

RO Training Course



Cleaning RO and NF Membrane Elements

Overview

- Introductory Remarks
- When to Clean
- Cleaning Method Selection
- Defining a Foulant and Scalant
- pH and Temperature Limits
- FT30 Resistance to Cleaning Agents
- Cleaning Carbonate Scaling
- Cleaning Sulfate Scaling

Overview (cont.)

- Cleaning Organic Fouling
- Cleaning Biological Fouling
- Cleaning Iron Fouling
- Cleaning Silt Fouling
- Cleaning Carbon Fouling
- Chemical Attack
- Permeate Back Pressure
- The Cleaning Process
- Safety

Cleaning Introductory Remarks

- Cleaning is a means of removing mineral scale, organic matter, biological growth, colloidal particles, or insoluble constituents which build up on the surface of the membrane
- Frequent cleaning should not be required for a properly designed and operated RO/NF system
- Membranes may become fouled or scaled due to improper operation or change in feedwater quality

Cleaning Introductory Remarks

(cont.)

- Membranes' elements can be cleaned effectively because:
 - chemical stability
 - broad pH tolerance
 - high temperature limits
- Elements with oxidized membrane or mechanical damage must be replaced

When to Clean

- Normalized flow declines by 10%
- Pressure drop increases by 15%
- Normalized salt passage increases by 5%*

***Dependent on individual system design**

Cleaning Regimen based on System Performance and Water Chemistry

- A wrong choice can aggravate a scaling/fouling problem
- Acids for scaling
- Alkaline for biological fouling
- Alkaline with detergent for organic fouling
- Frequently both alkaline and acid cleanings are required

Characterizing Foulant or Scalant

- Analyze the normalized plant performance
- Analyze feed water quality
- Check performance after previous cleanings
- Analyze cartridge/SDI filter residue

Characterizing Foulant or Scalant

- Inspect lead element and feed scroll end for suspended solids fouling
- Inspect scroll of tail element for scaling
- Clean and analyze cleaning solutions (control samples required)
- Destructive autopsy

pH Range and Temperature Limits During Cleaning

	Max Temp 50°C pH Range	Max Temp 35°C pH Range	Max Temp 30°C pH Range
SW ₃₀ /SW ₃₀ HR	3 - 10	2 - 11	2 - 11.5
BW ₃₀ /TW ₃₀	2 - 10	1 - 11	1 - 11.5
NF ₄₅	3 - 10	2 - 11	2 - 11
NF ₇₀	3 - 10	2 - 11	1 - 11.5
NF ₉₀	3 - 10	2 - 11	1 - 11.5

FT30 Cleaning Agents

<u>Agent</u>	<u>% Concentration</u>	<u>Resistance</u>
Hydrochloric Acid*	0.2	Excellent
Na-EDTA*	1.0	Excellent
Sodium Hydroxide*	0.1	Excellent
Nitric Acid	5.0	Excellent
Acetic Acid	5.0	Excellent
Boric Acid	5.0	Excellent
Phosphoric Acid	0.5	Excellent
Sodium Salt of Dodecylsulfate (DSS or Lauryl Sulfate)	0.05	Excellent
Sodium Hydrosulfite	1.0	Excellent
Trisodium Phosphate (TSP)	2.0	Excellent
Sodium Triphosphate (STP)	2.0	Excellent

***Most common agents used**

Carbonate Scaling

- Causes:
 - High Hardness
 - High pH
 - High alkalinity
 - High recovery rates
- Symptoms:
 - Heavy element
 - Low permeate flow
 - Poor salt rejection
 - High pressure drop

Carbonate Scaling (cont.)

- Cleaning
 - 0.2% (Wt) hydrochloric acid, HCl
 - 0.5% (Wt) phosphoric acid, H_3PO_4
 - 0.2% (Wt) sulfamic acid, $\text{NH}_2\text{SO}_3\text{H}$

Sulfate Scaling

- Causes
 - Exceeding solubility limits
 - Loss of antiscalant
 - High recovery rates (Means increase saturation level than solubility product)
- Symptoms
 - Heavy element
 - Low permeate flow
 - Poor salt rejection
 - High pressure drop

Sulfate Scaling (cont.)

- Cleaning
 - Very difficult to clean
 - 2.0(Wt)% Na-EDTA and 0.1(Wt)% NaOH at pH12, 30°C maximum
 - Overnight soak/recirculation may be necessary--
reaction slow

Biological/Organic Fouling

- Causes
 - Improper membrane preservation
 - Biological/Organic material in feedwater
 - Improper carbon bed maintenance
- Symptoms
 - Odor
 - Moldy or discolored scroll end
 - Low permeate flow
 - High salt rejection
 - High pressure drop

Biological/Organic Fouling (cont.)

- Cleaning (best solution)
 - 0.5% - 1.0%(Wt) Na-EDTA and 0.1%(Wt) NaOH
 - At pH 12 and $< 30^{\circ}\text{C}$ (86°F)
- Cleaning (alternate solutions)
 - 0.1% (Wt) NaOH and .05% Na-DSS at pH 12 and $< 30^{\circ}\text{C}$ (86°F)
 - 1.0% (Wt) STP and 1.0% (Wt) Na-EDTA or
1.0% (Wt) TSP and 1.0% (Wt) Na-EDTA

Iron Fouling

- Causes

- Rusty well casings or piping
- Air with greater than 0.1 ppm Fe in feedwater

- Symptoms

- Rust coloring on scroll end or ATD*
- Rusty colored concentrate upon start-up
- Low permeate flow
- Poor salt rejection

***Anti-telescoping device**

Iron Fouling (cont.)

- Cleaning Solutions
 - 1.0% (Wt) sodium hydrosulfite (best) $\text{Na}_2\text{S}_2\text{O}_4$
 - 2.0% Citric acid (Alternative)
 - 0.5% (Wt) phosphoric acid H_3PO_4
 - 0.2% (Wt) hydrochloric acid HCL

Silt Fouling

- Causes
 - Turbid surface waters
 - High suspended solids
 - Inadequate pretreatment
- Symptoms
 - Dirty feed scroll end
 - Low permeate flow/poor salt rejection
 - High permeate flow/very poor salt rejection
 - Heavy element

Silt Fouling (cont.)

- Cleaning
 - Difficult to clean
 - Caustic and Na-EDTA
 - Proprietary Detergents

Carbon Fouling

- Causes

- Incorrect backwash and rinse rates resulting in inadequate flushing of carbon bed
- Soft carbon

- Symptoms

- Black deposits on scroll end
- Low permeate flow (early stage)
- Poor salt rejection

Carbon Fouling (cont.)

- Cleaning
 - Very difficult to clean
 - Proprietary Detergents

Chemical Attack

- Causes

- Incomplete dechlorination (oxidation)
- Exposure to strong oxidants (i.e., permanganate)
- Prolonged exposure to pH extremes

- Symptoms

- Very high permeate flow
- Very poor salt rejection

Damage irreversible, elements must be replaced

Permeate Backpressure Damage

- Causes

- Mechanical failure in system
- Inappropriate design
- Operation error

- Symptoms

- High permeate flow and very poor rejection

- Evidence

- Wrinkles in membrane near back glue line

Damage irreversible, elements must be replaced

Cleaning Process Steps

- Mix cleaning solution
- Low flow pumping (low psi)
- Recycle
- Soak
- High flow pumping (low psi)
- Flush out

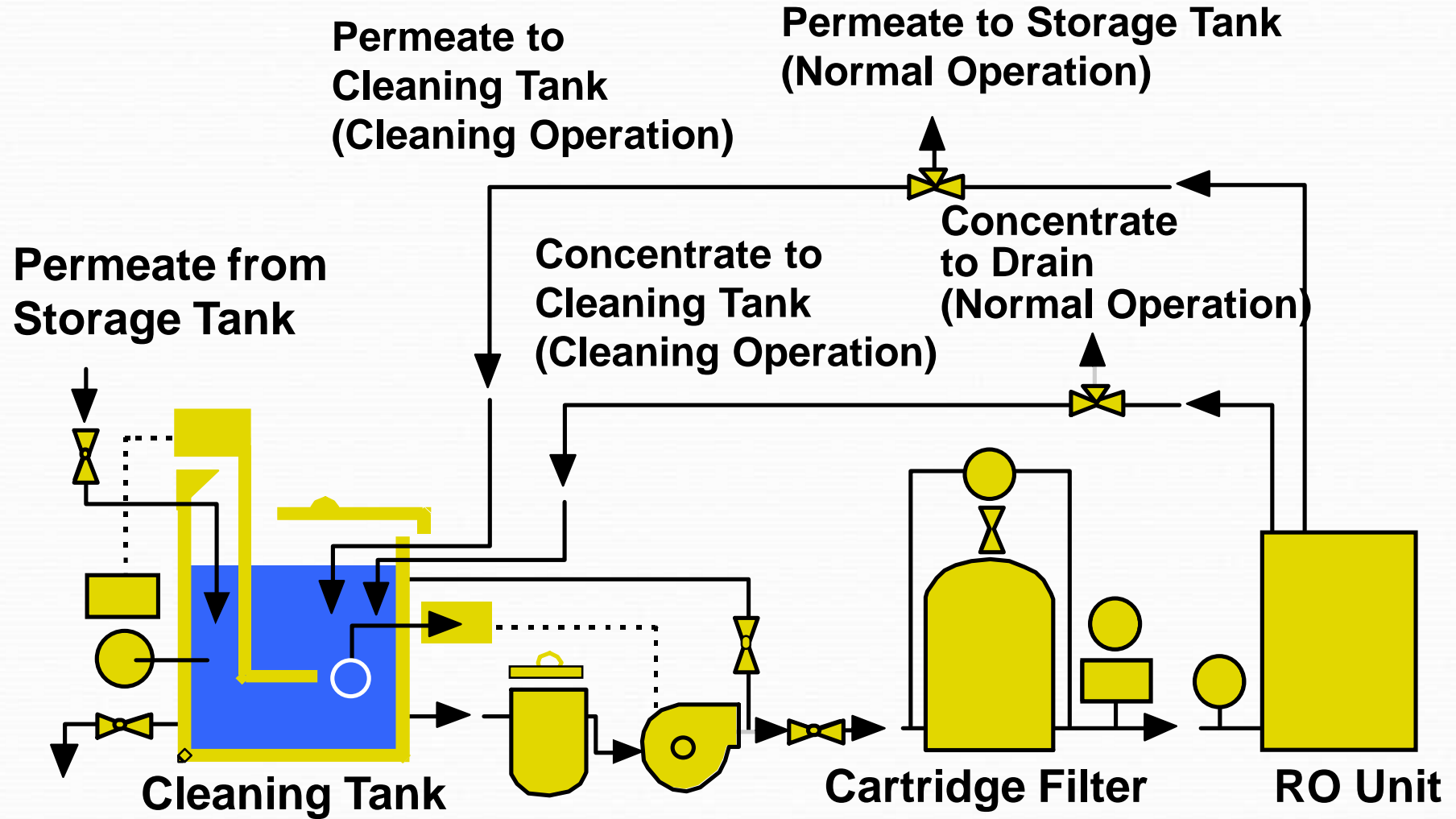
Use permeate for solutions and flush

Recommend Feed Flow Rate Per Pressure Vessel

Element Diameter inches	Feed Pressure* (psig)	Feed Flow Rate gpm
2.5	20-60	3-5
4	20-60	8-10
6	20-60	16-20
8	20-60	30-40

***Dependent on number of elements in pressure vessel**

Cleaning System



Safety

- Review MSDS documents
- Use protective equipment: goggles, gloves and clothing
- Vent tanks and/or cleaning area
- Assure chemical compatibility with system hardware
- Dispose of spent solutions and chemicals accordance with local regulations
- Properly mix chemicals (i.e., acid into water, etc.)



Open Question



Thank you for your attention