DAYLIFF

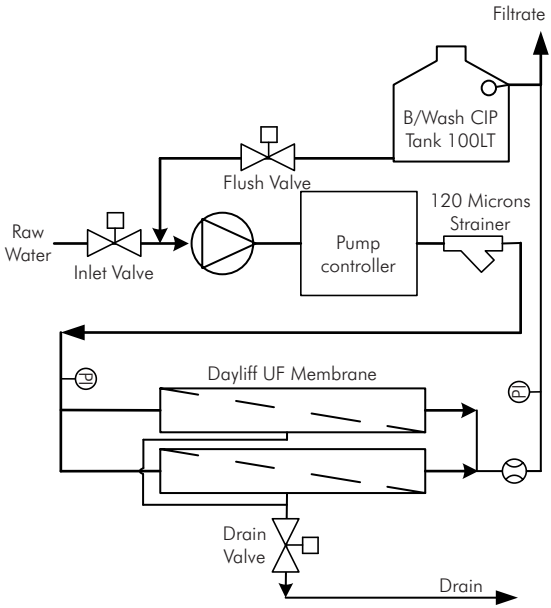
BUF 4
Ultrafiltration Treatment Plant

Installation & Operating Manual

INDEX

Congratulations on selecting a BUF4 Ultrafiltration Treatment Plant. They are manufactured to the highest standards and if installed and operated correctly will give many years of efficient and trouble free service. Careful reading of this Installation Manual is therefore important, though should there be any queries they should be referred to the equipment supplier.

1. SPECIFICATIONS



DAYLIFF BUF4 Ultrafiltration plants are highly effective, easy to operate and simple to maintain systems that offer the ideal solution for small and medium scale water treatment requirements. Their particular application is for the removal of particles, colloidal material, sand, organic and inorganic polymeric particles. They are particularly suitable for the treatment of polluted surface waters from dams, rivers, reservoirs etc. as well as wastewater recovery. The process will not remove dissolved salts including sodium, calcium and chlorides and so is not suited to the treatment of groundwater with high TDS levels. Standard models are suitable for low turbidity (up to 15NTU) raw water applications.

Systems are frame mounted and supplied as complete units with all necessary accessories and controls for simple integration with the flow process.

They offer the following features:-

- Fully automated plant operation including normal filtration and backwash cycle with solenoid valve activation.
- High efficiency single Dayliff feed/backwash/cleaning pump with integral Brio pump controller for auto switching and dry run protection.
- 120-micron pre-filter.
- Integrated CIP/Cleaning/Backwash/Flushing tank.
- System monitoring instruments including product flow meter and pressure gauges.
- Skid mounted for simple installation.

DAYLIFF BUF4 systems provide a high performance, high efficiency treatment process that produces fully potable water without chemical additions. The process uses low energy consumption and provides consistent quality without frequent operational intervention. Due to the efficiency of the membranes, it also offers considerable savings over conventional systems and is the ideal solution where potable water is required.

OPERATING PARAMETERS

Operating Pressure: 0.2 - 2bar
Maximum Feed Pressure: 3 Bar
Maximum Operating Trans Membrane Pressure (TMP): 2 Bar
Chlorine Tolerance: 100 ppm
Max Operating Temp: 45^0 C
Operating pH Range: 2-12
Raw Water Quality: Turbidity <15 NTU, Oil/Grease 0 mg/l
Treated Water Quality: <0.2µm
Recovery Range: 95-98% depending on raw water quality.
Backwash Frequency: Every 20-60mins
A raw water analysis should be provided to establish the extent of pre-treatment necessary.

EQUIPMENT SPECIFICATIONS

		BUF4/40	BUF4/70	BUF4/100	BUF4/140
Flow Rate(m^3/hr)		0.35	0.7	1.0	1.4
No. Membrane Modules		1	2	3	4
Pump	**Type**	DDP50A		DDP60	DDP65
	kW	0.25		0.37	0.75
Dimensions (LxWxH)mm		1200x1100x1700			
Weight, Kg		80	90	100	110

1.1 Working Principle

Ultrafiltration (UF) involves pressure-driven separation of materials from a feed solution. The technology is used to remove particulate and microbial contaminants, but it does not remove ions and small molecules. Pressure drives the process, which typically operates with a feed pressure of 0.2 to 2bar. UF plants are automated and have low operational labor requirements. These systems, however, can require frequent cleaning. UF membranes are commercially available in tubular, hollow-fiber, and spiral wound configurations.

UF membranes reject solutes ranging in size from 0.2 microns and larger. The UF membrane process separates molecules within the solution on the basis of size. The pore size and molecular weight cut-off (MWCO) are often used to characterize a membrane. The pore size is the nominal diameter of the openings or micro-pores in the membrane expressed in microns. BUF4 membranes have a 100K pore size.

Different membrane materials with the same nominal MWCO may have differing particle rejection. Pore size distribution and uniformity rather than the chemical nature of the membrane material may cause this effect.

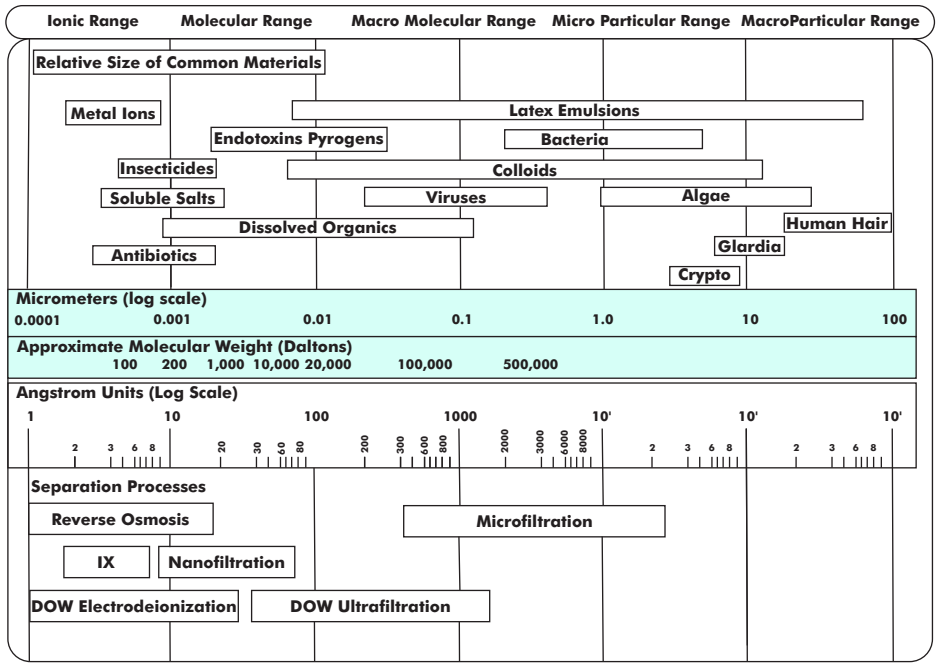


Fig 1: Material Size and Membrane Filtration Process Guide

2. INSTALLATION

2.1 Equipment Specification

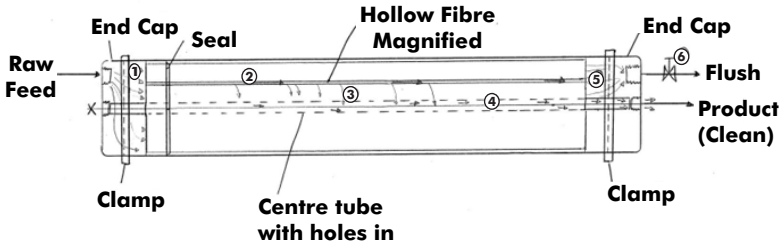
The Ultrafiltration plant consists of the following major components

1. Feed pump/Backwash/CIP pump.
2. Electric Solenoid valves -Inlet, Flush and Drain valves.
3. Backwash/CIP tank.
4. Pump controller.
5. Timer circuit.
6. UF membrane.
7. Piping.
8. Optional Waste water tank.
9. Optional Raw water tank.
10. Optional chemical dosing tanks.
11. Optional chemical dosing systems.

2.2 Module Description

Systems are frame mounted and supplied as complete units with all necessary accessories and controls for simple integration with the flow process. They offer the following features:-

- Fully automated plant operation including normal filtration and flushing cycle.
- High efficiency single Dayliff feed/backwash/Cleaning pump saving energy, i.e. Low CAPEX and OPEX.
- Integrated automated backwash/flushing/cleaning process.
- System monitoring instruments including product flow meter and pressure gauges.
- 120-micron pre-filter.
- Skid mounted for simple installation.
- Integrated CIP/Cleaning/Backwash/Flushing tank.
- Dry running pump protection



1. Feed water enters chamber on offset
2. Floods hollow fibres internally
3. Breaks through walls
4. Exits through middle (center tub) pipe
5. Flows through center fitting
6. Electric valve flush valve opened to strip build up inside each hollow fibre

Fig 2: UF Membrane Cross Section

3. OPERATION

3.1 Pre Treatment

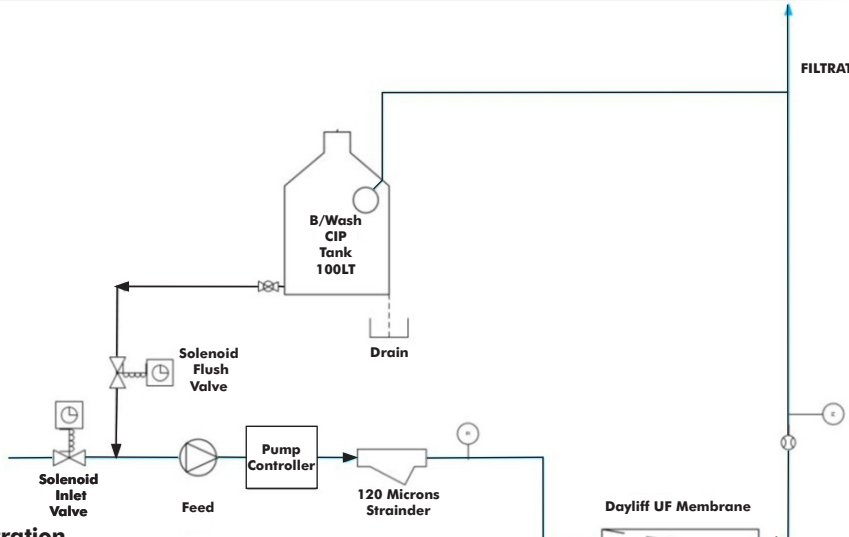
Ultrafiltration membrane designs are based on qualified feed water conditions as shown in table above. If the feed water quality is outside of the required levels, a pilot study should be done to confirm performance, increase the number of UF membranes to lower filtration flux or pretreatment must be considered.

Depending on application, a safety screen of 150 – 300 microns is recommended on the feed to the UF system, which must be frequently cleaned at least once a day depending on

If the system is designed and installed to the conditions shown but the feed water quality is not maintained as required, then consult a Dayliff retailer.

Depending on application, a safety screen of 120 microns is recommended on the feed to the UF system, which must be frequently cleaned at least once a day depending on the quality of water. A variety of technologies can be used such as self-cleaning screens and bag, cartridge, or disc filters. Depending on the type of water or range of feed water parameters other pretreatment technologies such as oxidation, coagulation, and sedimentation and media filtration may also be recommended.

3.2 Filtration & Flushing Process



Filtration

- Inlet solenoid valves open | flush solenoid valve closed | Drain solenoid valve closed
- Settable timer settings - 30min*
- Flush tank filling until full
- Monitor differential pressure (feed pressure filtrate pressure should never be more than 2Bar
- Regular cleaning of feed line screen filter every week or sooner

Fig 3: Filtration Step for UF membrane

Normal operation refers to the routine operating sequence of a system and includes the filtration and flushing steps. At initial startup, the UF membranes are flushed for 3hrs to remove any residual chemicals.

- This is done by manually adjusting the timer box settings to extend flushing time. The flush process does not make filtrate.
- After the start up forward flush is done, the UF membrane can be placed in the filtration mode by manually adjusting the timer settings.
- A filtration cycle ranges from 6 to 30 minutes and while in operation, all the feed water is converted into a filtrate. As contaminants are removed during the filtration mode, the trans-membrane pressure (TMP) increases (difference in pressure between the feed and the filtrate line).
- At the end of the set filtration cycle time, a flushing (cleaning) sequence will be triggered automatically for the flush duration set and the process is routine and repetitive during normal operation.

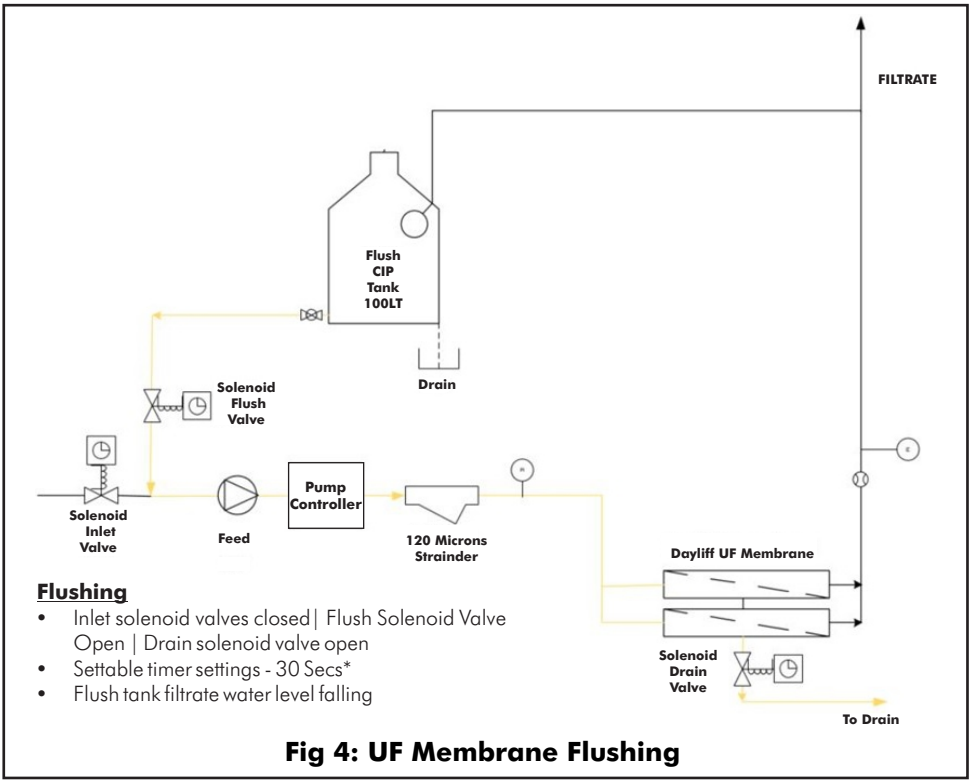


Fig 4: UF Membrane Flushing

- The flushing mode occurs automatically (after manually setting the timer) and is used to loosen and wash-out particulates deposited on the hollow fiber of the UF membrane.
- It's critical that the flushing time be set long enough to wash-out all dirt until clear water is observed.
- The flush time may therefore vary depending on the water quality. Typically, 30sec is set as standard flush time but should be changed at site appropriately.

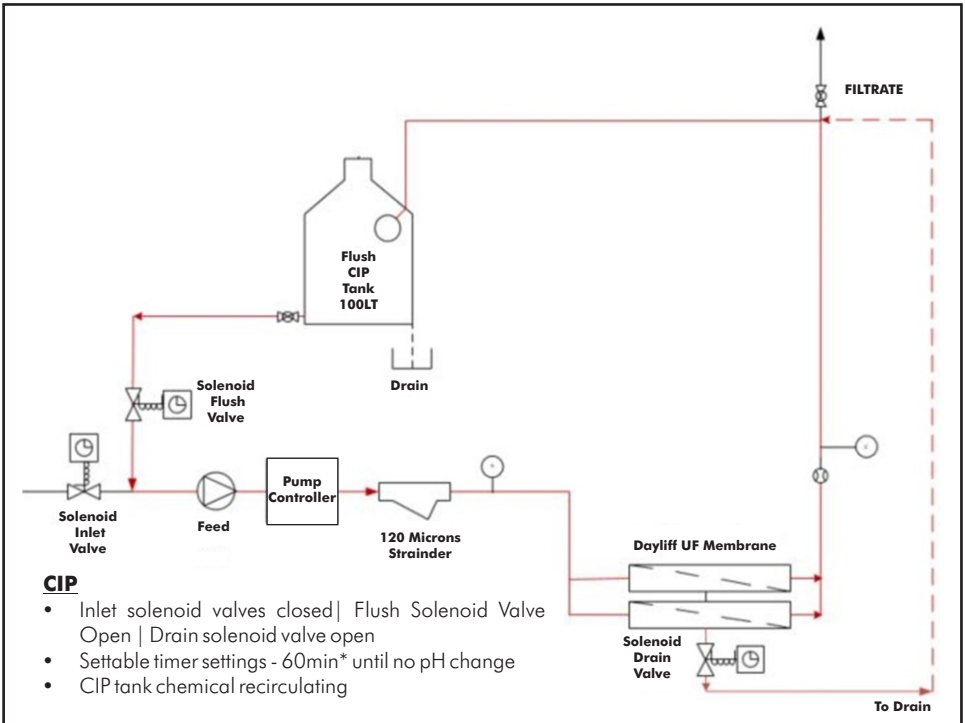


Fig 5: BUF4 CIP Process

The Clean in Place (CIP) is performed by circulating CIP chemicals until UF membrane recovers operating flow and pressure.

- During the CIP process recirculation of the chemical is done until there is no further change in the pH of the CIP chemicals which indicate no further chemical reaction is ongoing.
- A soak operation can also be included to improve the effectiveness of the cleaning.
- Soaking for 1-2hrs allows more time for the chemical to react with contaminants that have attached to the membrane surface or penetrated the fiber wall. To soak, once the unit is circulating the CIP chemical, power off the unit and close off all ball valves to ensure CIP chemical stays within the UF membranes for the soak period. After the soak a routine flushing is performed to remove any remaining particulates and residual chemicals.

3.3 Start Up and Start-up pre-checks

Once the UF membranes supplied loose along with the equipment are installed inside the housing that carry the membranes, the following procedures should be followed for the start-up of Ultrafiltration unit. Manually start the equipment during initial operation. Flush the UF unit to remove the particles, debri and preservative storage solution before operating the equipment. Target a filtrate flow of 60% of design during initial operations. After 24 hours, the filtrate flow can be adjusted to design conditions. Check all valves have been opened or closed appropriately and both raw water and storage tanks are connected.

Start the equipment by following the steps below:

1. Plant power source should be powered through an Automatic Voltage Switch (AVS).
2. Confirm timer settings okay (Filtration 30mins /Flushing 30sec).
3. Connect the loose CIP/Flush tank to the inlet and clean water lines of the UF unit.
4. Start the feed pump by switch ON the power socket.
5. Confirm the flushing operation is draining waste water from the unit.
6. Once flushing is complete, confirm filtration time is properly set.
7. Record the feed pressure and the filtrate pressure from the pressure gauges.
8. Confirm proper operation of float valve in the Flush/CIP tank.
9. Confirm filtrate water quality is okay.
10. Confirm dry running protection by closing and opening the raw water source.

3.4 Module Flushing

The Ultrafiltration membranes should be rinsed prior to startup to remove preservative fluid shipped in the UF membranes. Flushing should be performed until no foam is observed in the wash water. Depending on the treatment application, additional rinsing or disposal of the filtrate may be required.

3.5 Shut Down

- To conduct a manual shut down the power socket should be turned off. It's however important to perform a flushing operation before shutting down the unit especially where the unit will be off for extended periods of time.
- If the equipment is down for more than two days, potential buildup of particulates and colloidal matter on the surface of the membranes is highly prevalent. High transmembrane pressure (TMP) indicates clogging and presence of contaminants on the surface of the UF membranes. 60 minutes of UF operation per day can protect the equipment from bacterial fouling. If the equipment is down for more than seven days, add a storage solution i.e. preservative (1% NaHSO3), and close all valves to ensure preservative is stored within the UF membrane. During the long-term storage, pH should be checked monthly. Replace the storage solution if the pH is above 3. During shut down, the UF membrane should always keep moist.

4. MAINTENANCE

The key to getting good service from a UF module is maintenance. The main maintenance procedure required is cleaning/flushing. The flushing cycle is automated to ensure it's not forgotten or skipped which can be detrimental to the life of the UF membrane. The filtration cycle (about 30mins) will automatically alternate with the flushing operation that removes particulates from the UF membrane.

4.1 CIP

A clean in place (CIP) operation includes flushing operation and chemical recycle to clean the UF membrane. The CIP is an on demand operation. The frequency of CIP is dependent on the feed water quality but can range from 1 to 5 months. Prior to a CIP operation, the routine flushing operation is performed. After completing the flushing operation, CIP chemicals are recycled/re-circulated from the CIP chemical tank to UF membrane while monitoring the pH until there is no change in pH.

An Alkali CIP chemical is first used followed by an acid CIP chemical. During the CIP operation, the flushing timer setting are adjusted to say 2hours to allow use of the Flushing tanks as the CIP tank using the feed pump. A small chemical filtrate stream will also be collected and must be recycled to the chemical cleaning tank. Note that the CIP solution can be heated up to 40°C to improve its effectiveness at removing contaminants from the UF membrane.

The process operating parameters for the cleaning steps are provided in table below.

Summary of Cleaning Process

Flushing Frequency		Once every 20 to 60 minutes (water source or pilot test reaults)
Flushing Duration		30 to 120 seconds
Flushing Flux		150 to 250 Lm^2h
Clean in Place	**Frequency**	When TMP* exceeds 1.0 bar above starting / initioal TMP* (at same temperature)
	Duration	120 minutes (recycle and soak) or longer (until no change in pH)
	Cleaning Solutions	Check with Dayliff retailer for approved chemicals
	Cleaning Flux per Module	$50L/m^2h$
	Temperature Range	$5\text{-}45^0C$

**TMP =Trans-Membrane Pressure (filtrate pressure minus feed pressure)

4.2 Fouling

There are four types of fouling common to UF operations including particulate, biological, inorganic, and organic.

Particulate fouling is caused by suspended solids, colloids, and turbidity that can be reduced by coagulation, sedimentation, clarification, and media filtration. The common cleaning method for particulate fouling is air scour and backwash.

Biological fouling is caused by the growth of microorganisms that can be reduced by using in-line chemical feed of chlorine or biocide or by elimination of nutrients by using PAC, GAC, or coagulation. The common cleaning method for removal of biological fouling is Chemically Enhanced Backwash (CEB) with oxidizers or biocides (Cl_2, H_2O_2, and SBS).

Inorganic fouling is caused by the precipitation of inorganics on the membrane that can be reduced by using oxidation/precipitation and filtration as pretreatment to the UF or in some cases using low hardness water for the alkali chemically enhanced backwash.

The common cleaning method for removal of inorganic fouling is chemically enhanced backwash with acid at pH 2 (HCl, H2SO4, Citric, Oxalic Acid).

Organic fouling is caused by organics adsorbing on the membrane (silt, organic acids, and humus) that can be reduced by using PAC, GAC, or coagulation. The common cleaning method for removal of organic fouling is CEB with alkali at pH 12 (NaOH).

4.3 Handling and Storage procedure for UF membranes

UF membranes should be handled in such a way to help control the spread of and reduce bio-growth during long-term storage, shipping or system shutdowns.

UF modules should be shipped and stored in their original factory packaging and loaded into the system skids just prior to start-up. If the UF membrane is exposed to air for an extended period of time, the membrane may become dry and at risk to irreversible damage and therefore, it is important to keep the membrane wetted.

UF membranes are recommended to be shipped and stored in their original packaging separate from the system skids, and loaded into the system just prior to start-up.

The following guidelines should be followed for the storage of new UF modules.

- Keep modules in original factory packaging.
- To prevent collapse of boxed modules, limit vertical stacking.
- Store inside a cool and dry building or warehouse away from sources of heat. Ambient temperature are between 20^0C ot 35^0C.
- Sealed membranes may be stored up to 1 year from the date of manufacture, at the recommended storage conditions in the original packaging without additional measures required for storage.
- Temperature limits for modules during shipping and storage should be limited to 5^0C to 45^0C.

5. TROUBLE SHOOTING

This troubleshooting guide can assist you in identifying common operating problems you may experience with your machine. The operator can easily correct many of these problems; however, for those that persist or are not understood, you should contact the Davis and Shirtliff Technical support team. Have the following information available when calling the Davis and Shirtliff Technical support team:

- Machine installation date.
- Model number.
- Serial number.
- Daily Log Sheets.
- Detailed description of problem.

5.1 Low System (Feed) Pressure

Low system pressure occurs when sufficient feed water pressure and flow are not obtained. This may cause any of the pumps installed on the UF system to cavitate. Failure to provide the proper feed flow and pressure will result in lower system pressure that may result in low output production. Check the following components:

Suction valves: Check the isolation valve between the raw water tanks and UF feed pump suction line. These valves must be open for the pumps to operate.
Pump: Isolate the pump and determine how much pressure can be achieved. This can be determined by checking the pump discharge pressure gauge at this point.
Pre-Filters: Pre filter need cleaning
Electrical Issues: Check to ensure that there are no electrical fuses blown or breakers tripped and that all electrical connections are secure. Use a voltmeter to verify that the pump motor is getting sufficient power. Refer to the electrical schematic supplied for required electrical power.
Pressure Gauges: Check for foreign matter on the gauge fittings. Remove any visible matter and replace the fitting. Verify that the tube is not pushed too far inside the fitting. This could restrict flow and cause an inaccurate display. If the fitting and tube are fine and the pressure gauge is still malfunctioning, the gauge should be replaced.
Electric Valves: Check that all electric (solenoid) valves are functioning well.
Motor: The motor may not be drawing the correct current or may be wired improperly. Use a clamp-on ammeter to check the current draw. If the three-phase legs are reversed, the motor rotation will be reversed and the pumps will not generate the specified discharge flow or pressure.
Leaks: Check the system for leaks, as this can result in low pressure.

5.2 Abnormal Filtrate Flow

Filtrate flow should be within 15% of the rated production, after correcting for feed water temperatures above or below 25° C. Check the filtrate flow meter to confirm the flow rate. If the flow meter is not working or you suspect it is inaccurate, measure the time it takes to fill a 20 liters container then calculate the filtrate flow rate.

5.2.1 Causes of Low Filtrate Flow

Low Operating Pressure: check the mechanical devices as indicated previously.
Fouled or Scaled Membrane: Accumulation of foulants or mineral scale on the membrane surface will reduce the filtrate or permeate flow. In most cases, membrane cleaning will be required. Refer to cleaning instructions in this manual

5.2.2 Causes of High Filtrate Flow

Defective Product O-Ring: If the interconnector O-rings are damaged, out of position or missing, waste water may be able to enter the filtrate piping and cause a dramatic increase in filtrate flow and decline in filtrate quality. Remove the fitting connections from the membrane and examine the interconnector O-rings to ensure they are in position and free of cuts, and debris.
Defective Or Oxidized Membrane: If the membrane has been exposed to certain solvents or oxidants the membrane may suffer irreversible damage, evidenced by high filtrate flow and low solids rejection. In most cases, membrane replacement will be required to restore filtrate flow. Before replacing membranes, determine the source of the oxidation or other contaminant and install the proper pre-treatment.

5.2.3 Causes of Poor Filtrate Quality

Poor quality filtrate may manifest itself in terms of;

- Bad smell of the filtrate, and this means that the membrane needs sanitizing as described in the cleaning step
- Filtrate having similar quality as feed, and this means that the membrane needs replacing or there is mixing of clean and waste water lines.

PROBLEM	POSSIBLE CAUSE	SOLUTION
Product flow low	Membranes are fouled	Identify the foulant. Follow the appropriate cleaning procedure.
	Abnormal valve open degree	Check the status and open degree valves
	Flow instruments malfunction	Keep instruments calibrated
	Feed water pressure low	Diagnose and solve the problem
	Feed temperature low	Adjust feed water temperature/ Increase flow
Poor filtrate quality	Instruments malfunction	Keep instruments calibrated. Cross check values with handheld devices or off line laboratory equipment
	Membrane Abrasion	Check pre filters, debris in pipes, examine membrane feed side
	Membrane aging, dying or damage	Contact D&S retailer
	Under Voltage	Check power quality
Solenoid valve failure to open//close	Over Voltage	Check power quality
	Improper valve status	Open solenoid valve electrical connection and correct
	Feed pump not in service	Check for proper wiring and operation of pump controller
System cannot start in auto status	Tank level low	Check tank level and level transmitters

6. TERMS OF WARRANTY

i) General Liability

- In lieu of any warranty, condition or liability implied by law, the liability of Dayliff in respect of any defect or failure of equipment supplied **is limited to making good by replacement or repair** (at the Company's discretion) defects which under proper use appear therein and arise solely from faulty design, materials or workmanship within a specified period. This period commences **immediately after the equipment has been delivered to the customer** and at its termination all liability ceases. Also the warranty period will be assessed **on the basis of the date that the Company is informed of the failure**.

- **The warranty applies solely to equipment supplied and no claim for consequential damages**, however arising, will be entertained. Also the warranty specifically excluded defects caused by fair wear and tear, the effects of careless handling, lack of maintenance, faulty installation, incompetence on part of the equipment user, Acts of God or any other cause beyond the Company's reasonable control. Also, any repair or attempt at repair carried out by any other party **invalidates all warranties.**

ii) Standard Warranty

If equipment failure occurs in the normal course of service having been competently installed and when operating within its specified duty limits warranty will be provided as follows:-

- **Up to 1 year - The item will be replaced or repaired at no charge.**
- **Over 1 year, less than two years - The item will be replaced or repaired at a cost to the customer of 50% of the Davis & Shirtliff market price.**

The warranty on equipment supplied or installed by others is conditional upon the defective unit **being promptly returned free to a Davis & Shirtliff office** and collected thereafter when repaired. No element of site repair is included in the warranty and any site attendance costs will be payable in full at standard charegeout rates. Also proof of purchase including the purchase invoice must be provided for a warranty claim to be considered.

DAYLIFF is a brand of **Davis & Shirtliff**

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