



# Unidesign/Drop in Manual English

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Version 1.4



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## 1 Introduction

### 1.1 Preamble

The purpose and intent of this manual is to provide the technical documentation required to operate a NANOSTONE Spiral Membrane.

After all given parameters have been set, manual intervention will not generally be required.

To ensure optimal production with constant quality, it is crucial, however, that certain prerequisites are met.

Moreover, the system should be checked at regular intervals during production for any variations of individual parameters and, in some cases, be readjusted.

All personnel operating the electro dialysis cells should acquaint themselves with the theoretical fundamentals of Ultrafiltration, but also with the practical handling of the plant. Understanding the general processes of electro dialysis will enable the operating personnel to rapidly detect and eliminate any issues.

The importance of the training of the operating personnel cannot be underemphasized. This manual represents the most important operating parameters with regard to preparation, course of production and cleaning.

## 2 Safety Instructions

### 2.1 Principles





The legal "Safety regulations and rules for prevention of accidents" apply irrespective of the safety instructions mentioned in this technical documentation.

Any individual entrusted by the operating company to operate, maintain and repair the plant, must have read and understood the applicable documentation, in particular the chapter "Safety" before starting his or her work.

Generally, all personnel are responsible for their own safety at work.

Compliance with all applicable safety regulations and legal instructions is precondition to avoid personal injury and damages to the plant during commissioning, maintenance and repair work.

Proper operation, maintenance and repair of the plant requires appropriately trained personnel. The operating company is responsible for training and instruction.

	<b><i>Proposal to improve or facilitate operation of the facility</i></b>
	<b><i>Indication of possible problems or threats</i></b>
	<b><i>The plant can be damaged if the operation is not done this as instructed.</i></b>
	<b><i>Risk of personal injury and machine damage if the operation of the system not done as instructed.</i></b>



## 3 Documentation

### 3.1 General

A plant-related technical documentation is elaborated for any plant designed, manufactured and delivered by NANOSTONE Water and supplied to the operating company.

In its execution, the technical documentation follows the applicable standards and regulations as well as the European Law on Product Liability.

The technical documentation has been structured to be user-oriented. Assignment of the respective part of the documentation to the right target group is the responsibility of the operating company. The operating company must also ensure that at least one copy of the technical documentation is kept in immediate vicinity of the plant and accessible to the concerned target group.

## **3.2 Proper Use**

### **3.2.1 Operating Safety**

The operating safety of the plant is only assured with proper use and is subject to the applicable safety regulations. Improper use of the plant or of individual parts of the plant may cause:

- Danger to life and limb of the operating, maintenance and repair personnel
- Danger to the plant and to other assets of the operating company or of third parties
- Danger to the efficient operation of the plant.

### **3.2.2 Technical Condition**

The plant shall only be operated in good technical condition with consciousness of safety and hazard, subject to the applicable regulations.

### **3.2.3 Purpose of Use**

The plant shall exclusively be used for the purpose that has been contractually agreed between the manufacturer/supplier and the operating company. Any other or extrinsic use shall be deemed to be improper use. The manufacturer/supplier does not undertake any liability for damages resulting from improper use. Improper use is at the operating company's own risk.

Proper use also includes compliance with the applicable operating and maintenance instructions as well as observance of the inspection and maintenance conditions.

## **3.3 Organizational Measures**

### **3.3.1 Compliance with Regulations**

The operating company shall ensure by suitable organizational and educational measures that the individuals charged with operation, maintenance and repair of the plant comply with the applicable safety regulations and rules for prevention of accidents.

The operating company shall ensure that the plant is operated, inspected and maintained appropriately. The responsibilities and competencies for these measures shall be clearly set forth. The operating personnel shall be trained to be acquainted with the safety devices of the plant and with their appropriate operation.

### **3.3.2 Protective Devices**

The operating company shall ensure that the plant and its protective devices are inspected for safe condition by an expert it has appointed, at intervals depending on service conditions, but at least once per year.

The result of these inspections shall be recorded by the expert in the inspection booklet or in the machine logbook.

The protective devices of the plant have been designed in a way that endangering the operating personnel is excluded if the plant is used properly. The operating company shall ensure that protective devices are not bypassed.

### **3.3.3 Personal Protective Equipment**

As far as required by regulations or by the operating company, the operating, maintenance and repair personnel shall use personal protective equipment. The operating company shall ensure that this regulation is complied with.

### **3.3.4 Danger Signs**

The operating company shall ensure that the safety and danger signs on the plant are observed and that the sign plates are kept in a legible condition.

### **3.3.5 Malfunctions**

In case malfunctions affecting safety occur on the plant or if the working process leads to the conclusion that there are such malfunctions, the plant shall be shut down immediately until the malfunction has been found and eliminated.

The operating personnel shall be obliged to report malfunctions immediately to the operating company.

Malfunctions shall be eliminated by expert qualified personnel only.

### **3.3.6 Modifications**

No modifications, extensions or conversions affecting safety shall be made to the plant without the consent of the manufacturer. The specified energy values shall not be changed.

This shall also apply to the installation of safety devices, membranes and valves, and to the execution of welding work on bearing parts.

### **3.3.7 Program Changes**

No program changes (software) shall be made to program control systems.



### **3.3.8 Spare Parts**

Only spare parts complying with the requirements set forth by the manufacturer shall be used.

This is always ensured in the case of original spare parts.

Improper and improvised repairs and false spare parts entail loss of warranty and exclude a product liability of the manufacturer for any damages resulting thereof.

### **3.3.9 Hose Pipes**

The joints, couplings and connections of the pneumatic lines shall be checked weekly for blowing or whistling noise. In the event a leakage is audible or visible, or in case the sheathing shows damages like cracks, kinks, detachments, chafing or embrittlement, relieve the pressure of the pneumatic system and replace the defective elements.

Replace the pneumatic hose lines at the intervals stated even if there are no signs of defects affecting safety.

### **3.3.10 Tests / Inspection**

Comply with the intervals stated in the Maintenance section for repetitive tests and inspections.

### **3.3.11 Appropriate Tools**

Use only appropriate tools to carry out maintenance and repair work. Do not use any improvised tooling. Contact the manufacturer in case of doubt.

## 3.4 Selection of Personnel

Working on/with the plant shall only be carried out by reliable personnel. The legal minimum age shall be complied with.

Employ only trained and accordingly instructed personnel on the plant; the case being, use the training and instruction courses offered by the manufacturers.

Let personnel who are in the course of training, instruction, education or apprenticeship only act under permanent supervision of expert specialized personnel.

Work on the electrical equipment of the plant shall be carried out by trained specialized electricians only.

Work on the pneumatic equipment of the plant shall be carried out only by personnel who have appropriate knowledge and experience of pneumatic technology.

## 3.5 Operating Stage

### 3.5.1 Automatic - Manual Mode

Abstain from any method of working that might affect safety.

Operate the plant only if all safety devices are fitted and operative.  
Check the plant at least once per day for visible damages and defects.

Immediately report to the competent department/individual if any change occurred, inclusive of the operating performance; if a change is detected, shut down the plant immediately and secure it against unauthorized use.

In the event of malfunction, shut the plant immediately down and secure it against unauthorized use.

Restart the plant only after the cause of the malfunction has been eliminated.

Carry out startup and shutdown procedures as set forth in the operating manual.  
Observe the control indicators.

Before switching on/starting up the plant, ensure that nobody can be endangered by the starting plant.

The "Mode" selector switch must be in the position required to operate the plant.

### 3.5.2 Inspection, Maintenance, Repair and Cleaning Work

Carry out properly and on time all inspection, maintenance and repair work set forth in the operating manual. Carry out repair work on the plant only if the required expert or competent personnel is available. Should this not be case, call for the manufacturer's specialists.

The above work shall only be carried out by expert personnel who have acquired the skills to do so by means of instruction and training.

Before beginning such work, the personnel operating the plant shall be informed of the intended work. A responsible supervisor shall be appointed.

The repair area shall be secured as far as required.

In case the plant is shutdown to carry out maintenance and repair work, measures against unauthorized restart must in any case be taken, e.g. by securing the main or control switch by means of a personal padlock. The key to such padlock shall under any circumstances remain with the person who carries out this work.

Appropriate signal plates shall be applied to indicate that maintenance, repair or cleaning work is carried out on the plant.

Take under any circumstances all necessary safety measures before beginning the maintenance, repair or cleaning work. In the event of manual cleaning, the cleaning personnel shall, as far as required by regulations, bear personal protective equipment. A supervisor must be informed of the cleaning work.

When dismantling parts and assemblies, care shall be taken that this dismantling work does not endanger the repair personnel, e.g. by unexpected movements of valves, pumps, gates etc. In case such danger cannot be excluded, precautionary protective measures shall be taken, e.g. by providing for supporting or retaining constructions.

Dismount parts and assemblies only if the personnel entrusted with such work have the required knowledge to carry out this work in a skilled and safe manner. In case of doubt, call the manufacturer for information or for sending his specialists.

In the event using lifting gears is required to replace parts or assemblies, care must in any case be taken that the parts are safely secured by means of slings and that the equipment has the required lifting capacity.

Use only suitable and technically unobjectionable lifting gears.

Do not stay or work under suspended loads.

In case of mounting work over body height, use the provided or other appropriate stairs and working platforms! Do not climb onto parts of the plant. Keep all handles, steps, railings, platforms, ladders etc. free from dirt.

Before cleaning the plant with high pressure cleaners or other cleaning agents, cover/occlude all apertures into which no cleaning agent may penetrate for reasons of safety and/or function.

This applies particularly to electric motors, switchgears, distribution boxes and switch cabinets.

After cleaning, remove all covers and obstructions.

In case of working on piping's or hose lines and valves carrying or containing fluids or vapors, take care that the pumps are shut off. The piping or hose lines and valves must be fully cooled down and depressurized. The shutoff valves located upstream and downstream of the concerned line sections and valves must be closed and secured against accidental opening. If possible, the medium shall be drained.

## 3.6.1 Electric Energy

Use original fuses with the prescribed rating only! In case of malfunction of the electric power supply, shut the plant immediately down.

Work on switch cabinets or electrical equipment shall only be carried out by skilled electricians or by trained personnel under the direction and supervision of skilled electricians according to the regulations of electrical engineering. The applicable VDE regulations shall be complied with.

Plants and plant parts on which maintenance and repair work is to be carried out shall, if prescribed, be switched idle.

First check that the plant parts switched idle are really idle, then ground and short-circuit. Insulate adjacent live plant parts!

The electrical equipment of the plant shall be inspected at regular intervals. Defects like damaged cables, cable joints etc. shall be eliminated without delay.

In the event work on live plant parts should be necessary, provide under any circumstances for a second person who will actuate the main switch to interrupt the power supply in case of emergency.

Use insulated tools only!

In the event work should be interrupted, always reestablish safe condition, e.g. close the switch cabinet.

If working on high-voltage parts and/or high-voltage assemblies, connect the supply cable to ground after having switched them idle and short-circuit the elements, e.g. capacitors, by means of an earth rod.

Work on live parts shall be carried out following the applicable safety regulations.

VBG 4 "Electrical plants and equipment"  
DIN/VDE 0105T1 "Operation of power installations"

## 3.6.2 Pneumatic System

Work on pneumatic equipment shall only be carried out by skilled personnel who have particular knowledge and experience of pneumatic technology.

All lines, hoses, screwed joints, flanges, valves etc. shall be checked at regular intervals for any signs of damage! Observe the special regulations for hose lines (ZH1/76)!

Immediately eliminate leaks and damages!

Open screwed joints, flanges, locking screws, valve attachments etc. in the pneumatic system, only if the respective section of the system has previously been depressurized!

Check the test pressure gauge!

In the event pressure accumulators and pressure vessels are integrated into pneumatic systems, care must absolutely be taken that these elements are depressurized before opening any parts of the line. There is danger due to accumulated energy!

Pressure accumulators and pressure vessels subject to the regulation on pressure vessels must be inspected according to this special regulation.

## 3.6.3 Oils, Greases and Chemical Substances

Always comply with the safety regulation applicable to the respective product when handling oils, greases and other chemical substances.

Particular care shall be taken when handling acids and lyes.

See safety data sheets.

Safety data sheets are placed at disposal by the manufacturer.



## 3.7 Environmental Protection

During all stages of operation as well as during all maintenance, repair and cleaning work, the applicable regulations for environmental protection shall be complied with. The DIN safety data sheet (DIN 52900) must be observed when using cleaning agents respectively solvents. The designations are:

- Particular hazards = R sets
- Safety recommendations = S sets
- Waste key numbers etc.

The supplier of these cleaning agents respectively solvents must place the data sheets at the disposal of the company operating the plant.

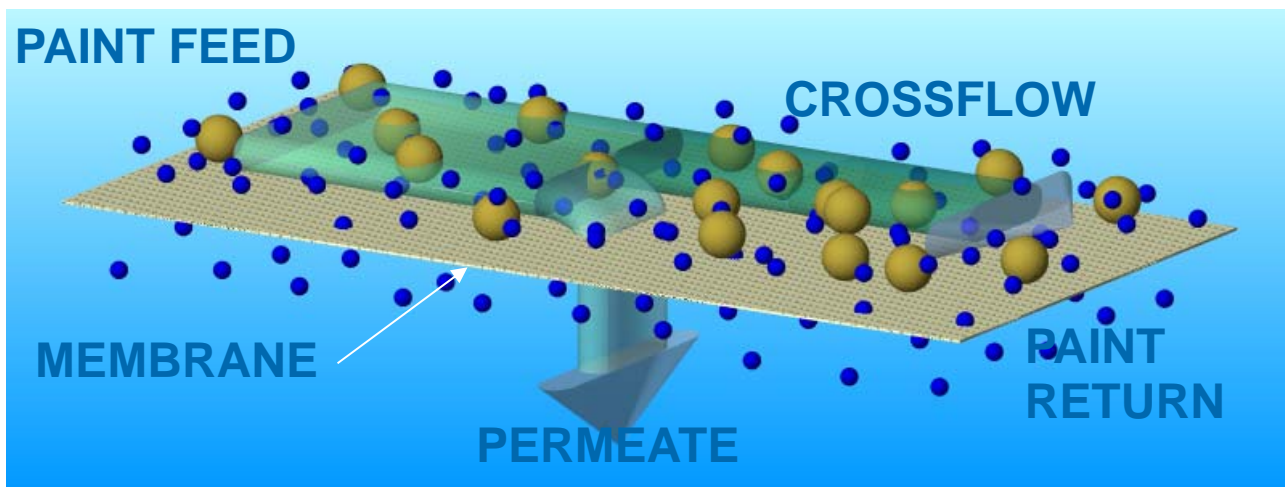


## 4 Introduction Ultrafiltration

Ultrafiltration is a pressure-driven membrane process capable of separating soluble 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 (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.



The degree of paint recovery depends on the quantity of rinsing water which is supplied to the electro-dip coat painting bath. This quantity corresponds to the quantity of filtrate.

The filtrate capacity refers to the membrane cartridge surface area at a certain paint recirculation capacity and is known as the "specific filtrate capacity". It depends on the type of paint used and must be determined from case to case by way of measurement.

The specific filtrate capacity is also influenced by the paint recirculation system, i.e.:

- Pressure
- Temperature
- Solids concentration
- Cross flow
- Carry over from pre-treatment

The most effective process is to use the filtrate as rinsing liquid as described above.

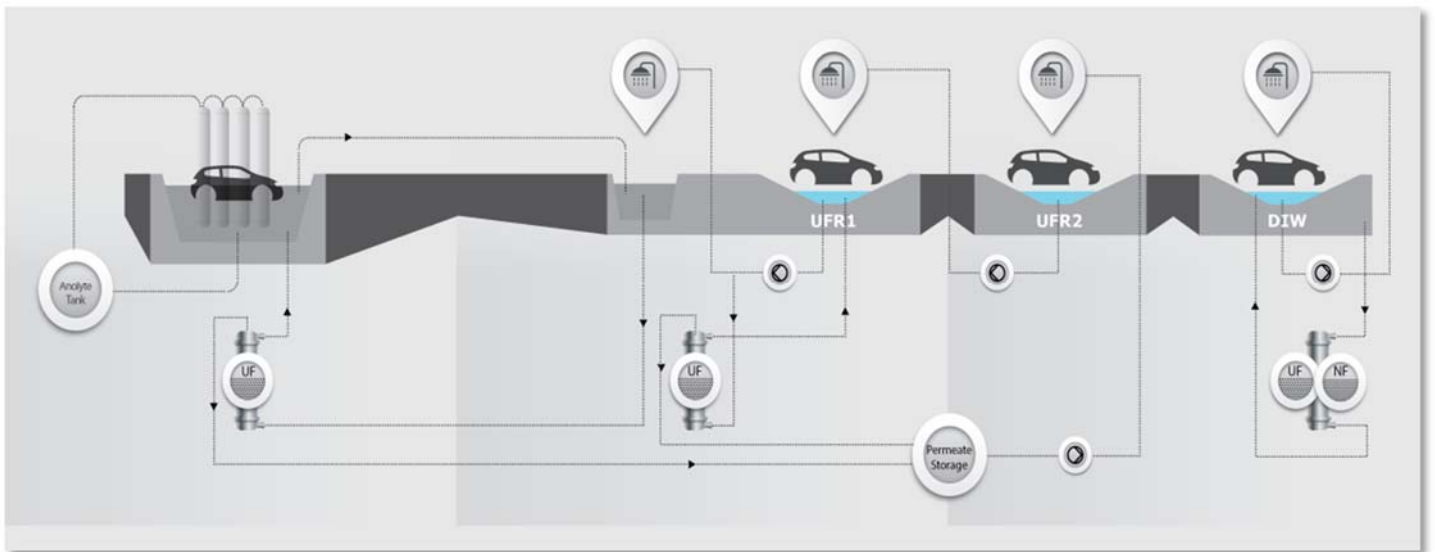
The influence of the filtrate as rinsing liquid on the quality of the paint as well as the influence of filtrate extraction on the quality of the paint bath should be examined by the supplier as part of the commissioning procedure.

It is necessary to adapt the replenishing material to the specific use of ultrafiltration.

In addition to the above-mentioned effects, a further advantage is offered by the fact that disturbing ions are separated from the paint - greatly simplifying bath monitoring and bath control.

#### 4.1 Summary of Advantages of Ultrafiltration:

1. Paint saving
2. Water saving (fresh and demineralized water)
3. Reduction in wastewater treatment costs or no costs incurred
4. Simplification of bath control
5. Increase in bath stability



Typical Closed Loop Rinsing System

## 5 UF Sealed Element Installation Instruction

### 5.1 Required Materials

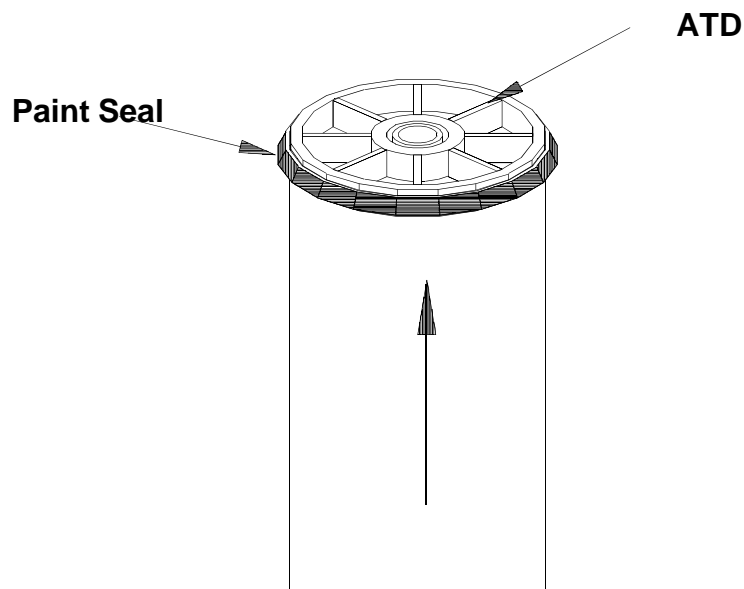
1. Clean rags
2. Glycerin and/or hand soap + water

### 5.2 Required Tools

1. Pipe wrench
2. Gloves
3. PSA

### 5.3 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. Install new O-rings on the top cap permeate tube and the bottom plug, unless provided.
4. 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.
5. 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).
6. 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.
7. Insert the top cap permeate tube into the top of the element, install and tighten the bolts on victaulic clamp.

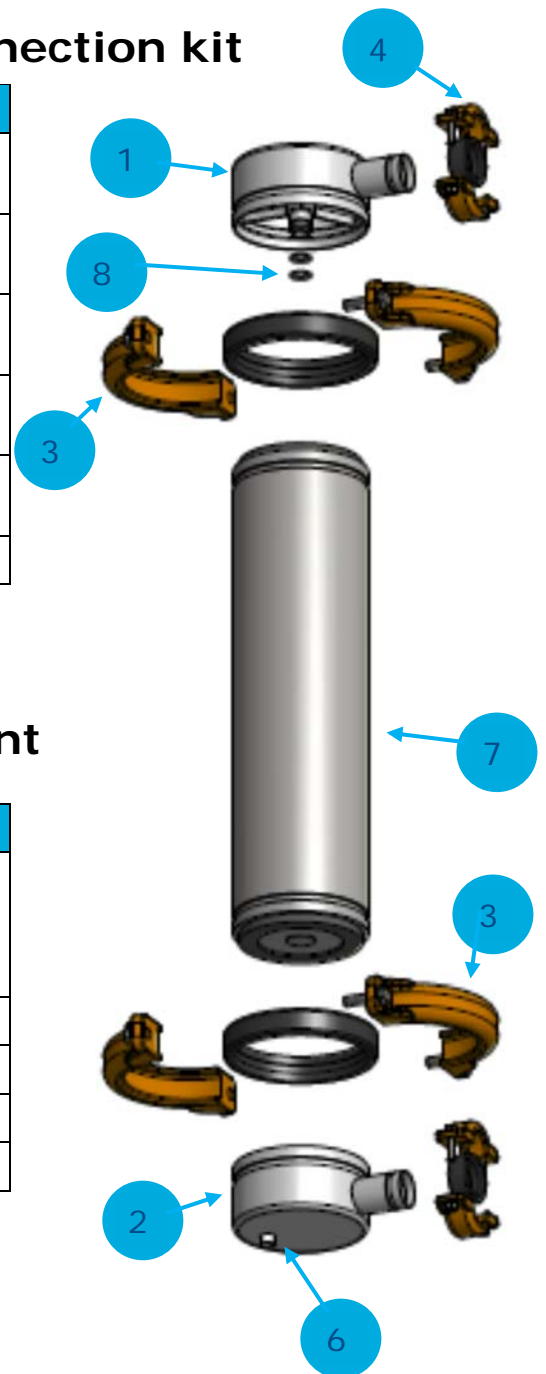


## 6 Unidesign 8" Installation Instructions

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. Install new O-rings on the top cap permeate tube.
4. Remove the element from the shipping carton and plastic bag, record the serial number and position on the log sheet and housing label.
5. Lift and attempt to install the element as is on the end cap.
6. Put the top cap permeate tube into the top of the element. Re-install the Victaulic fittings making sure they are properly lined up.

## 7 Included in the Unidesign connection kit

Item	Description	Amount	Size / Material
1	End Cap Standard 8" / 1", top	1	304 (silicon free)
2	End Cap Standard 8" / 1/2", bottom	1	304 (silicon free)
3	Victaulic Coupling 8"	2	steel / EPDM (silicon free)
4	Victaulic Coupling 2"	2	steel / EPDM (silicon free)
5	Connection for manifold 90mm x 2"	2	steel / EPDM (silicon free)
6	1/2" Connection for Drain	1	304



## Included in the Unidesign Element

Item	Description	Amount	Size / Material
7	ECOAT Element Housing PV400-8640AH-TX1D or PV400-8640FH-TX1D or R1-8640AH-TX1D	1	PVC-C PVDF 400 PVDF 400 PES
8	O-Ring for Permeate adapter	1	EPDM
9	Glycerin pack	1	Silicone free
10	Installation instruction	1	Paper
11	Silicon free certificate	1	Paper

## 8 System Start Up

### 8.1 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 (not needed with a slow starting pump controlled by frequent converter).
2. Never start the cleaning pump without first closing pump discharge valve.
3. The 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.
4. No anti-foaming agents of any type are to be introduced into the UF system.
5. No silicone-based materials (waterproofing sprays, lubricating fluids or greases, etc.) are to be used in or around the 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 backpressure or vacuum. Excessive backpressure or vacuum will delaminate the element.
7. Minimize the time the system is under "low flow" conditions. These are periods when bypass 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 ultrafiltration system. Otherwise, premature fouling of the membranes may occur.



## 9 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 2.7 bar In, and 0.7 bar 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.
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)

## 10 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 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 UF 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 3.0 bar inlet pressure and 0.9 bar outlet pressure (or a Delta P of 2.0-2.3 bar).
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.

## 11 Maintenance

Ultrafilter (UF) maintenance ultimately relates to the decline of the flux rate and the recovery procedure. Several factors in the normal operation of the ECOAT 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
- "drag-in" contamination from pretreatment

Due to 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 possibly be avoided and the cause of flux decline be pinpointed more accurately and eliminated as a potential or recurring problem.

After system start up, the UF flux rate will decline to a steady-state flow within some days.

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 elements. If an unplanned shutdown occurs, immediately drain and flush the system with fresh D.I. or R.O. water (better to use permeate if available) and institute a chemical cleaning procedure before leaving the system shutdown for any period of time.

## 11.1 Known Causes of Flux Decline

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

### 11.1.1 Contaminants (Limits for foreign ions)

Concerning paint-critical components such as  $\text{PO}_4^{3-}$ ,  $\text{M}^{1+n+2}\text{P}_n\text{O}_{3n+1}$ ,  $\text{Fe}^{3-}$ ,  $\text{Fe}^{2-}$ , the actual limits given by the paint suppliers are valid, as long process dependent (pH, carryover, concentration etc.) no membrane inhibiting precipitates are formed.

### 11.1.2 Bacteriologic

Many bacteria, such as pseudomonas aeruginosa or bacillus mycoides proliferate at typical paint conditions. Make sure that bacteria checks, even for slime forming bacteria, are made on a weekly basis.

### 11.1.3 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:

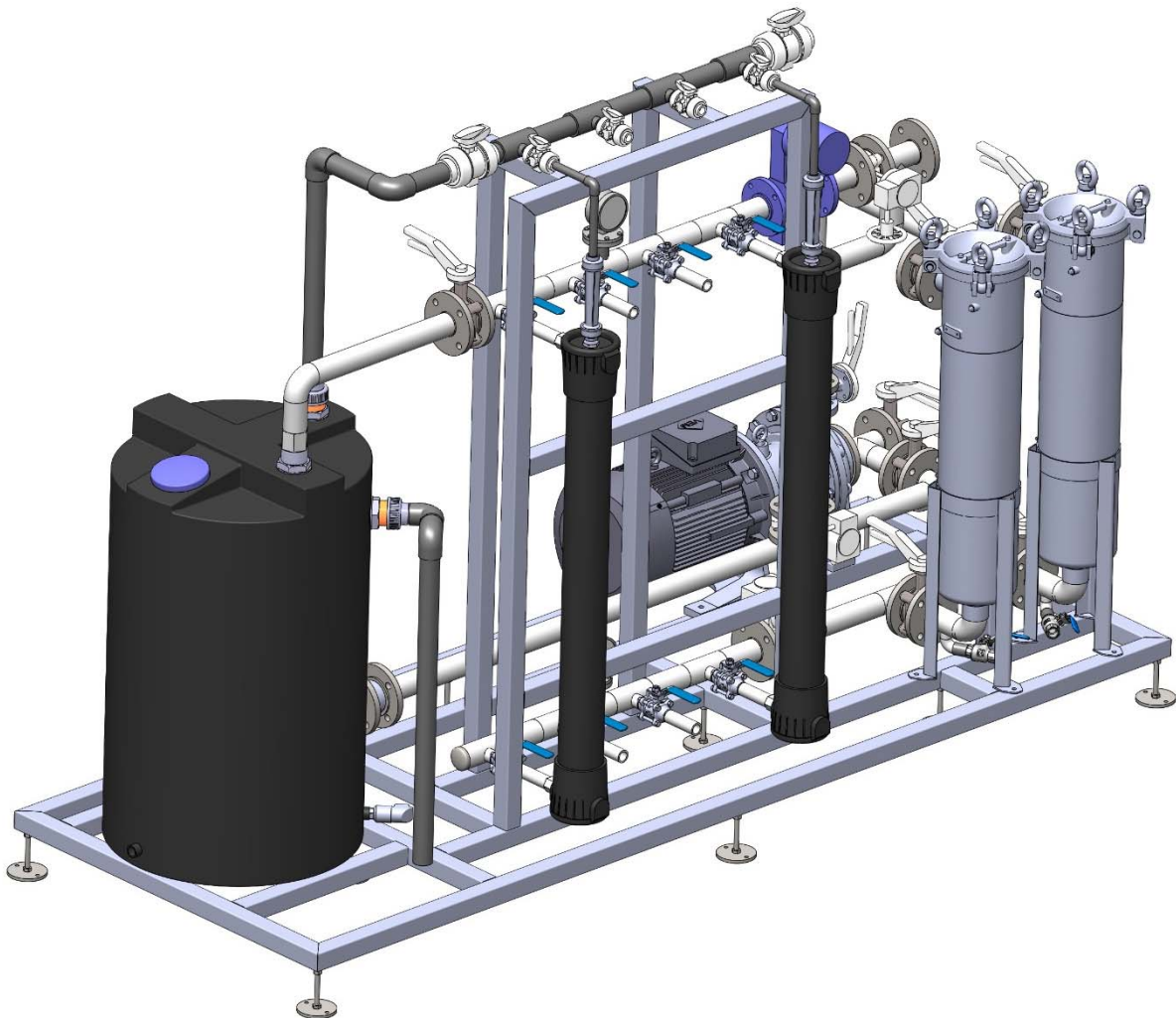
- Inadequate solubilizer levels causing the paint pH to move out of range
- Contaminants (such as iron) reacting with the solubilizer or paint
- Bacteria consuming the solubilizer or otherwise disturbing the paint solubility
- Flow rates too low to sweep away the fouling layer at the surface of the membrane
- 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 2.0 – 2.3 bar, with a minimum outlet pressure of 0.7 bar.

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 from the UF system.

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



Unidesign System for 2-4 Unidesign Elements PV400-4040-31H

## 12 Risks

Paints always contain some minor percentage of destabilized paint particles which will cause sediment or agglomerate formation in system areas of zero flow. Because some 10 g of agglomerates can ruin an 8" Element, utmost care must be taken to avoid sediments and / or agglomerates which can hit the UF-modules

Beside others, following items are of major concern:

- pump breakdowns
- changing pH value at production free phases caused by unbalanced anolyt system
- long piping between bag filters and UF-unit
- depressions in feed piping
- dead-end piping during bag filter change between bag filter and paint feed manifold pipe
- dead-end in feed pipe after the last module
- over filtration by filter bag
- insufficient data monitoring
- Closed permeate valve or high permeate pressure
- Air in the UF circulation loop



## 13 Warnings



Improper treatment or handling of the UF-modules may cause early element breakdown. For example, the inner membrane layers may lose integrity and the permeate runs turbid. Following instructions should be taken into serious consideration:

- For UF-module treatment never use tap water, always use demineralized-water (DI-water) pH adjusted DI-water or permeate
- Keep modules wet with permeate for storage
- New installed modules have to be flooded with permeate or pH adjusted DI-water immediately
- Do not exceed the recommended pH- values and temperature ranges
- Avoid alkaline-, silica-, chromate- and phosphate compounds
- Start- up and shut-down procedures must be done with care
- Avoid pressure and feed flow peaks
- Avoid sediments downstream of the filter bags, starting with clean filter bag cages.
- Take notice of all relevant technical and other local regulations.
- Adhere to the relevant SAFETY REGULATIONS

## 14 Recommended working conditions



Ideal working conditions do not exist; only paint specific compromises between permeate performance, process conditions and lifetime of the module. In the event that process conditions change, rough flux predictions can be made after the system has been stabilized, which can take several days.

In order to determine the best process conditions, some trials at different pressures would be necessary, where it is essential to know the effective paint flow. Masking or fouling of a cross flow membrane means a particle layer has formed on the membrane, like a filter cake.

The thickness of the layer is dependent on the paint composition, flow velocity and transmembrane pressure and actual condition of the module itself. In the case of too low feed flow velocities, the turbulences cannot keep the membrane surface clean any longer. The masking layer will increase continuously and flux rate declines. The transmembrane pressure (TMP) is the driving force that generates permeate. Low TMP will generate lower flux rates, but high TMP will also reduce flux rate as the pressure compresses the masking layer thus reducing its permeability.

It is highly recommended to develop an efficiency diagram (flux rate as a function of feed flow, inlet and outlet pressures) of the individual paint system during commissioning by means of an inductive flow meter. Please be aware to the fact modules that have been operated already with other paints are likely to behave differently than when operated in unused condition with the new paint. Resulting flux rates may be very different! After installation of a new module, it takes time and slowly increased pressures to get all the air out of the module construction (observe the air bubble development in the permeate flow meter).

Air bubbles can cause module failure due to induced higher flow velocities in the fluid. Do not allow an excessive air bubble stream which would turn the permeate flow almost into white condition. Allow some more flow / pressure, when permeate is looking like nice sparkling mineral water. At a careful handling, the module should be properly vented within 10 minutes.

When starting new modules, record the individual flux rates, type and serial number of the module and pressures of the system.

## 15 Delamination Risk

- Never fill the housing via the permeate pipe!
- Avoid static backpressure on the permeate!
- Permeate pressure shall never exceed the paint outlet pressure during operation!
- During start-up the permeate back pressure should never exceed 0.3 bar - otherwise the thin membrane layer would be delaminated from the permeate side!
- Vacuum is not allowed!  
(take care if permeate storage tank or Feed pump is not on the same level than the UF System)

## 16 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

## 17 Cleaning Formulations

### 17.1 Cleaning Formula #1

To 92% – 94% DI water add 3% butyl cellosolve, 5% glacial acetic acid or 3% formic acid or up to 3% hydrochloric (muriatic) acid, and 2% by weight of granular citric acid\*\*. The initial volume of DI/RO water depends on which acid is used for cleaning.

This formulation is for normal paint fouling. Circulation time is typically 1-2 hours at 40.6° C) [do not go over the maximum temperature your paint supplier would want to see in the paint tank] maximum temperature. Measure the pH of the cleaning solution before circulating it through the element. Maintain the pH between pH 2.0 and pH 2.3. DO NOT GO BELOW pH 2.0 or damage to the element could occur. Measure the pH of the cleaning solution as time goes by and adds acid to maintain the pH as listed above.

\*\* - The weight of citric acid to add (in pounds) is determined by multiplying the total volume being circulated in gallons by 8.34 pounds, then multiplying that answer by 0.02.

Note: Citric acid is used to remove free iron from the membrane surface. If you have not received a report from your paint supplier that there is free iron in the bath over 20 PPM, you do not need to add citric acid to the cleaning formulation.



Personal protective clothing has to be worn!



Heavy fouling can make a higher detergent concentration required. In this case, please contact a NANOSTONE representative.

## 17.2 Cleaning Formulation #2

To 91.5% – 93.5% DI water add 3% butyl cellosolve, 5% glacial acetic acid or 3% formic acid or up to 3% hydrochloric (muriatic) acid, and 2% by weight of granular citric acid\*\*. Add 0.5% by volume of Triton X-100 (available from Union Carbide) to the cleaning solution for the last 30 minutes only. Make sure the cleaning return and the permeate cleaning return pipes are below the liquid level in the cleaning tank or you will generate excessive amounts of foam and suds. The initial volume of DI/RO water depends on which acid is used for cleaning.

This formulation is for severe paint fouling and it is typically circulated for 2-4 hours at 41°C maximum temperature.

Note: If your elements are severely fouled, and/or you notice that the cleaning solution is really dirty (evidence of a lot of paint in it), consider circulating the cleaning solution you are using for an hour, and then stopping. Drain the cleaning solution from the cleaning tank, flush the element thoroughly and start to clean again with a fresh cleaning solution, starting to circulate it when it is at the same temperature as the paint in the paint tank.

Alternate Premixed Cleaning Formulations:

There is a number of premixed UF membrane cleaning solution available from various chemical suppliers. When using these, always check with your element supplier and fax or e-mail a copy of the MSDS for the cleaner to them so they can check for chemical compatibility.

Follow the supplier's dilution recommendations unless the diluted concentration would exceed 3% butyl cellosolve. In addition, measure the pH of the cleaning solution. Add one of the above referenced acids (always check for compatibility with the paint bath with your paint supplier!) to bring the pH to between 2.0 and pH 2.3 as well as to maintain it at that level.

### 17.3 Cleaning Formulation #3

This formulation is for lead and phosphate fouling. It is done after cleaning the element with either of the first 2 formulations listed above. Circulate this solution for 30 minutes only.

To 99.5% DI or RO water, add 0.5% technical grade nitric acid, pH 2.0 to pH 2.3.



Before adding cleaning chemicals fill containers with water.  
Danger of a chemical reaction.



Ensure adequate ventilation of the plant!



Personal protective clothing has to be worn!



## 17.4 Cleaning Formulation #4

This formulation is used when there is evidence of iron fouling in the paint bath, as measured by your paint supplier. This solution is circulated after cleaning the elements with either of the first 2 formulations listed above.

To 100% DI water, add 2% by weight, of granular citric acid. Monitor the pH level and do not allow it to go below pH 2.0.

## 17.5 Cleaning Formulation #5

This formulation is used when bacteria (biological fouling) is found or suspected in the paint bath. Also use this formulation to clean the elements when a “bacteria kill” has been done to any of the paint tank post rinses or to the final pretreatment post rinse before the e-coat tank.

To 100% DI water, add enough hydrogen peroxide to reach a level of 500 PPM. This procedure is covered under a separate cleaning regimen.

Some membrane manufacturers will list a cleaning procedure for bacteria or biological fouling using chlorine bleach. Most of the paint suppliers do not approve of using chlorine bleach to clean UF elements because of the risk of contamination to the paint bath as well as possible damage to the stainless steel anodes used in the e-coat tank.

For cleaning UF elements used in anodic paint baths, the following formulations are used. On very rare occasions, you may have to clean an element used in an anodic tank with Cleaning Formulation #5 due to bacteria or biological fouling.



## 17.6 Cleaning Formulation #6

To 99.8% UF permeate, add 0.2% solubilizing amine. The amine is to be specified by the paint supplier. Circulate this cleaning solution for 30 minutes.

This formulation is used for mild paint fouling or preventative maintenance.

## 17.7 Cleaning Formulation #7

To 89.7% permeate; add 10% butyl cellosolve and 0.3% solubilizing amine. The amine is to be specified by the paint supplier. Circulate this cleaning solution for 1 hour.

This formulation is used for severe paint fouling.

The above cleaning guidelines will help maintain the useful life of an ultrafiltration membrane, provided the elements are cleaned before the permeate rate has dropped below the 20% from steady state level. If the permeate rate has dropped more than 50% before being cleaned, repeated cleaning will be necessary in order to try and restore the permeate rate. It may not work.

The effectiveness of cleaning an element may be enhanced by installing a standard 304L stainless steel 2 long bag filter vessel in the cleaning return line and using 1 micron or tighter glazed polypropylene bag filters to capture the paint solids removed from the membrane and held in suspension.



## 17.8 Post Cleaning Treatment

The use of a post cleaning membrane “conditioner” has been recommended by several membrane manufacturers in the past and at the present time, for elements used with cathodic paints. The hypothesis is that by “fouling” the membrane with a positive electrical charge, you can better restore the permeate rate of an element as well as possibly extend the time between cleanings by causing the membrane to reject the positively charged paint particles. This “conditioner” is Polymin P made by BASF.

The extent that this conditioning works depends to a great extent on how successful a person is with cleaning the element(s) in his UF system.

The standard ratio for this solution has been 1 gallon of membrane conditioner (known as P-3 and Power Charge Concentrate by two of the membrane manufacturers) to 500 gallons of DI or RO water for the P-3 and to 250 gallons of RO or DI water for the Power Charge Concentrate. In the case of P-3, the solution is premixed in a pail with the pH adjusted to the pH range of the paint bath. It is then added to the cleaning tank (filled with clean DI or RO water) where the pH is again checked and a final adjustment made before circulating it through the element(s).

In the case of Power Charge Concentrate, the conditioner is premixed with hydrochloric acid close to the required pH range. Once it is added to the cleaning tank, check the pH and make a final adjustment before circulating it through the element(s).

The dilution ratio for the membrane conditioner can be reduced to as low as 1 gallon to 125 gallons of water in order to try and maximize its effectiveness.

Follow the vendors’ recommendations for using a post cleaning treatment membrane conditioner.

This is not needed with NANOSTONE Membranes e-coat elements.

Please call NANOSTONE Membranes with your questions about cleaning spiral paint elements at:

**+49 (0) 3941 5843 61**

We will work with you to provide a cleaning regimen that will best work for your facility.