Ultrafilter System
Operating Manual

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Customer Responsibilities

1. Insure that all involved personnel have read and understand this Operating Manual, and have been properly trained, either by Parker Process Advanced Filtration (PAF), or personnel trained by PAF.

2. Maintain records of serial numbers, installation date and position, startup output, daily pressure and individual outputs, bag filter pressure and changing data, and UF cleaning data.

3. Notify PAF immediately of any problems or warranty claims.

4. Maintain operating parameters within PAF specified limits, using PAF's recommended or authorized procedures, and maintain paint bath parameters within recommended limits.

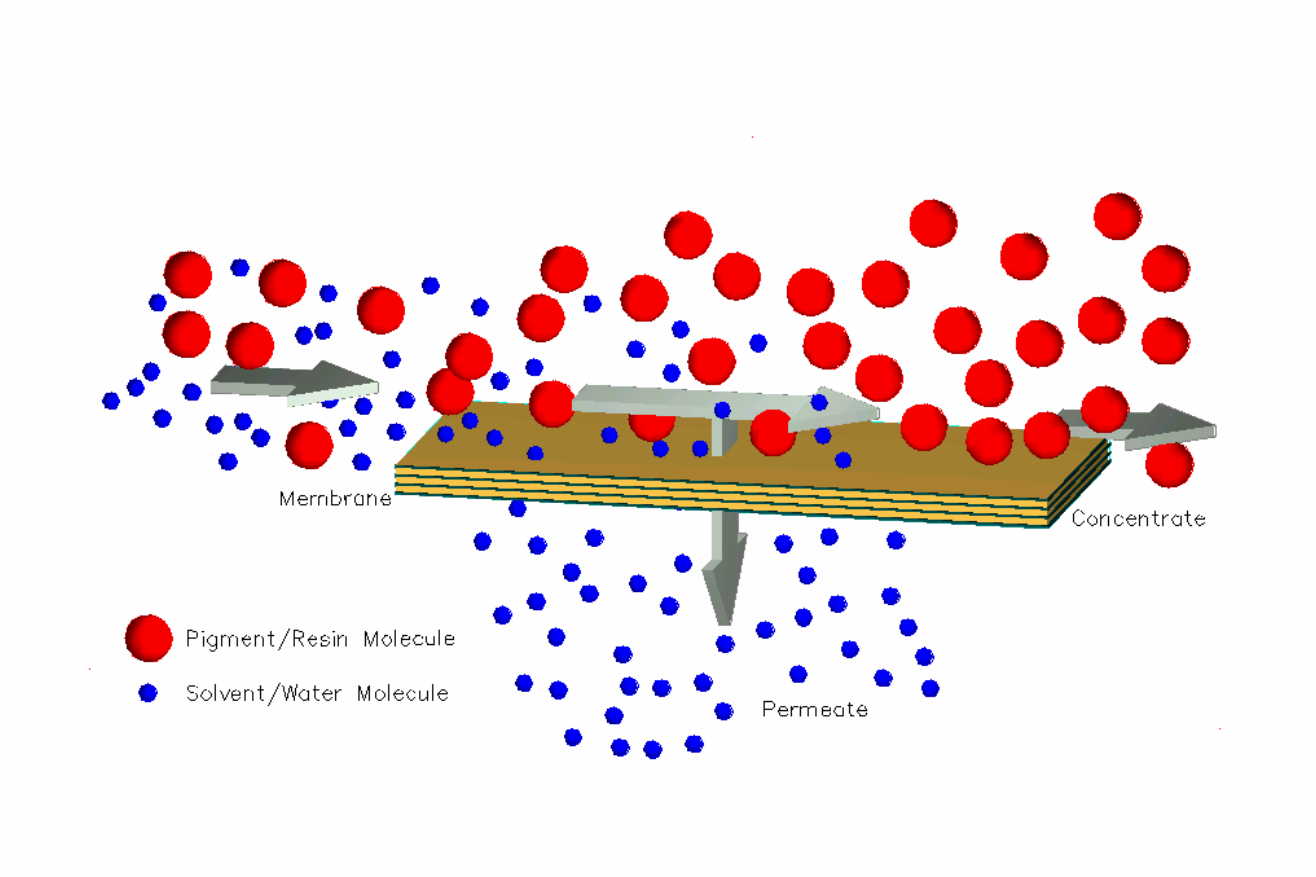
5. Proper authorization, paperwork (including MSDS of paint), and packaging must accompany a cleaned element returned for autopsy and subsequent warranty disposition.

Section 2: Introduction

Ultrafiltration

Ultrafiltration is a pressure-driven membrane process being capable of separating solution components on the basis of molecular size and shape. Under an applied pressure difference across an ultrafiltration membrane, solvent and small solute species pass through the membrane and are collected as permeate while larger solute species are retained by the membrane and recovered as a concentrated retentate.

In electrocoat paint systems, the ultrafiltration permeate contains water and paint solubilizers. The permeate is used in the paint line rinse section. This recycling method provides a closed loop rinse system for recovering paint solids (drag-out). The permeate can also be diverted to drain to reduce conductivity of the paint.



Glossary

Anionic or Anodic Paint	A negatively charged paint that will deposit a film on the anode (part) in an Anodic electrocoat system.
Anode	A positively charged electrode.
ATD (Anti-Telescoping Device)	A spoke-like device that fits on each end of the spiral membrane.
Cathode	A negatively charged electrode.
Cationic or Cathodic Paint	A positively charged paint that will deposit a film on the cathode (part) in a Cathodic electrocoat system.
Closed-Loop Rinse	An auxillary portion of an electrocoat system that uses permeate extracted from the paint with UF to rinse coated parts and recover dragged out paint.
Concentrate	Also known as retentate, is the material that does not pass through the membrane, that leave the UF more concentrated than the feed because the permeate has been removed.
Deionized (DI) Water	Pure Water produced by chemically exchanging contaminant ions for good ion that make up H2O. See also RO water.
EDUF Membrane	An spiral membrane or element used for electrocoat.
Electrocoat	An electrochemical process where a voltage is applied across two electrodes, immersed in a solution containing organic material. The organic material migrates to one of the electrodes and depositss a film on that electrode.
Fouling	Unwanted obstruction of the passage of permeate through the membrane, and/or the passage of the paint through the flow channels of the membrane element, caused by contaminants, insoluble or agglomerated paint, or by bacteria.
Flux	Rate of permeation, usually expressed as GFD (gallons per square foot of membrane area per day).
Membrane Separation Process	A process using a semipermeable membrane to make a separation of different size molecules.
Module	A housing to contain a spiral element.
Permeable	Porous to passage or penetration by fluids

Permeate	The fluid substance (water, solubilizers and dissolved material) passed through the membrane, separated from the paint bath.
RO Water	Pure water produced by a Reverse Osmosis System which uses membranes to pass virtually only small H2O molecules.
Semipermeable	The material that allows the passage of smaller molecules but blocks the passage of larger ones
Solubilizer	Paint additive that imparts an electrical charge to the paint that keeps the paint solids suspended in water by repelling each other.
Ultrafilter	A membrane device used to mechanically separate liquid components based on their size.
Ultrafiltrate	A synonym for "permeate"
Ultrafiltration (UF)	A process for separating smaller materials from larger materials by passage through microporous or semipermeable membranes.

Section 3: Installation

(Use assembly drawing in rear of manual for reference)

Netted Membrane Installation Instructions

1. Close all cartridge isolation valves, from each position that will be loaded.

2. Remove the flow meter assembly and top cap. Check for and remove any foreign material.

3. If available, fill each housing approximately 1/2 full with DI or RO water, to aid in lowering the element into the housing.

4. Install new O-rings on the top cap permeate tube and the bottom plug, unless provided.

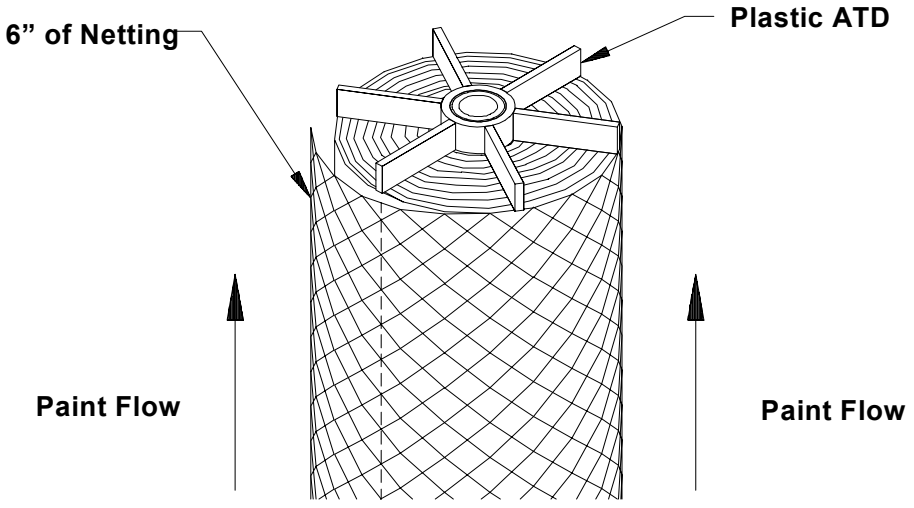
5. Remove the element from the shipping carton and plastic bag, record the serial number and position on the log sheet and housing label.

6. Insert the bottom plug into the element, this is the end with the plastic ATD. Remove and discard tape from the element.

7. Lift and attempt to install the element as is into the housing, bottom plug end first, guiding the element in with a circular motion to make sure the mesh does not roll. If the element is too large, trim six inches off the netting. Repeat the process until the element fits snugly into the housing. (Figure 3.0)

8. Insert the top cap permeate tube into the top of the element. Re-install the victaulic fittings making sure they are properly lined up.

Figure 3.0



Sealed Membrane Installation Instructions

1. Close all cartridge isolation valves for each position that will be loaded.

2. Remove the flow meter assembly and top cap. Check and remove any foreign debris that may be in housings.

3. If available, fill each housing approximately 1/2 full with DI or RO water, to aid in lowering the element into housing.

4. Install new O-rings on the top cap permeate tube and the bottom plug, unless provided.

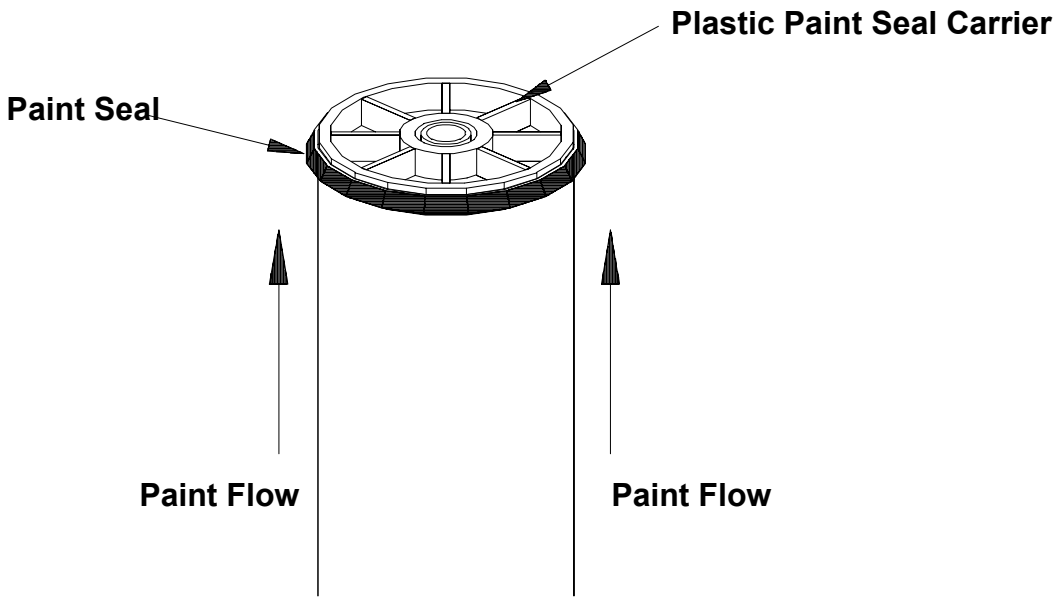
5. Remove the element from the shipping carton and plastic bag, record the serial number and system position on the log sheet. Record date a serial number on each housing label also.

6. Insert the bottom plug into the element, opposite end of the seal. Also ensure that the seal opening faces the paint flow (Figure 3.1).

7. Lift and install the element into the housing, bottom plus end first and guide the element in making sure that the paint seal does not roll out of the ATD groove or flip upward.

8. Insert the top cap permeate tube into the top of the element, install and tighten the bolts on victaulic clamp.

Figure 3.1



Section 4: System Start Up

Preliminary Checks

1. Visually check the system for damage

2. Check all services to the system to ensure they are properly connected.

3. Check all valves in the paint and permeate system for proper operation and tighten all unions.

4. Check cleaning pump for proper rotation. Flush system with D.I. water for leak testing.

Precautions

1. Never start the paint feed pump without first closing the system paint inlet valve. Throttling will prevent the membranes from being shocked by an excessive flow/pressure surge.

2. Never start the cleaning pump without first closing pump discharge valve.

3. Membrane must never be allowed to dry out. The elements must remain filled with either DI or RO water or permeate if the system is shut down. If allowed to dry-out it will permanently damage the membrane. (See Storage)

4. No anti-foaming agents of any type are to be introduced into the PAF UF system.

5. No silicone-based materials (waterproofing sprays, lubricating fluids or greases, etc.) are to be used in or around the PAF UF system. Using these materials in any amount will cause complete and irreversible membrane fouling and paint cratering.

6. Provisions must be made for properly venting the system during shutdown procedures and draining to avoid back pressure or vacuum. Excessive back pressure or vacuum will delaminate the element.

7. Minimize the time the system is under "low flow" conditions. These are periods when by-pass valves are open or circulating pumps are not running.

8. When starting up new paint systems, the bath charging components should all be added, and recirculate at least 8 hours to allow the equilibration of the paint, before introducing paint to the ultrafilter system. Otherwise, premature fouling of the membranes may occur.

4.3 Membrane Preparation Procedure

Prior to starting new membranes on paint, they must be properly prepared to ensure proper operation. The recommended procedure is as follows:

1. Open valve on the DI or RO water inlet to tank, and fill the cleaning tank with fresh DI or RO water. Make sure the tank drain valve is closed. Close inlet valve when the cleaning tank is full.

2. Make sure the following valves are closed.

   Paint return butterfly valve
   Paint feed butterfly valve
   Paint return isolation valve
   Paint feed isolation valve
   Permeate to rinse valve
   Permeate to drain valve
   CIP drain valve
   Paint purge / CIP to drain valve

3. Open the following valves.

   Permeate to CIP valve
   Permeate to tank valve
   CIP return isolation valve
   CIP feed isolation valve
   CIP tank isolation valve

4. Start the cleaning pump. **Slowly** open the cleaning pump discharge valve.

5. Adjust cleaning pump discharge valve to regulate the pressure profile to 25 PSI In, and 0 PSI Out.

6. Circulate the DI or RO water through the system for 10 minutes.

7. Drain and refill the CIP tank with fresh DI or RO water and circulate for another 10 minutes. Repeat this step two times.

8. Leave DI or RO water in the system and close all cleaning and isolation valves. Allow the elements to soak in the DI or RO water until the system is put on line. (NOTE: If the system will not be put on line for more than two weeks after this procedure, use the long term storage procedures outlined in Section 6 - 1.)

4.4 System Start Up Procedure

After the installation and assembly of the elements/housings and the recommended DI or RO water flushes, the system is ready for start up. Follow the procedure listed below to bring the PAF UF system on-line:

1. Close the following valves.

   CIP feed isolation valve
   CIP return isolation valve
   CIP drain valve
   CIP tank drain valve
   Paint purge / CIP to drain valve
   Permeate to tank valve

2. Open the following valves.

   Permeate to drain valve
   Permeate to CIP valve
   Paint return isolation valve
   Paint feed isolation valve

3. Open the paint return valve on the PAF system manifold.

4. Start the paint feed pump.

5. **SLOWLY** open the paint supply valve on the PAF manifold.

6. Adjust the paint supply and return valves to obtain the optimum pressure profile of 50 PSI inlet pressure and 20 PSI outlet pressure (or a Delta P of 25-35 PSI).

7. Check the pressure on the supply line to see if the adjustment on the return line affected the supply pressure. You may have to adjust both valves a few times to balance the system.

8. After system has been operating for a short period slowly close permeate to tank valve while opening permeate to rinse.

At this time the start up procedure is complete. Periodically check the pressure profile to ensure that nothing has changed since start up. If the profile has dropped considerably, check the valve setting for proper adjustment. Also check the output from the paint feed pump. Check the prefilters (bag filter) pressures in front of the system. The bags may need to be replaced.

Section 5: Maintenance

Ultrafilter maintenance ultimately refers to decline of the flux rate and the recovery procedure. Several factors in the normal operation of the E/Coat system can affect the permeate output from UF membranes: paint type, percentage of solids, temperature, conductivity, pH, paint flow to the UF, inlet pressure to the UF, pressure profile/drop and "drag-in" contamination from pre-treatment, just to mention a few. Because the number of variables affecting the proper performance of the UF system, ***it is important that a detailed log be kept and maintained on a regular basis).*** This will ensure that potential problems can possible be avoided and the cause of flux decline be pinpointed more accurately and eliminated as a potential or recurring problem.

After start up, the UF flux rate will decline to a steady-state flow within an hour or so.. This steady-state flow will be considered the baseline for your system. When the system declines to 70% of the steady-state flow, it is time to clean it. **A delay in cleaning can lead to irreversible fouling from which recovery is improbable!**

Note: Paint should NEVER be allowed to stand idle in any element(s). If an unplanned shutdown occurs, immediately drain and flush the system with fresh D.I. or R.O. water (permeate if available) and institute a chemical cleaning procedure before leaving the system shutdown for any period of time.

Known Causes of Flux Decline

Under some circumstances, flux rate decreases more rapidly than expected. Some causes of unsatisfactory performance are described below:

Paint Fouling

Paint fouling is by far the number one source of abnormal flux decline. Paint fouling occurs when the stability or solubility of the paint allows agglomeration of the paint particles to occur, and the membrane surface becomes obstructed with these 'gummy' agglomerates. Agglomerates obstruct or 'foul' the membrane from allowing permeate to pass through the membrane.

Healthy paint consists of dispersed paint particles that carry optimum electrical charges to repel each particle from others, which inhibits the formation of agglomerates. Unstable paint loses these electrical charges by one or more of the following conditions:

- Inadequate solubilizer levels causing the paint pH to move out of range
- Contaminants (such as iron) reacting with the solubilizer or paint
- Bacteria consuming the solubilizer or otherwise disturbing the paint solubility

- Flow rates too low to sweep away the fouling layer at the surface of the membrane
- Severely low flow rates resulting in settling, loss of electrical charge, and agglomeration
- Improperly introduced replenishment feed material
- Introduction of occluded air into the paint, through vortexing at the pump, etc.

Paint stability, solubility, and general health is key to maintaining UF performance. If you experience declines in output due to paint stability problems, contact your paint supplier for assistance.

At low flow rates, the rate of fouling may be greater and cleanings become more frequent. Care should be taken to maintain the recommended flow rate for your particular system. On paint, you must maintain a pressure differential of 25-35 psi, with a minimum outlet pressure of 15 PSI.

When an unplanned shutdown occurs, paint must not stand idle in the UF system. If allowed to stand idle for too long of a period, the membranes may become fouled beyond recovery. Care should be taken when an unplanned shutdown occurs to immediately drain and flush the paint form the UF system. (Follow the procedure outlined in Maintenance: Section 5 of this manual.)

When resin, pigment, solvents or solubilizers are added to the paint, they should be added slowly and the paint suppliers recommendations closely observed. These additions should not be made near the intake of the UF pump.

Incompatible Chemicals

- Chemicals which are hydrophobes, such as silicones and some surfactants, will block water transport through the membrane and should be avoided
- Chemicals which are destructive to membrane components should be avoided, including:
    - Ketone solvents
    - Ester solvents, including Glycol Ether Esters
    - Aromatic solvents
    - Chlorinated solvents
    - Strong oxidizers or inorganic acids

Cleaning Procedures

Formulas For Cationic (Cathodic) Paints			
	Purpose	**Circ. Time**	**Formulation**
CC-1	Normal paint fouling	1-2 hours 90 - 120°F	• 91.9% DI or RO Water • 3.0% Butyl Cellosolve • 5.0% Acetic Acid • 0.1% Citric Sol'n ***
CC-2	Cleaning to recover from severe paint fouling	2-4 hours 90 - 120°F Last 30 min only>	• 93.8% DI or RO Water • 3.0% Butyl Cellosolve • 3.0% Formic Acid • 0.1% Citric Sol'n*** • 0.1% Triton X-100

Proprietary	**OK To Use ***	**Proprietary**	**Do Not Use**
Gage	532 or 534	Gage	690 or 699
GM	UF Cleaner	Henkel	2225 or 2229
Henkel	2224	Koch	CPC-6
PPG	Chemkleen 39C or F	Synder	Power Flux
Prochem	EDP UF Cleaner	Yonar	Filter Cleaner 1

Formulas For Anionic (Anodic) Paints			
AC-1	Mild fouling or preventive maintenance	1-2 hours	• 99.8% Permeate • 0.2% Solubilizing Amine**
AC-2	Severe paint fouling	2-4 hours	• 89.7% Permeate • 10.0% Butyl Cellosolve • 0.3% Solubilizing Amine**

* At recommended dilution only - pH not to be below 2.0

** Amine to be specified by paint supplier - ph not to be above 10.5

*** Citric Acid Solution - 50% by weight powdered Citric Acid in DI Water

Triton-X-100 is a product of Union Carbide

Note: Acids for cathodic cleaning may be substituted - 2.5% Formic, or 2.5% Synthetic or Distilled Natural Lactic, 2.5% Phosphoric, or 5% Acetic

Chemicals not to be used: Inorganic acids, Ketone solvents, Ester Solvents, Chlorinated Solvents, Aromatic Solvents

Cleaning Formulas For Special Conditions			
	Purpose	**Circ. Time**	**Formulation**
SPL-1*	For lead phosphate fouling in Cathodic Paints Only	30 min, Max.	• 0.5% Nitric Acid • 99.5% DI or RO Water
SPL-2*	For iron fouling in Cathodic Paints Only	30 min, Max.	• 96.0% DI or RO Water • 4.0% Citric Sol'n ***
SPL-3*	For Bacterial / Biotic Fouling	1 - 2 hours	• 99.99% DI or RO Water • 0.01% Chlorox 5.25% • Adj. pH to 10-10.5 with Caustic Soda
SPL-4*	For Bacterial / Biotic Fouling	1 - 2 hours	• 99.95% DI or RO Water • 0.05% Hydrogen Peroxide - 37%

* All Special Cleaning must be preceded by a cleaning to remove paint fouling

*** Citric Acid Solution - 50% by weight powdered Citric Acid in DI Water

Recommended Cleaning Procedure

1. Fill cleaning tank with permeate or RO or DI water.

2. Close the following valves of the housing to be cleaned, in this order:

   Paint Feed Isolation Valve
   Paint Return Isolation Valve
   Permeate to Rinse Valve

Drain and Purge

1. Open the following valves and drain the paint from the system:

   Permeate to CIP Valve
   Permeate to Tank Valve
   CIP Feed Isolation Valve
   CIP Return Isolation Valve
   Paint Purge / CIP to Drain valve

2. Start the cleaning pump and slowly open pump discharge valve . Watch the cleaning tank level.

3. Stop the cleaning pump when the cleaning tank level is about 2 to 3 inches from bottom.

4. Close paint purge and cleaning pump discharge valves.

DI or RO Water Rinse

1. Open the following valves:

   Permeate to CIP Valve
   Permeate to CIP Tank Valve
   CIP Feed Isolation Valve
   CIP Return Isolation Valve
   CIP Tank Isolation Valve

2. Open DI or RO Water Supply Valve, and fill cleaning tank with DI or RO water. Close valve when cleaning tank is full.

3. Start the cleaning pump and slowly open CIP Pump Discharge Valve. Circulate the DI or RO flush through the element to the cleaning tank for 5 minutes. Dump and repeat if necessary with clean DI or RO water until the water is clear returning to the cleaning tank.

4. An alternative way to flush paint from the element until the flush water is clear is to follow step 1 above, providing your system has the appropriate valves and piping. Open the Paint Purge / CIP to Drain Valve. Slowly open the DI or RO Flush Valve, and flush the element to drain until the flush water is clear. You must be able to see the flush water in order to follow this alternative procedure.

Cleaning

1. To the DI or RO water circulating through the element back to the CIP tank, add the recommended cleaner to the cleaning tank (do not reuse cleaning solutions). Circulate with the cleaning solution for the prescribed time outlined in the cleaning formula table, with the pressure profile at 25 PSI In, and 0 PSI Out (Return valve open).

2. At the end of the cleaning time, slowly close the CIP Pump Discharge Valve and stop the cleaning pump.

Drain and Refill Tank

1. Open the CIP Tank Drain Valve, and the CIP Drain Valve, to drain the cleaning tank and element. Close valves when the cleaning tank is empty. Open the DI or RO Water Supply Valve to fill cleaning tank. Close valve when the cleaning tank is full.

Circulation DI or RO Rinse and Drain

1. With cleaning tank full, start the cleaning pump and slowly open discharge valve . Circulate the DI or RO Water for 15 minutes. Slowly close valve and stop the pump. Open valves to drain the element and CIP tank.

Cleaning Complete

1. Close the following valves:

    CIP Tank Drain
    CIP Drain Valve
    CIP Return Isolation Valve
    CIP Feed Isolation Valve

Return to Paint

1. To go back on paint, slowly open the following valves, in the order outlined below:

   Paint Return Isolation Valve
   Paint Feed Isolation Valve

2. After the element has been on paint for 10-15 minutes, **slowly** open the Permeate to Rinse Valve, while **slowly** closing the Permeate to CIP Valve. Check and record the permeate flux rates after the element has been on-line for hour.

Section 6: Storage Instructions

New Elements

In all cases, the element of the housing/element combination will be shipped in a sealed bag with a preservative solution applied to the membrane surface area. This solution allows for element storage up to one year at a temperature between 40º F and 100º F. After one year of storage, PAF cannot insure normal membrane performance.

The shipping container should be checked immediately upon receipt to ensure its integrity. Should it be damaged and leaking preservative solution, immediately seal the tear in the plastic bag with a hot iron or similar device and store it in your conventional manner. What has leaked out in shipping is excess preservative and its loss will not affect the membrane, when the sealed bags are intact. Under no circumstances should you replace the solution with water as this will encourage microbial growth that is detrimental to the membrane.

The preservative solution contains the following:

Ingredient	Composition
Glycerin	47.7%
RO Water	47.7%
Proprionic Acid	3.8%
Caustic Soda	0.8%

Use personal protective equipment (i.e., gloves, apron, protective glasses, etc.) when handling these elements.

Long Term Storage

If it becomes necessary to store the system for an extended period of time, such as during a plant shutdown, the following procedure(s) should be followed:

Clean the system as outlined in section 5.2, and flush the cleaning solution from the system with DI or RO Water. Refill or leave it filled as listed below:

If system is to be shutdown for 1 - 7 days, refill with permeate or leave filled with DI or RO Water.

If system is to be shutdown for longer than 8 days, and personnel will be available, the DI or RO Water should be exchanged weekly to avoid bacteria growth.

If system will be shut down for more than 30 days, or if plant personnel will not be available to exchange the DI or RO Water, a bacteriocide should be added to the system. Contact paint supplier or PAF for specific recommendations.

7: Troubleshooting

There are generally three categories of problems that can occur with UF membranes:

- Fouling (and obstruction) - the most common problem
- Paint in the permeate
- Physical damage or visible deterioration

These problems can appear slowly over time, with a sudden onset, or confusing variable up and down activity. Recognizing all of the circumstances involved with a problem occurrence helps to identify the cause(s). Good record keeping is a key to identifying the source of most of these problems. Startup problems are usually different in nature than those occurring later.

FOULING

Fouling with paint and/or bacteria accounts for 95% of all of the problems reported by UF customers. It is often (and wrongly) considered a membrane failure, but actually the fouling layer obstructs the passage of permeate through the membrane, resulting in decreased permeate output.

Fouling is a condition that can be avoided most of the time by proper operating procedures, proper system design, and maintanence of oPAFmum paint bath chemistry and UF system parameters. See Section 5.1 for more information on fouling.

Fouling can only be treated by chemical cleaning with the proper formulations, and even then cleaning is not always successful. Severe and untreated fouling can be irreversible in worst case situations.

OBSTRUCTION

Obstruction can occur in piping or at the inlet or outlet face of the membane. Dried or hard settled paint is the most frequent, however, anything could cause such blockage. Physical remoaval and cleaning of this condition is required.

If the inlet face of a membrane is 'blinded' by debris, and the membrane is reversible, often the problem can be remedied by turning the membrane upside-down, and relocating the brine seal if applicable. As much of the debris should be physically removed prior to restarting.

PAINT IN THE PERMEATE

The normal boundary between the paint and the permeate streams is the membrane itself, and any number of O-rings on the Top Cap, Bottom Plug ,or Interconnector. A failure of any of these items can result in paint in the permeate. Rare occurances of out-of-round, or cracked permeate tubes in the membrane can also cause paint in the permeate.

O-rings are inexpensive and relatively easy to replace. In all cases of paint in the permeate, the O-rings should be relaced before replacing the more expensive membrane.

When the point of paint leakage is very small, the leak can often be controlled by throttling the permeate valve, to apply some back pressure to the leak site. Also the paint can produce a 'scab' which can temporarily plug the leak site. This can be permanent or can dissolve at the 1st chemical cleaning. If the leakage cannot be stopped by changing O-rings, then the membrane must be replaced. Contact PAF if the membrane is within the warranty period.

PHYSICAL DAMAGE OR VISIBLE DETERIORATION

Physical damage that has historically been seen would include some of the following examples:

- Flipped, torn, or wrinkled Brine Seals
- Crushed Hard Outer Wrap on the membrane
- Cracked, crumbled, or broken Plastic Seal Carriers
- Chemical attack to Seal Carriers or Hard Outer Wrap (dissolved, warped, etc)

8: Limited Warranty

Parker Process Advanced Filtration, Inc. (PAF) conditionally guarantees its electrocoating membranes elements against failures from material and manufacturing defects, for a period of ninety days after the date of shipment. Excluded from warranty considerations are those elements subjected to the following:

1. Shipping or handling damage
2. Damage from misuse or neglect
3. Operating outside of specified limits of temperature, pressure, concentration, pH, or chemical compatability.
4. Operating without using PAF recommended procedures, including, without limitation, not following PAF cleaning procedures with recommended cleaning agents.
5. Use of unapproved materials in the system.
6. Acts of God
7. Normal wear and tear.
8. Fouling or obstruction of flow, by materials in the process stream

Any claim made by the Customer shall be made in writing to PAF within ninety days of the date that the Customer discovered, or should have discovered with the exercise of reasonable care such defect.

PAF reserves the right to have any failed membranes returned, freight prepaid, for evaluation and/or autopsy. Any membrane element must be returned for autopsy cleaned and properly packaged, with a CAR number on package (obtained from PAF), MSDS sheet on the material being processed, and detailed description of the defect. PAF may also request the required operating records and logs, to aid in determining the disposition of a warranty claim. Customer shall provide reasonable cooperation for the processing of any warranty claim, including the providing of operating logs and records. PAF's disposition of the warranty on any claim is final and non-negotiable.

Additional performance warranties, as stated in the sales order, are subject to the same exclusions and conditions stated above. Credit for performance warranty shortcomings may be awarded on a use-prorated basis.

PAF's liability to Customer is hereby expressly limited to to the repair or replacement of any membrane elements, equipment, or system components found to be defective in material and/or workmanship, or at PAF's election, to the repayment of, or credit for an amount equal to the purchase price for said membrane elements, equipment, or system components. Under no circumstances may PAF be held liable for consequential or indirect damages, including, but not limited to: loss of profits, down-time, or suits by a third party against PAF's customers or users.