| **Instruments** | Wipedown, visual inspection, leak check, zero and span, cleaning | Maintain data history log for each instrument. Keep consumables and spares in stock. |

A daily operators log, along with RO system maintenance and cleaning schedules, can be found in the rear of this manual. Make copies for the operators and send the completed copies to XYLEM to validate the warranty.

**Follow these basic guidelines to minimize unplanned downtime**

**Complete Log Sheets regularly. Add data as needed.**
**Review the data periodically. Look for unusual readings and trends.**
**Be familiar with your equipment. Periodically inspect all components.**
**Use sight, sound, smell and touch to discover unusual conditions.**

# Major Components

**Remove pressure and shut down the RO system attempting any service or repair on high pressure components.**

## Reverse Osmosis Membranes

Mineral scale, biological matter, colloidal particles and organic constituents can cause membrane fouling during normal operation. Build-up on the membranes causes loss in water output, salt rejection, or both. Clean the membranes when the normalized water output rate drops by 10%, salt content in the product water rises noticeably, or the differential pressure increases by 15% from the reference conditions. (Reference conditions refer to the flow rate and differential pressures established during the first 24 to 48 hours of operation.)

Water output drops as feed water temperatures decrease. Malfunction in the pre-treatment, the pressure control or pump can cause a drop in the feed water pressure or flow, the product water output or increase in salt passage. Consider these situations when problems are observed. Membranes may not require cleaning. Refer to the Cleaning section of this manual or the Filmtec OEM Literature for details.

## RO Pump

Follow the recommended interval for the duty cycle of your specific RO unit. Lubricate pumps and motors with manufacturer recommended lubricants for longest life. Environmental and operational conditions will contribute to the minimum required lubrication intervals.

**Ensure that the set screw is tight and the coupling is not loose. If the set screw is allowed to become loose, damage to the shaft and coupling could occur.**

## 5 Micron Pre-filter

The 5-micron rated cartridge filters remove particulate matter from the feed water harmful to the RO pump and membranes**.** When the pressure difference between the filter inlet and outlet reaches 10 PSID, replace the filter cartridges. Differential pressure across filters increases with time. When the ifferential pressure drops, open the filter housing and inspect the cartridges for damage. Replace the cartridges (4) four times per year, regardless of pressure drops, to minimize bacterial growth.

**Extreme care must be taken not to allow debris to enter the RO feed. Adequate pre-filtration is recommended to avoid damage to the RO membrane elements.**

## Activated Carbon Filter

(If installed) An activated carbon filter may be included with the ES series RO system to remove chlorine that can damage the membranes. The carbon filter must be rinsed and backwashed before initial startup and at regular intervals to ensure that loose carbon fines are flushed to drain.

Carbon filters lose efficiency over time and require periodic testing for chlorine breakthrough. Activated carbon should be REPLACED every 4 months OR SOONER to prevent breakthrough. A chlorine test kit (available from your dealer) is used to check for chlorine as follows:

With the unit running, draw a sample from the pre-filter drain valve. Test the sample for free chlorine residual. If any chlorine is detected, replace the activated carbon immediately.

**Do NOT replace the 5 micron pleated cartridge with an activated carbon cartridge. An activated carbon cartridge does not have enough surface area to effectively remove all of the chlorine in the feedwater. Severe pressure drops may also occur, causing the unit to continuously cycle on and off and damage the pump.**

## Pressure Vessels

The pressure vessels need no maintenance other than periodic inspection and wipe down with a damp cloth and mild dish soap solution. All connections should be checked for leakage. No leakage should be tolerated which might cause corrosion of fittings.

## Conductivity Monitors (TDS), Flow Meters, Pressure Gauges

No instrument or sensor lasts forever and any wide variations in a reading over a short interval should be investigated. Connections should be checked and the sensor reading tested against a sample taken from an appropriate system sample port. Calibration charts for each instrument should be maintained and each unit tested with fresh standard solutions immediately prior to use. Detailed maintenance and operating procedures are located in the OEM literature included with this manual.

# Cleaning RO Membranes

## Overview

**RO membranes should be cleaned whenever:**

- ✓ **Normalized water output rate drops by 10%,**
- ✓ **Salt content in the water rises noticeably (10%)**
- ✓ **Differential pressure (∆P) increases by 15% from the flow rate and ∆P established at initial startup**.

**Failure to observe this cleaning schedule will cause premature fouling and reduced service life from the membranes.**

In normal operation, the membranes in the RO system pressure vessel(s) become fouled by mineral scale, biological matter, colloidal particles and insoluble organic constituents. Deposit build up on the membrane surfaces can cause loss of water output, loss of salt rejection, or both.

Membrane elements should be cleaned whenever the normalized water output rate drops by **10%,** or the differential pressure **(∆P)** increases by **15%** from the initial startup reference conditions. (The need for cleaning more than once per month may indicate that pre-treatment is inadequate.)

Acid and alkaline cleaners are the standard cleaning chemicals. Use acid cleaners to remove *inorganic* precipitates including iron, and alkaline cleaners to remove organic fouling including *biological matter*. Use reverse osmosis permeate water for mixing cleaning solutions whenever available. If permeate water is not available, use only clean, **chlorine-free** water for cleaning. Rinse the RO unit thoroughly of one chemical before introducing another.

When working with chemicals, follow the accepted safety practices. Water Equipment Technologies supplied chemicals are generally mixed with 1 pound of powdered cleaner to each 15 US gallons of clean water. For severe fouling, this concentration can be increased to as much as 1 pound per 10 US gallons of water, but this should be avoided as harsh cleaning can reduce the useful life of the membranes.

The pH levels for acid and alkaline cleaning depend on water temperature. It is NOT recommended to use a cleaning temperature below 15° C because of the very slow chemical kinetics at low temperatures. When difficult organic fouling problems exist, alkaline cleaning procedures will be more effective when performed at elevated temperatures. Solutions maintained at 45 - 50 degrees C at a maximum pH of 10, 35 degrees C at a maximum pH of 11, or 30 degrees C at a maximum pH of 12 are recommended.

Several conditions can cause a reduction in the water quality and/or water production. The following items should be checked before considering cleaning.

1. Temperature change

   Water temperature will affect production rates. Lower water temperature will result in LESS water passing through the membrane. Higher water temperature will result in MORE water passing through the membrane. As a rule, at a given pressure and TDS level, for each one degree change in water temperature the change in water production is approximately 2%. Thus, if the water temperature is 20 degrees C, the amount of water produced will be 10% less than at 25 degrees C.

2. TDS level increase

   As the TDS (Total Dissolved Solids) level climbs, the amount of water passing through the membrane decreases. If the TDS level has climbed since the time of installation the unit will produce less water. Check the TDS level of the feed water and compare it with the TDS level at the time of installation. If the TDS levels have climbed, the rejection rate will have to be increased to reduce the TDS level build-up within the membrane.

3. Pre-filters plugged

   A dirty pre-filter can reduce the amount of water and the pressure going to the RO unit. If a 5 micron filter cartridge appears dirty, it should be cleaned or replaced. On extremely dirty water, a larger pre-filter may be needed. When cleaning the pre-filter, check its condition. If signs of wear appear, replace it immediately.

4. Change in flow rates or water pressure change

   Check the product and reject flow rates to determine any change from normal conditions. Adjust the flows and pressures if necessary to maintain the proper settings.

Follow the unit's normal direction of flow during cleaning. Refer to the OEM literature in this manual for more information about cleaning RO membranes.

This unit was shipped without a cleaning system. For purposes of illustration, a simplified cleaning diagram and the cleaning instructions in this section reference the typical RO membrane cleaning system available through your XYLEM representative.

# Procedure

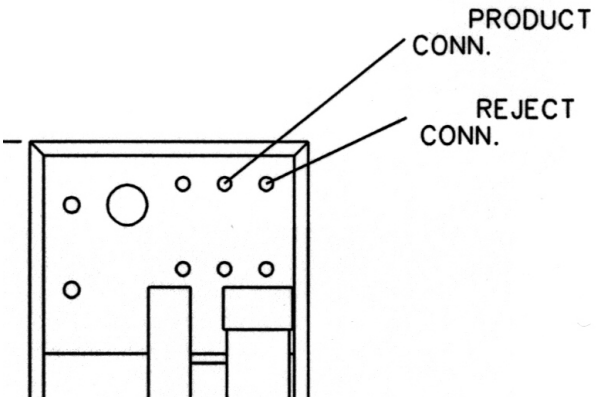
## Step 1 Mix the Cleaning Chemicals

Remove the plug and connect a line to the product connection. Connect the other end to the Product Return connection on the cleaning tank.

Fill the cleaning tank with non-chlorinated product water.

Add the appropriate amounts of chemicals (1 lb. to 15 gal of H2O) of the appropriate chemical (i.e. acid/alkaline) into the cleaning tank. Refer to the labels on the chemical containers for instructions. Mix the solution, checking the pH, until all chemicals are dissolved and well mixed before circulating the solution to the elements.

Close the *Reject* valve completely.




## Step 2 Low Flow Pumping

Connect a line to the feed cleaning connection. Connect the other end to the cleaning system feed connection.

Remove the plug/cap and connect a line to the reject cleaning connection on the reject header and back to the reject return connection on the cleaning tank.

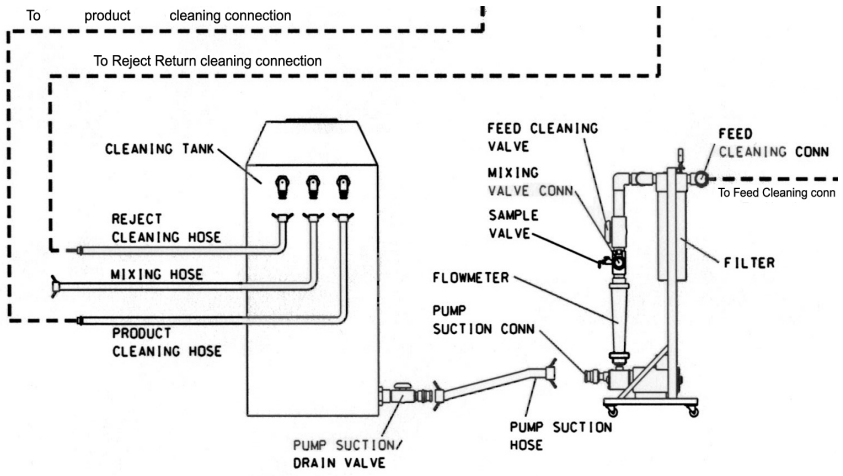
Close the feed cleaning valve halfway (50% open) and start the cleaning system pump. This will pump the cleaning solution through the membranes at a low flow and low pressure to displace the process water. Low flow and pressure (between 4 to 5 GPM for each pressure vessel) minimizes redisposition of dirt on the membranes.

Verify the flow at the cleaning tank and observe the color of the returning solution. (Color may indicate the type of membrane fouling). Check the pH level and add more chemicals to adjust the pH to its original value. Recirculate the solution for 30-45 minutes.

## Step 3 Soaking

After 30-45 minutes, turn the cleaning pump off and allow the system to soak. Normally a (1) one hour soak period is adequate. For extreme fouling, an extended soak period is beneficial. Soak the membranes overnight for 10 - 15 hours.

***Soak is generally not recommended with a low pH (Acid) cleaner. The pH of the cleaning solution will rise as mineral salts are dissolved. If it rises too far (~0.5pH units), the salts may drop out of solution and redeposit. To compensate, closely monitor the pH of the solution in the vessels and either add acid, recirculate, or flush and start with new solution.***




## Step 4 High Flow Pumping

Open the feed cleaning valve completely and start the cleaning pump. This will recirculate the cleaning solution through the vessels at a high flow rate. (Recommended high flow cleaning rate is 8-10 GPM for each pressure vessel.) Recirculate the cleaning solution for 30 minutes.

## Step 5 Flushing

a. Shut down the cleaning pump. Disconnect the feed and reject cleaning lines from the RO unit and replace the plugs/caps. Keep the product line connected to the RO unit but direct the other end to drain.

b. Start the RO system. The automatic Inlet valve will open and the preflush will begin. Dump the product water to drain for a minimum of 10 minutes.

**Send all product water to drain for at least 10 minutes after cleaning RO membranes.**

c. Shut down the RO. Remove the temporary product-to-drain hose and replace the original piping. Inspect the pre-filter cartridges on the cleaning system and replace if necessary. Clean residual chemical from hoses and cleaning system.

d. Restart the RO to resume normal production.

## Step 6 Return to Service

After the system is up and running, the flows, pressures and conductivity should be back to original specifications or close to it. If not, but substantial improvement was obtained, then repeat the cleaning with new solutions of the same type.

If no significant improvement was obtained, then the cleaning chemicals/solution should be changed and the cleaning performed again. If severe fouling has occurred, then the cleaning of individual pressure vessels at a very high recirculation flow rate might be required. Check with the XYLEM Service Dept. prior to cleaning individual RO vessels.

**Test both reject and product water for traces of cleaning or disinfection chemicals before sending water to the service connection or product storage.**

# Disinfection

## Overview

If the RO unit has been infected by bacteria or mold, disinfection must be carried out after the cleaning. The procedure is the same as for cleaning, except that the high flow pumping step can be skipped.

Formaldehyde can be used as a disinfectant with 0.5 to 3.0% concentrations. Care should be taken in handling this chemical and in flushing the system after use.

Hydrogen peroxide or hydrogen peroxide/peracetic acid solutions can be used at concentrations up to 0.2%. The biocidal efficacy of peracetic acid is much higher than that of hydrogen peroxide, but as most peracetic acid solutions also contain hydrogen peroxide, care must be exercised not to exceed the 0.2% concentration as a sum of both compounds. Continuous exposure at this concentration may eventually damage the membrane. Instead, periodic use is recommended.

When hydrogen peroxide is applied, the pH of the solution must be lower than 4. A pH of 3 is recommended. This will ensure optimal biocidal results and longer membrane lifetime. If no acid is added to the hydrogen peroxide solution, the chemical attack on the membrane will be much faster. When a mixture with peracetic acid is used, pH adjustment is usually not required.

If an alkaline cleaning has preceded disinfection, the alkalinity has to be carefully rinsed out also from the permeate side (check pH) before peroxide/ peracetic acid is applied. Otherwise the membrane might become oxidized.

**The following procedure is recommended for disinfection with hydrogen peroxide solutions:**

1. Any type of deposit on the membrane or other parts of the system should be removed with an alkaline cleaner before disinfecting. Removal of these deposits, which harbor micro organisms, will maximize the degree of disinfection. After alkaline cleaning, flush the system with RO permeate.
2. Clean the RO system with acid to remove any iron from the membrane surface. Flush the unit with RO permeate.
3. Circulate a solution of 0.2% hydrogen peroxide (preferably containing peracetic acid) diluted with RO permeate and pH adjusted to 3-4 with HCl at a temperature below $25^{O}C$ for 20 minutes.
4. Allow the elements to soak in the disinfecting solution for 2 hours.
5. Flush out the disinfecting solution. Rinse the system.
6. Replace the pre-filter cartridges.

# Preservation

## Overview

**When the system is shut down for extended periods of time (longer than 48 hours), the membranes must be preserved. Preservation is performed using the cleaning system equipment provided for RO membranes.**

1. If the system has been in operation, the membranes must be cleaned and disinfected before preserving. After cleaning, preservation should follow within the next 10 hours.
2. Connect the hoses per the cleaning instructions provided in this manual.
3. Mix a solution of 1 to 1.5% of sodium metabisulfite (SMBS) in the cleaning system tank. Using the cleaning system, start the cleaning pump to circulate the SMBS throughout the membranes for ten minutes. After circulating, disconnect hoses and quickly reconnect all plumbing to minimize any air from entering the pressure vessels. Contact with oxygen will oxidize the SMBS.
4. Change the preserving solution once a month on systems that have been operated in the field. Systems that have been preserved at the factory can go three months before re-preserving is required. Cleaning is not required as long as the system has not been operated.

# Preserving Individual Membranes

Any membrane that has been used and removed from the pressure vessel for storage or shipping must be preserved. Soak the membranes in an aqueous solution, 20% (by weight) glycerin or propylene glycol and 1% (by weight) sodium bisulfite. Glycerin or propylene glycol can be omXylemed when freezing temperatures do not exist. Soak the membranes for one hour in the solution, allow dripping out, and sealing it into an oxygen barrier plastic bag.

**See the OEM literature for details.**

# Troubleshooting

**This is a listing of some common problems, their causes, and the appropriate remedy. For conditions other than those listed here, contact your sales representative for guidance.**

| Problem | Probable Cause | Remedy |
|---|---|---|
| Not making enough water | Flush fill valve open | Wait for the high limit sensor in the tank to indicate a full tank. Check sensor operation and wiring if valve fails to close. |
| | Water temperature is lower than normal. Production drops 2% for every degree below 77 degrees F. | Control the water temperature to stay within RO unit design limits. |
| | Low supply water pressure to the RO unit. | Check the 5-micron pre-filter, clean or replace. Check the supply pressure to the 5-micron pre-filter. |
| | The RO membranes are fouled. | Clean the RO membranes. |
| | Low RO pump pressure. | Increase the RO pump pressure by adjusting the pump throttle, and reject valves. |
| | Product pressure is increasing. | Check the product piping and the check valve for any blockages. |
| | Feedwater TDS level is too high. | This is a normal occurrence and cannot be adjusted. The higher the TDS level of the feedwater the lower the amount of product water will be produced. |
| Making too much water | 1. Reject valve closed too far. | Open the reject valve and set to operating specifications. |
| | 2. Water temperature has increased. | Control the water temperature to stay within the RO unit design limits. The higher the water temperature the more water will pass through the membrane element; the lower the water temperature the less water will pass through the membrane element. |
| Product water conductivity too high | O-ring by-pass in the reverse osmosis membrane vessel | Remove the membrane element from the housing and inspect the o-rings. Be sure that the o-rings are seated properly. If this does not restore performance, replace the membrane element. |
| | *Turn disconnect switch to Off position and release pressure before attempting to disassemble pressure vessel components.* | |
| | Chlorine damage has occurred in the membrane element. | Replace the membrane element. |
| | The reverse osmosis membrane is fouled. | Clean the membrane element(s). Replace them if cleaning does not restore performance. |
| | The feedwater TDS has increased since the time of installation. | This is a normal occurrence and cannot be adjusted. The higher the TDS level of the feedwater the higher the TDS level will be in the product water. |
| | High or Low pH level in the feedwater. | Control the pH level to stay within the RO unit design limits. If the pH level is out of range, contact the factory. |

**This is a listing of some common problems, their causes, and the appropriate remedy. For conditions other than those listed here, contact your sales representative for guidance.**

| Problem | Probable Cause | Remedy |
|---|---|---|
| High conductivity (cont'd) | Recovery ratio is too high. | Bring the recovery ratio down to RO design limits by adjusting the pump throttle, and reject valves. |
| | TDS indicator or probe is not functioning properly. | Inspect and service the TDS instrument if necessary. |
| RO pump will not stay on | Low supply water pressure to the RO unit. "*LOW PRESSURE*" light on. | Check the 5 micron pre-filter, clean or replace. |
| | | Check the feedwater supply pressure to the 5 micron pre-filter |
| | High pH or conductivity | Check feedwater supply |
| | | Check chemical injection pumps |
| | | Check pH/ORP meter and sensors |
| | "*HIGH PRESSURE*" light on. | Adjust the pump throttle and reject valves. |
| | | Check for product line blockages |
| | | Check feedwater pressure |
| | Instrumentation is not reading correctly. | Calibrate or replace the defective instrument. |
| RO pump runs but no product water is being delivered to service | Reject valve is open too far. | Adjust the pump throttle, and reject valves |
| | Flush/Clean tank not yet full | Wait for tank to fill |
| | Blockage in the product lines. | Check the product water line for blockages. |
| | Reject flush pneumatic valve is not closed. | Check for flow through the valve and replace if defective. |

## RO Process Corrective Matrix

| Permeate Flow | Salt Passage | Δ P | Direct Cause | Indirect Cause | Corrective Measure |
|---|---|---|---|---|---|
| ↑ | ⇑ | → | Oxidation Damage | Free Chlorine, Ozone, KmnO4 | Replace Element |
| ↑ | ⇑ | → | Membrane Leak | Permeate Back pressure:<br>Abrasion | Replace Element<br>Improve Pre-Filtration |
| ↑ | ⇑ | → | O-Ring Leak | Improper Installation | Replace O-Ring |
| ↑ | ⇑ | → | Leaking Product Tube | Damaged during Element Loading | Replace Element |
| ⇓ | ↑ | ↑ | Scaling | Insufficient Scale Control | Cleaning; Scale control |
| ⇓ | ↑ | ↑ | Colloidal Fouling | Insufficient Pre-treatment | Cleaning; Improve Pre-treatment |
| ↓ | → | ⇑ | Biofouling | Contaminated Raw Water<br>Insufficient Pre-treatment | Cleaning, Disinfection<br>Improve Pre-treatment |
| ⇓ | → | → | Organic Fouling | Oil; Cationic Polyelectrolytes | Cleaning, Improve Pre-treatment |
| ⇓ | ↓ | → | Compaction | Water Hammer | Replace element<br>Add Elements |

## Legend

| | | | |
|---|---|---|---|
| **↑ Increasing** | **⇑ Main Symptom** | **↓ Decreasing** | **→ Not Changing** |