

Operation & Maintenance Manual

Ultra Filtration System



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1.0 Introduction

Your Ultra Filtration system components have been built to provide years of reliable performance. This manual is intended to provide general operational instructions and preventative maintenance information to ensure trouble-free operation. Detailed component information and equipment warranty details have also been included in this manual.

Please thoroughly review this manual and ensure that it is stored in a safe place, easily accessible for future reference. Should you have any questions or comments regarding this manual or equipment, please do not hesitate to contact *Filter Innovations* in Toronto, Ontario at (416) 490-7848 or by e-mail: inquiries@filterinnovations.com

1.1 Precautions

1. This unit is a demonstration/rental unit. Each facility may or may not be designed for continuous operation.
2. Membranes must not be allowed to dry out. The tubes must remain filled if the system is shut down. Membrane dry out is irreversible.
3. No anti-foam agents of any kind are to be introduced into the ultrafiltration system without prior approval from Filter Innovations. **Especially those that are silicone based!!**
4. No silicone-based materials (waterproofing sprays, lubricating fluids or greases, etc.) are to be used in or around the ultrafiltration system. Using these materials in the system in any amount will cause complete and irreversible membrane fouling.
5. Provisions must be made for properly venting the system during shutdown procedures and draining. If pressure on the permeate side of the membrane exceeds the pressure on the process side by more than five (5) psi, membrane delamination may result.
6. Minimize the time the system is under low flow conditions. These are periods when bypass valves are open or circulating pumps are not running.
7. **Caution:** Never run the system with the permeate valves closed.
8. Never start a pump without first throttling the pump discharge valve. Throttling will prevent a pressure shock wave from damaging the membranes.
9. The maximum pressure the membranes should be exposed to is 70 PSIG.

10. The maximum temperature the membranes should be exposed to is 130 F.

11. The normal pH range for membranes is 4.0-10.5 at 130 F (54 C).

12. During cleaning pH can extend from 2 to 12 at 120 degrees F.

Batch Operation

Manually fill process tank, then transfer pump connections. The low level process tank and alarm light will not function automatically, but the unit will operate in manual fill and must be shut off by operator. The low level alarm defeat switch must be turned to the ON position. The low pressure shut-off alarm (signaling no more process fluid) and the high temperature process fluid shut-off alarm (signaling high fluid temperature for membranes) will still function.

Modified Batch – Continuous Operation

In a 24 hour period, three float switches, inserted into a process tank, in addition to a transfer pump and input to pump are required. Please consult with *Filter Innovations* for information regarding set-up.

1.2 Glossary

Air Vent	A valve which is manually opened to allow air to escape from the system to the atmosphere during start-up, and opened at shutdown to prevent a vacuum in the system.
Cleaning System	An accessory system incorporated in the UF unit to clean the membranes if they become fouled. It consists of a cleaning tank, pump, and associated piping and valves.
Concentrate	The mixture returned to the concentrate holding tank after processing.
Deionized Water	Water from which virtually all dissolved solids have been removed.
Demineralized Water	See “Deionized Water”
Emulsified Oils	A suspension of oil droplets in water made by blending the oil with emulsifying agents and other material. Emulsions are also called “soluble oils”, a misnomer, but generally used in the metal working industry.
Flux	The rate of permeation, usually expressed as GFD (Gallons per square Foot of membrane area per Day).

Fouling	A condition in which the membrane flux rate is restricted due to the accumulation of material on the membrane surface.
Free Oil	All unemulsified oils that are present in the process fluid.
Membrane Processing	Separation of the elements of a fluid, at the molecular level, by a membrane. The membrane will allow smaller molecules to pass through while retaining larger molecules.
Metal Fines	Very small slivers of metal generally produced in a grinding operation.
Oil Skimmer	A device for skimming free oil off the surface of the process fluid in a tank.
Permeable	Porous to the passage or penetration of fluids.
Permeate	The term used to describe the passage of water through a membrane. It is also the fluid (basically water) separated from the process fluid in the ultrafiltration system.
Preservative Solution	A solution that is introduced to the membrane tubes during idle periods to prevent membrane deterioration.
Process Fluid	The oil and water mixture (or other process fluid) delivered to the UF unit for processing.
Purge	A displacement procedure that exchanges the process fluid in the UF system with water from the cleaning tank.
Sludge	Deposits on the bottom of the process tanks that are undesirable as they cause membrane fouling.
Spongeballing	A method of hydraulically forcing balls of sponge-like material through the flow channel of a tubular membrane.
Surfactant	Surface active agents used for cleaning the UF system.
Tramp Oil	See "Free Oil"
U-bend	A "U" shaped tube used to connect one membrane tube to another in the same pass to provide a series-connected configuration.

Ultrafilter	An arrangement of tubular membranes used in the ultrafiltration process.
Ultrafiltrate	A synonym for permeate.
Ultrafiltration	A pressure-driven permeation process used in conjunction with semi-permeable membranes. Flow rate through the membranes and permeate selectivity are governed by pore size, distribution, membrane porosity, and the specific process fluid itself.

1.3 System Overview

Ultrafiltration is an industrial process in which semipermeable membranes are used to separate water and some dissolved low molecular weight materials from a mixture that is submitted for processing. The goal of the process is to effectively fractionate the original process stream into a concentrate stream and a very low concentration permeate stream. The concentrate is then disposed of by the most economical means or further processed if the concentrate contains valuable material. The permeate stream is normally discharged to a sanitary sewer or recycled to rinse systems since it is relatively clean.

In *Filter Innovations* Ultra Filtration systems, the membranes are tubular in shape and bonded to the inner surface of the tube support backings. The process fluid is circulated through these membrane tubes under pressure. The oil is retained and the water is separated from the mixture as shown in Figure 1.1.

The pore structure of the membrane acts as a filter, allowing water and small solutes (e.g. salts) to pass through, while larger emulsified and suspended matter is retained. The pores of ultrafiltration membranes are much smaller than the particles rejected. These particles cannot enter the membrane structure and hence the pores cannot become plugged.

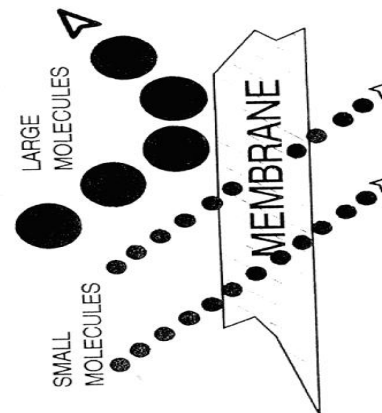


FIGURE 1.1 GENERAL ULTRAFILTRATION

FEG Tube Description

In FEG Ultra Filters, the membrane is cylindrical and bonded to the inner surface of a protective, porous backing called a support tube. Each membrane and backing is enclosed in a tubular housing. The housing is threaded at both ends for connecting them in series and to the process inlet and outlet manifolds.

Boot seals, installed at each end of the membrane and the support tube, isolate the permeate from the process stream. The boot seal wraps around the inside and the outside of the tube ends. A stainless steel ferrule holds the boot seal in place, and the outer portion of the boot has two formed O-rings to provide the boot-to-housing seal (see Figure 1.2). When in operation, permeate travels through the membrane, collects in the annular space between the membrane tube housing and the boot seals, and then flows out of the permeate port.

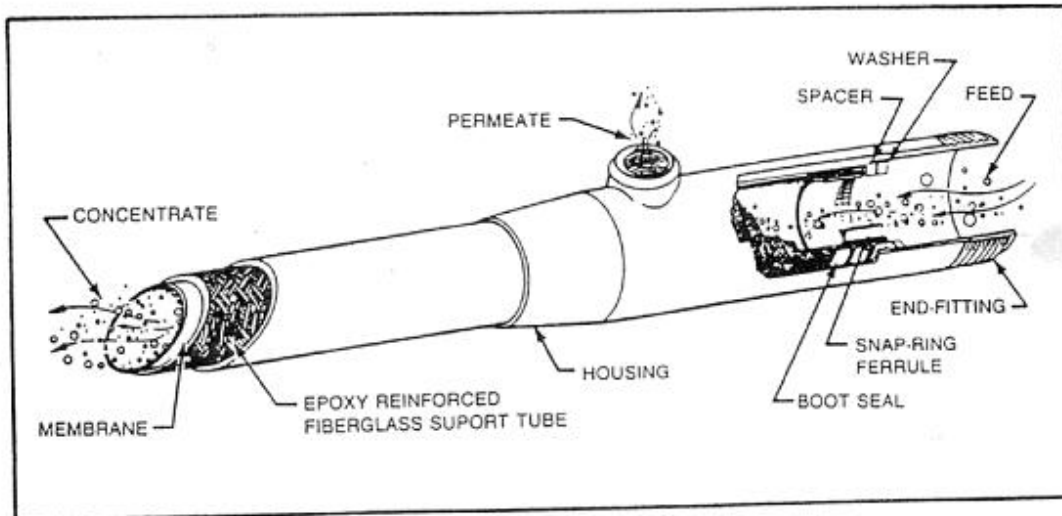


FIGURE 1.2 FEG TUBE DESCRIPTION

1.4 Operational Parameters and Limitations for Oil/Water Emulsions

Maximum operating pressure at pass inlet	70 PSIG
Maximum operating pressure at pass outlet	28 PSIG
Minimum operating pressure at pass outlet	20 PSIG
Pressure drop at 30 GPM/tube	4 PSIG
Maximum operating temperature	130 F
Maximum back pressure at permeate outlet	5 PSIG
Membrane area per FEG tube	2.2 Sq. ft.
Hold up volume per tube	0.437 gal.
Minimum flow per series pas of tubes	30 GPM

1.5 System Description

The Ultra Filtration system consists of four membrane tubes in series. The remaining components of the system include: a circulation pump rated at 20 GPM at 105 feet of head, a 50 gallon process/feed tank, and associated piping along with various switches, valves, and gauges.

1.6 System Alarms and Faults

Filter Innovations Ultra Filtration systems are protected by several different alarms. When activated, these alarms will shut the system down to protect the membranes. This system includes a high temperature alarm and a low level process tank pump shut-off.

After an alarm fault has been corrected, the system may be restarted. For guidance regarding correcting faults, refer to the Troubleshooting guide at Section 4.4.

Temperature Switch and Alarm

A high level cut off temperature switch has been provided to protect the membranes from high fluid temperatures. The switch has been preset at the factory to disable the system when the temperature is above 135°F. The switch also activates an alarm indicator on the main panel (requires pressing RESET to restart).

Process Tank Low Level

A low level limit switch is provided in the process tank to protect the process pump from operating with no fluid. At low level (no fluid in process tank), the UF system will stop pumping and the green light on the control panel indicating process pump operation will turn off. As the process tank fills and the upper limit (swing) of the low level switch is obtained, the process pump will go back on.

1.7 Routine checks and Data Collection

The ultrafiltration system should be checked at least twice a shift. These checks should include a visual inspection for leaks and a visual check of the permeate quality and flow rate. In addition, operating data should be recorded in the Log Sheet supplied with each system.

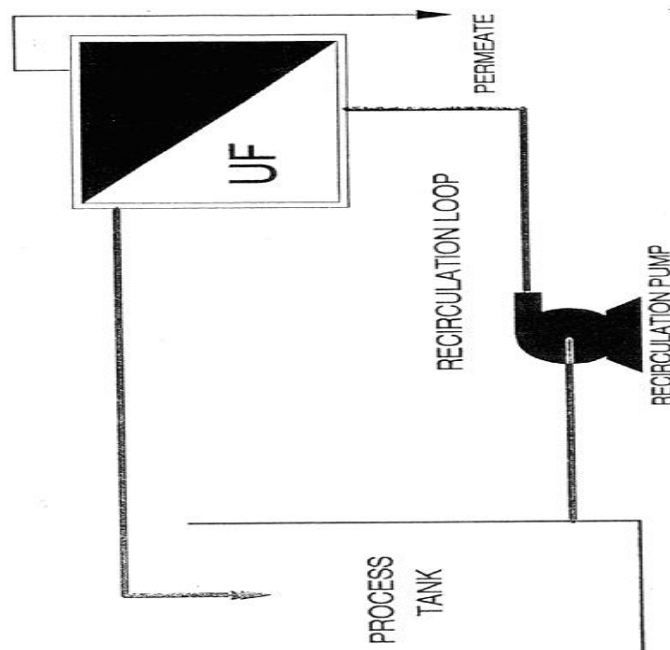


FIGURE 1.3 BATCH FLOW SCHEMATIC

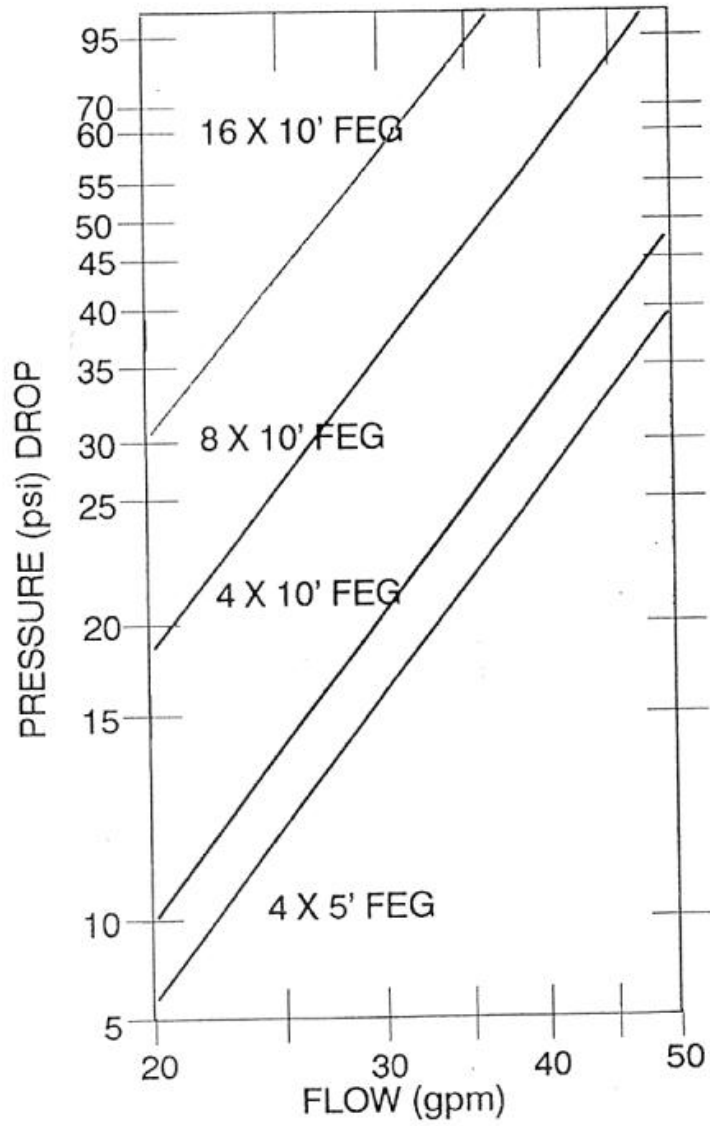


FIGURE 1.5 PRESSURE DROP vs. RECIRCULATION RATE

2.0 Ultra Filtration System Installation

This section provides installation instructions for the skid mounting, electrical, and system inlet and outlet connections.

2.1 System Mounting

The UF system should be mounted on a level surface. The systems should be located in a dry area. The location of the system should satisfy all site requirements including adequate space around the unit for safe operation and maintenance.

2.2 Electrical

The electrical requirements for the system are listed below. All work/ wiring must be in accordance with electrical codes. To reduce moisture or vapor damage to electrical components, ensure that all cable entry holes into the control box's are properly sealed and the door is securely closed during operation.

Power Requirements: 110 VAC, 20A

Power Connection: 120 Volt, 20 A plug

See the electrical Schematic in section 3 or more details.

Caution: Only trained and certified persons should attempt to make electrical connections.

2.3 Piping Connections

All five of the system pipe connections are located on the right end of the skid (as viewed facing the front of the panel) The output connections sizes and types are listed below:

Connection	Size	Type
Inlet (From Process Tank)	1 ½"	FNPT
Reject / Concentrate (Back to Process Tank)	1 ½"	FNPT
Permeate (Clean Water	½"	FNPT
Pump Out	1 ½"	FNPT
Drain	1 ½"	FNPT

Note: Teflon tape should be used for all pipe connections.

2.4 System Component Description

Ball Valves, Pressure Gauges & Drain

V1	Input feed from process tank
V2	Input feed from cleaning tank & Inlet sponge ball insertion isolation valve
V3	Drain
V6	Inlet pressure regulating valve & Outlet sponge ball insertion isolation valve
V8	Cleaning tank return valve
V9	Process tank return valve
V10	Pump out valve
V11	Permeate low flow isolation valve
V13	Permeate high flow isolation valve
V14	Permeate return valve to Discharge/cleaning tank (3-way valve)
V15	Permeate return valve to sewer/holding tank
V16	Pressure Regulatory Valve
P1	Inlet pressure gauge
P2	Outlet pressure gauge
S	Small drain valve on permeate for draining permeate prior to draining (permeate sample port)
PFM	Permeate flow meters
TSH	High temperature cut off switch set at 135 F
LSLL	Level Switch in Equalization Tank
LSHL	High Level Switch for transfer pump control
LSLL	Low Level Shut off for process pump

3.0 Ultra Filtration System Operation

3.1 Start Up

The following items should be checked before the system is operated.

- Ensure that the membrane housing U-bend and terminator nuts are tight (*Hand tighten only!*)
- Ensure that the permeate tubing connections on the membrane shells are secure (*Hand tighten only!*)

The Ultra Filtration membranes have been impregnated with a preservative solution prior to shipment. This must be removed from the system prior to operation. To remove the preservative, follow the cleaning procedure outlined in Section 3.6.

Once the system has been checked and cleaned it is ready for operation. Cleaning should be performed with *Filter Innovations* detergent solutions only.

3.2 Batch Operation/Modified Batch Operation

Batch Operation

In the batch operation, process fluid is pumped from a large process tank through the Ultra Filtration system and back into the process tank. As the water permeates from the ultra filters, the process emulsion becomes more concentrated. When a predetermined concentration has been reached, the batch is completed. The remaining emulsion is then disposed of. The water which is permeated from the filters can be directed to drain or reused.

CAUTION: Before dumping any effluent into the drain, adequate testing should be performed to ensure proper compliance with any applicable discharge regulations.

After each batch a proper cleaning of the ultrafiltration system should be performed. The process tank is then refilled and processing of a new batch may begin.

Modified Batch Operation

Modified batch operation differs from the batch operation mode only in that as the level in the process tank drops due to the removal of permeate, fresh process feed material is added to the process tank. The advantages of the modified batch mode of operation are that run times are extended and cleaning frequency is reduced.

3.3 System Startup

1. Ensure that all the valves are in the positions described in the following table:

Process Run

Valve	Position	Valve	Position
V1	Open	V10	Closed
V2	Closed	V11	Open
V3	Close	V13	Open
V6	50% Open (after 1 min 100% open)	V14	Open to (permeate tank)
V8	Closed	V16	Open
V9	Open		

2. Turn on the main disconnect.
3. Fill the process tank with fluid and ensure that the inlet valve (V1) is open. Hand position on transfer pump selector switch can be used if wired to control panel.
4. Set the transfer pump HAND/OFF/AUTO selector switch to AUTO.
5. Set the process pump on the UF selector switch to AUTO position.
6. If there is enough fluid in the process tank, the process pump will start when switched to the AUTO position. Start the process pump by pulling START/STOP.

Attention: An air lock which needs to be purged may be in feed piping if the process tank is filled for the first time. Repeat step 6 until the air pocket is removed.

For a 4-Tube System

Adjust the inlet pressure regulatory valve V6 to reduce start-up pressure of the pump until a pressure of 20 psig is observed on P1. V16 should be partially closed to show approximately 25 psig on P2.

Note: The minimum P2 pressure is 20 psi and the difference between P1-P2 must be between 10 and 35 psi. .

7. Examine the permeate. It may be colored, but it should be clear. Observe the two permeate flow meters. Only one should be operating at any time and appropriate isolation valves should be shut.

For a 4-Tube System During Process

Ensure: V13 ON
V11 OFF

As process continues and waste thickens, permeate flow will drop and the smaller scale will be necessary. At this time, open V 11 and shut V13.

Caution: At no time should all of these valves be closed.

As process continues adjust accordingly.

Caution: If the permeate remains cloudy after two hours, the membranes are probably leaking. *Call Filter Innovations for technical support!*

Once process fluid is concentrated to the desired level the treatment can be stopped and the process fluid removed.

NOTE: Shut-down occurs approximately when permeate flux reduces to 30% of start up.

8. Shut down the system by turning the process pump on UF selector switch to OFF position.

Now that the process fluid has been concentrated, the next step is to remove the concentrated process fluid from the process tank. There are several ways to do this and the right choice depends on the configuration of the system. The system has been designed to aid in this process.

If the process tank is equipped with the sludge/oil collection drum ,simply open the process tank drain valve and drain the sludge into the drum.

If the concentrate holding tank is plumbed to the Pump Out outlet, the process pump can be used to pump from the process tank to the concentrate holding tank.

9. Adjust the valves as follows:

Valve	Position	Valve	Position
V1	Open	V9	Open
V2	Closed	V10	Open
V3	Closed	V11/13	Open same position
V6	Closed	V14	Open (to permeate tank)
V8	Closed	V16	Open

10. Start the process pump by turning the process pump on UF selector switch to HAND position.
11. The concentrate is now being pumped from the process tank to the concentrate storage tank.
12. When the tank is empty or the pump begins to cavitate, stop the pump by putting the selector switch back to OFF.

The system is now ready for Flushing and Cleaning.

3.4 System Flushing

Caution: Prior to any cleaning or short term shut down, the system must be flushed to maximize the cleaning or minimize fouling during shut down.

1. Fill the cleaning tank with soft hot water at 120° F. If water at this temperature is not available, use the hottest water possible that can be brought to the cleaning tank.
2. Check that the valves are in the following positions:

Flush

Valve	Position	Valve	Position
V1	Closed	V9	Open
V2	Open	V10	Closed
V3	Closed	V11/13	Open
V6	50% Open	V14 (3-way)	Open (to washing tank)
V8	Closed	V16	Open

3. Set the process pump on UF selector switch to HAND position.
4. Process pump will start.
5. Slowly open the inlet pressure regulating valve V6.
6. Pump between 1/3 and 1/2 of the hot water from the cleaning tank into the process tank.
7. Stop the circulation pump – turn process pump on UF selector switch to OFF position.
8. Close the process tank return valve V9.
9. Open cleaning tank return valve V8 and turn the three-way valve V12 to the permeate return position. Close the discharge tank (permeate discharge) valve.

The system is now ready to be cleaned and all cleaning fluids and permeate will be pumped from and back into the cleaning tank.

3.5 Chemical Cleaning

The usual cleaning solution is either 1% of Filter Innovations Ultron Detergent or a 1% solution of Filter Innovations Ultraflux Liquid Detergent.

Note: The following procedure should be used when performing a chemical cleaning

1. Ensure system is flushed as per Section 3.4.

Cleaning valve position

Valve	Position	Valve	Position
V1	Closed	V9	Closed
V2	Open	V10	Closed
V3	Closed	V11/13	Open
V6	50% Open (after 1 min 100% open)	V14 (3-way)	Open to (washing tank)
V8	Open	V16	Open

Caution: If there is no water in wash tank, the pump will run dry and overheat. There is no low level pump protection in cleaning cycle.

2. Fill the cleaning tank with the appropriate cleaning solution at 120° F, according to the table below:

Sol.	Ingredients	Comments	Cleaning Time
1	1% Filter Innovations Ultron and Water	Higher concentration may be required for severely fouled membranes.	One hour sponge ball 2-3 times
2	1% Filter Innovations Ultraflux and Water	More effective than Sol. 1.	One hour sponge ball 2-3 times
3	2.0% Ultron Liquid Detergent and Water	May be more effective than Sol. 1. Excellent for complexing metals.	Two hours sponge ball 2-3 times
4	2.0% Ultraflux Liquid Detergent and Water	More effective than detergent alone with some process streams.	Two hours sponge ball 2-3 times
5	2.0% Citric Acid to pH 3.0-3.5	This cleaner is used to clean metal fouled membranes. It must be preceded and followed by one of the above cleaners.	30-60 minute sponge ball 2-3 times

3. Set the process pump on UF selector switch to HAND position.

4. When fluid begins to return to the cleaning tank adjust valves.

For a 4-Tube System

Adjust the inlet pressure regulatory valve V6 until a pressure of 45 psig is observed on P1. Adjust the process tank return valve V16 partially closed to showing approximately 29 psig on P2.

Note: The minimum P2 pressure is 20 psi and the difference between P1-P2 must be 25 psi. .

5. Circulate the cleaning solution for approximately one hour or until the permeate stops increasing. If the membranes are severely fouled, repeated cleanings may be needed. Note: Sponge ball 2-3 times per cleaning cycle.
6. Mechanically clean the membranes as described in Section 3.6 Sponge ball (4 at a time) should be done 2-3 times per cycle.

Note: A method for determining Flux is outlined in Section 3.7.

7. On completion of the chemical cleaning, stop the circulation pump.
8. The dirty cleaning solution may be sent to either the drain or the process tank.
9. Drain the system by opening the system drain V3 or by diverting flow back to the process tank via return drain line V9. Follow valve steps from flush procedure as per Section 3.4.
10. Once the system is drained, flush the system with hot water as outlined in Section 3.4. Record clean water flux rate and temperature to determine effectiveness of the cleaning procedure.

3.6 Mechanical Cleaning

During a chemical cleaning of the system, a mechanical cleaning will also be required. This is performed by hydraulically forcing spherical sponges through the membrane tubes. It is done during a chemical cleaning and often 2-3 times per cleaning sequence. It is nearly always of some benefit.

The mechanical cleaning procedure should proceed as follows:

1. Perform a chemical cleaning by following the procedure in this manual. except that once the solution has been circulating for *10 minutes*, stop the *circulation pump*.

2. Close isolation valve V6. Close V2. Open the sponge ball insertion union and insert four sponge balls into the sponge ball insertion point. Replace the sponge ball insertion union.

Valve	Position	Valve	Position
V1	Closed	V9	Closed
V2	Open	V10	Closed
V3	Closed	V11/13	Open
V6	Open	V14 (3 way)	Open (to washing tank)
V8	Open	V16	Open

3. This procedure will be repeated every 20 minutes until flux rate does not increase after sponge balling.
4. *Following insertion of sponge balls*, adjust the valves.
5. Start the circulation pump and the sponge balls will push through the system. After 20-25 seconds, stop the pump to retrieve the sponge balls from the sponge ball collection strainer on top of cleaning tank.
6. Close V8. Open drain to the sponge ball retrieval system and remove the sponge ball cage to retrieve sponge balls. Count sponge balls to ensure all of them have been accounted for.
7. Repeat steps 2 through 6, three or four times, until the sponge balls come through free of dirt and deposits.

3.7 Water Flux Measurement

Standard conditions for measuring flux are set at an average pressure of 50 psig and a temperature of 77°F. These conditions are not always attainable, so the measured flux must be corrected for temperature and pressure. The water flux should be taken at an average pressure of 20 psig or more.

The units for water flux are gallons of permeate per square foot of membrane surface per day (GFD). The permeate rate is generally measured in gallons per minute, so the rate will have to be converted as follows:

$$J_m \text{ (GFD)} = \frac{\text{(Permeate rate in GPM * 1440 min/day)}}{\text{Total membrane area in sqft.}}$$

UF 2 System 4.5 sqft.

The measured flux J_M = can be corrected to standard conditions by using the following equation:

$$J_{\text{corr}} = \frac{(J_m * 50 * F)}{(P_{\text{in}} + P_{\text{out}}) / 2}$$

Pin Inlet pressure, PI1
Pout Outlet Pressure, PI2
F Temperature correction factor

The normal fluxes for clean membranes at standard conditions are listed below:

Membrane Type	Water Flux (GFD) @ 50 psig, 25°C
HFM	100 to 150
HFP	100 to 150

WATER FLUX TEMPERATURE CORRECTION FACTOR TABLE

T (°F)	T (°C)	F	T (°F)	T (°C)	F
126	53	0.595	82	28	0.935
124	51	0.605	81	27	0.956
122	50	0.615	79	26	0.978
120	49	0.625	77	25	1.000
118	48	0.636	75	24	1.023
117	47	0.647	73	23	1.047
115	46	0.658	72	22	1.072
113	45	0.670	70	21	1.098
112	44	0.682	68	20	1.125
109	43	0.694	66	19	1.152
108	42	0.707	64	18	1.181
106	41	0.720	63	17	1.212
104	40	0.734	61	16	1.243
102	39	0.748	59	15	1.276
100	38	0.762	57	14	1.310
99	37	0.777	55	13	1.346
97	36	0.793	54	12	1.383
95	35	0.808	52	11	1.422
93	34	0.825	50	10	1.463
91	33	0.842	48	9	1.506
90	32	0.859	46	8	1.551
88	31	0.877	45	7	1.598
86	30	0.896	43	6	1.648
84	29	0.915	41	5	1.699

3.8 Shut Down Procedures

If the system must be shut down during the process run, waste may be left in the unit for a maximum of 60 minutes. When the unit is restarted the flux rate will probably be lower depending on the type of waste being processed. While the flux rate is recoverable by cleaning, the safest route is to perform a displacement with warm water prior to shut down.

If the system must be shut down for more than 60 minutes, perform the shut down procedure outlined below.

These procedures will serve to:

- Displace waste from the unit (See Section 3.4)
- Chemically clean the system (See Section 3.5)
- Rinse the system of cleaning chemicals (See Section 3.4)

Method:

1. After the system has been displaced, cleaned and rinsed, it is ready to receive the storage solution. See the table below for the required solution.

Length of Shut Down	HFA, HFM, HFP
15 min. to 7 days	Clean Water Soap
7 days to 30 days	99.5% Water 0.5% Sodium Benzoate
30 days and longer	80% Glycerin 20% Water

Note: When the system is ready to be restarted, it must be cleaned using solution 1.

2. Fill the cleaning tank with the proper solution.
3. Circulate the storage solution for 20 minutes as in a normal cleaning.
4. Ensure that all the system valves are closed.

The system is now ready for storage.

4.0 System Maintenance

Caution: This system pumps waste water under pressure. Before removing any components or breaking any pipe connections the system pressure must be removed.

4.1 Pump Replacement

After system pressure has been relieved, close the pump inlet valve and lock out the panel disconnect. The pump is now ready to be removed.

4.2 Membrane Bypass

A defective (leaky) membrane will cause turbid permeate. This problem can be temporarily overcome without shutting down the system. Permeate in the defective tube can be prevented from entering the permeate handling lines by plugging the permeate port (1/4" NPT) of the defective tube and capping the permeate fitting that is connected to the defective tube.

4.3 Membrane Tube Replacement

The optimum time to replace a defective membrane is during shut down. The faulty membrane can be isolated to prevent leaking concentrate from contaminating the permeate. The procedure for this is outlined in the previous section. This section will outline membrane tube replacement.

Preparing the Membrane Tube

1. Remove end caps and permeate plug from membrane tube.
2. Flush out the membrane tube with de-ionized water.
3. Drain the membrane tube.
4. Reinstall the end caps to protect threads.

Installing Membrane Tube

After the membrane tube has been prepared by the above procedure, install the membrane tube as follows:

1. Drain the system according to the instructions in Section 3.5.
2. Stop the circulation pump and lock out the disconnect.
3. Disconnect the permeate hose fittings attached to the defective membrane tube.
4. Disconnect the membrane tube to be replaced from the PVC U-bends.
5. Remove the defective membrane tube from the rack by releasing the snap-on tube clamps with a flat-head screw driver.
6. Install the new membrane tube on the rack and snap on the two tube clamps.
7. Remove the protective end caps from the membrane tube.
8. Ensure that both PVC spacers and rubber washers are installed at both ends of the tube.

Note: The PVC spacer is installed before the rubber washer.

9. Reconnect the PVC U-bends. Carefully orient the permeate port into the proper position. *Hand tighten* the PVC U-bend rings.
10. Reconnect the permeate tubing.
11. Start the system as outlined in Sections 3.1 – 3.3. If a process fluid leak appears at one of the U-bends, stop the circulation pump and tighten the U-bend ring by hand. Start the system again and check for leaks.

Note: If the leak can not be stopped by this method, it may be necessary to add another membrane washer.

4.4 Troubleshooting Guide

Problem	Probable Cause	Corrective Action
Low Flux	Fouled Membranes	Clean or replace membranes
	Improper operating pressure	Adjust system inlet and outlet pressure
	High feed concentration	Remove feed from system
	Low temperature	Increase temperature (but do not exceed 125° F)
	Batch over concentrated	Add process fluid to tank or empty tank and refill with fresh fluid.
Low Pressure	Empty process tank	Add process fluid to tank
	Ruptured membrane tube	Replace membrane
	Faulty Pump	Repair or Replace Pump
	Low pressure switch set to more than 10 psig.	Adjust pressure switch.
High Temperature	High fluid temperature	Shut down system and allow to cool.
Permeate with high turbidity	Leaking membrane	Plug or Replace membrane

5.0 Warranty

Filter Innovations Inc. warrants and guarantees products of its manufacture against defective workmanship or material for a period of one year from the date of shipment from the factory. This warranty is expressly and strictly limited to replacing or repairing, without charge, any part or parts which prove to its satisfaction, upon examination, to have been defective and which have not been neglected, abused or misapplied, provided the buyer gives FII immediate written notice upon discovery of any claimed defect.

FII will also guarantee component parts manufactured by others to the extent of the guarantee made by the manufacturer of such equipment. In any case guarantees on specific components will be extended a minimum of one year from date of shipment.

Warranty Exclusions:

Warranty coverage does not include: (a) freight, labour, travel, and living expenses associated with parts replacements; (b) normal maintenance items such as lubrication, fan belts, and cleaning of the equipment.

In the event the customer, or any installation contractor employed by the customer, contracts outside of *Filter Innovations Inc.* for installation work or erection of quoted equipment, the customer shall assume full responsibility from said contract.

6.0 System Information

Company Name:
 Location:
 System Identification:
 Operator:

Source:
 Sludge/Solids:

Feed Information

Date/Time	pH	Colour	Inlet Pressure psi	Outlet Pressure psi	Temp. F	Perm. Rate GPH

Cleaning

Time Hr	Flux GPH

Remarks

Comments e.g. Indicate when & where sample taken

PERFORMANCE LOG SHEET