

Advanced Operator Training Course

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Causes for RO Membrane Damage



Water Globe Consulting

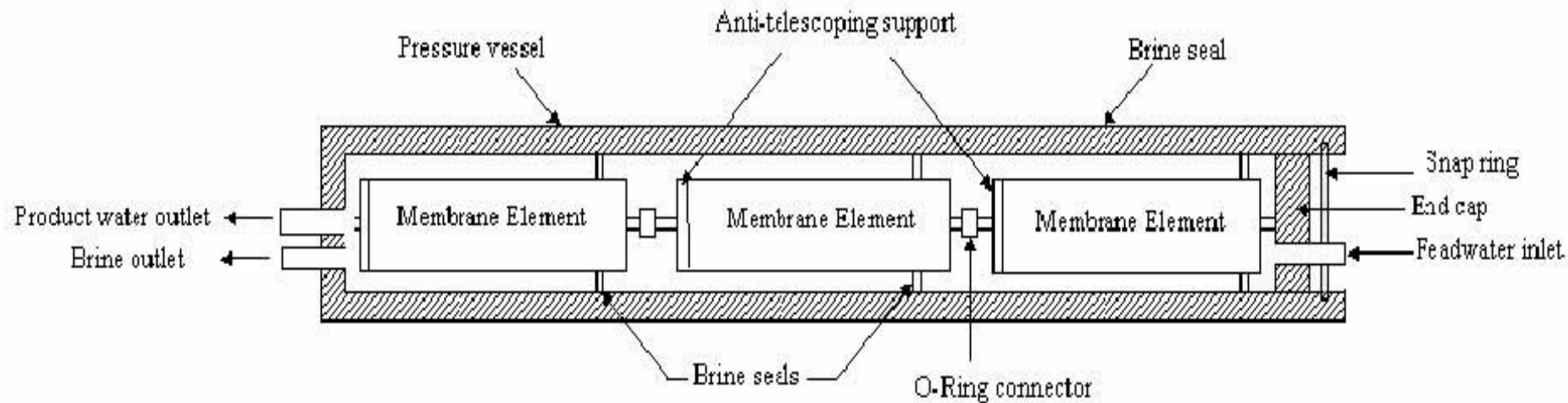
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Membrane Integrity Loss Related Challenges

- Loss of Salt Rejection of Individual RO Elements
- Loss of Integrity of Membrane Interconnectors:
 - O-rings
 - Brine Seals
- Membrane Damage:
 - Membrane Breakage/Collapse
 - Membrane Telescoping

What Could Cause Increased Salt Passage?

(#1 Cause – Incomplete Oxidant Removal)



2 Cause – Water Hammer - Typically Occurs After Membrane Replacement/Cleaning or Abrupt Power Shutdown:

- Broken Brine Seals
- Broken O-ring Connectors

3 Cause - Defective Membrane Leaf Glue Connections

4 Cause - Membrane Puncture by Sharp Objects/Debris

Salinity Increase Due to Damage of Membrane Components

- Typical Membrane Damages Include:
 - Leaking O-rings
 - Cracked Membrane Tubes
 - Telescoping
 - Punctured Membranes
 - Centerfold Cracking



Leaking O-rings

- Detected through Direct Observation or Inspection
- O-rings May Leak After Exposure to Certain Chemicals or Due to Water Hammer
- Leakage May Occur from Inappropriate Installation and their Displacement
- If O-ring Breaks During Operation, It Usually Happens at the Front End of the Housing Where Most of the Movement Occurs

Membrane Telescoping

- Caused by Excessive Pressure Drop from Feed to Concentrate
- Severe Telescoping Ruptures the Glue Line of the Membranes
- Most Commonly Occurs When Pressure Pump is Started before a Drained RO System Has the Time to Fill Up – To Avoid it the Throttling Valve of the Feed Pump Should be Opened Slowly.

Bursting of Permeate Line

- Occurs When the RO System is Operating with Closed Permeate Valve
- If Valve is Closed, Permeate Pressure Increases Until it Equals Feed Pressure and Then the Permeate Pipe Bursts
- To Avoid This Problem RO Systems Are Designed Not to Allow Permeate Pressure to Exceed 1.5 bars – Automatic High Pressure Shut Down Switch is Installed on the Permeate Line Valve
- The Best Approach is to Avoid Installation of Isolation Valves on the Permeate Line

Membrane Cracking at Center Tube Connection (Centerfold Cracking)

- The Salt Passage Increases with or w/o Increase in Permeate Flow
- Caused by:
 - Hydraulic Shock During Start Up
 - Too Fast Increase in Feed Pressure
 - Abrasion by Scaling & Fouling
 - Permeate Back Pressure
- Centerfold Cracking Occurs Only After at Least One Year of Operation and Only in Systems with High Start & Stop Frequency

Increase In Permeate Conductivity/Salt Passage

Diagnostics

- Check Feed Seawater ORP/Temperature
- Prepare Conductivity Profiles to Find Problem Vessels
- Compare With Historical Data of That Train and Others

➤ Potential Solutions:

- Replace Brine Seals or O-rings – If Damaged
- Replace RO Membranes – If Oxidized
- Conduct CIP – If Fouling is the Prime Cause

Controlling Oxidants in Seawater

- Most-stable Sodium Bisulfite (SBS) Solution – 40 %
- 3.66 ppm of Sodium Bisulfite Needed to Neutralize 1 ppm of Free Chlorine
- Add After Cartridge Filters & Before Antiscalant Injection Point (Some Antiscalants are Oxidized by Free Chlorine)
- Watch Out for:
 - Ammonia/Bromamines in the Source Water
 - Content of Mn in Ferric coagulant

Manganese-Triggered RO Membrane Oxidation

- Challenge: Mn above 5 $\mu\text{g/L}$ in RO Feed Creates Oxidative Compounds – Membrane Rejection is Reduced. Process is Accelerated when Feeding SBS.
- Solutions:
 - Use Ferric Sulfate instead of Ferric Chloride because of its lower content of Mn;
 - If Ferric Sulfate is not available request FeCl vendor to supply product with content of Mn < 5 $\mu\text{g/L}$;
 - Reduce Sodium Bisulfite Dosage.

Chlorine Self-Generation in RO Membrane

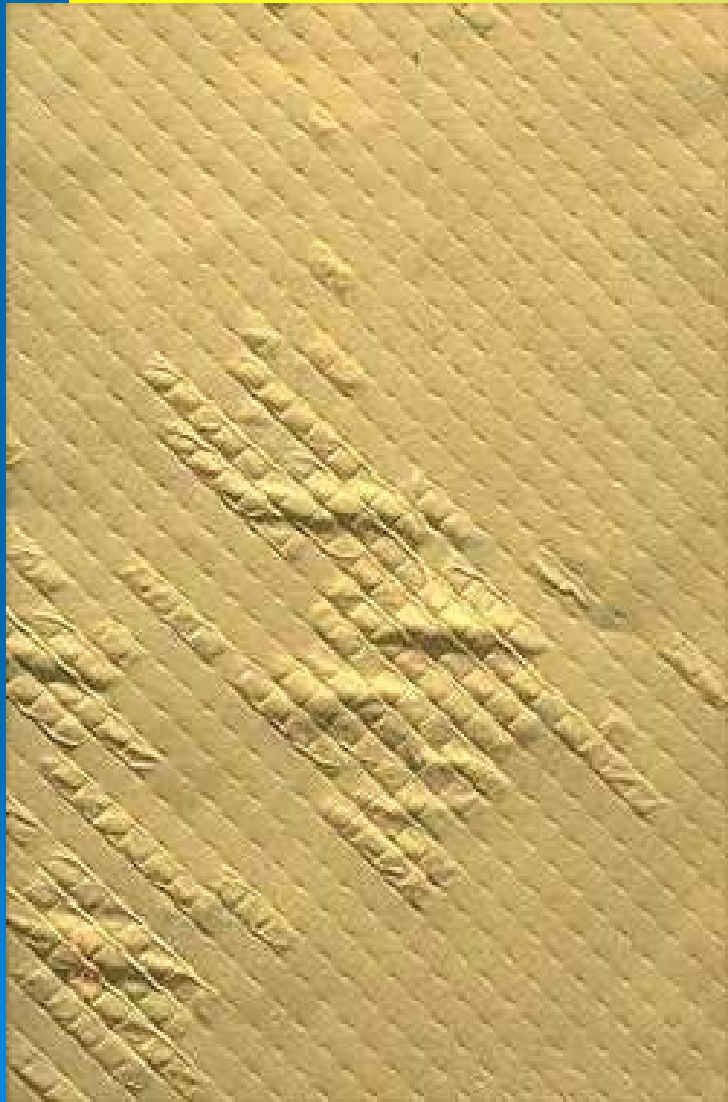
➤ Challenge: Metals Catalyzing Chlorine Generation in RO Membranes -

- Copper > 50 µg/L
- Nickel > 100 µg/L
- Titanium > 20 µg/L

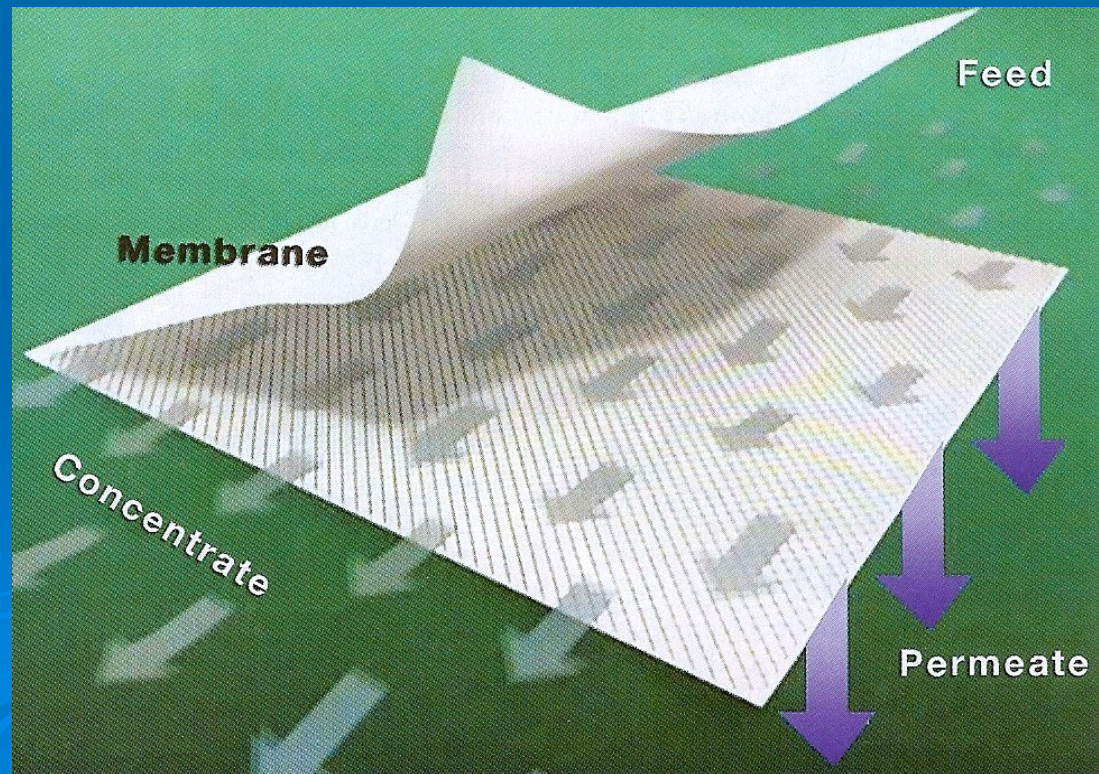
➤ Solutions:

1. Eliminate the Source/s of Metals in the RO Feed Water (Contaminated Seawater/MSF Cooling Water or Chemical Impurities)

Controlling Membrane Delamination – Caused by Excessive Permeate Back-pressure



Maintain Permeate Backpressure
Pressure Lower than Concentrate
Pressure by At Least
0.3 bar (5 psi) At All Times



Preventing Membrane Damage

- Challenge: Membrane Breakage/Collapse or Membrane Telescoping Caused by:
 - Hydraulic Surge
 - Heavy Fouling
- Solutions
 - Provide/Maintain Surge Protection Devices on RO Feed Pipes: Pressure Relief Valves & Rupture Disks
 - Do Not Allow dP to Increase Beyond 4 bars
 - Limit RO Feed Pressure to 70 bars

Monitoring & Troubleshooting

The “Golden” Rules:

1. Do Not Take Chances – Monitor Water Quality & Performance Daily!
2. Biofouling Is Typically the Cause of Most SWRO System Problems!
3. Involve Equipment Suppliers In the Selection of Coagulants, Antiscalants and Cleaning Chemicals!

Questions?

