OLTREMARE
LIQUID SEPARATION

OLTRE$_{CAP}$ V- SERIES

OUTSIDE – IN AIR SCOUR

ULTRAFILTRATION MEMBRANES

CONTENTS

1. Company Profile

OLTREMARE is an Italian Company founded in 1989 as a chemical manufacturer and distributor for Reverse Osmosis membranes through its technical-oriented organization. Being involved since its first day in the reverse osmosis water treatment field, the company acquired major interest in being engaged in membrane research and development up to the point to start the production of spiral - wound Reverse Osmosis membranes.

Since 1999, all the efforts and the resources of the company are devoted to improve the manufacturing of a complete range of spiral-wound Reverse Osmosis membranes up to 8".

Today **OLTREMARE** has a complete line of products in all the filtration ranges from ultrafiltration to reverse osmosis.

OLTREMARE elements are used in many different applications such as potable water, boiler feed-water, industrial process water, waste treatment reclamation, seawater desalination, electronic rinse water, agriculture and pharmaceutical.

2. Description of OLTRE$_{CAP}$ –V ultrafiltration module

OLTRE$_{CAP}$ -V series ultrafiltration (UF) is a pressurized UF introduced by Oltremare . OLTRE$_{CAP}$ - V series membrane is an "Outside-In" hollow-fiber membrane that has a nominal pore size of 0.075µm. OLTRE$_{CAP}$ - V membrane is made by an innovative patented technology which is called "complex Thermally Induced Phase Separation(c-TIPS)" method for membrane production.

2.1 Features of OLTRE$_{CAP}$ –V Series outside-in UF module

The performances of the membranes made by the c-TIPS method are superior to those made by the NIPS or the classical TIPS method using the same materials. It can greatly solve the problem of the membrane's being easily broken. The OLTRE$_{CAP}$ - V membrane modules offer the following features:

✧ **Longevity**

OLTRE$_{CAP}$ - V membrane modules are created with advanced membrane formation technologies and unique module structures that provide superior filtration efficiency and durability.

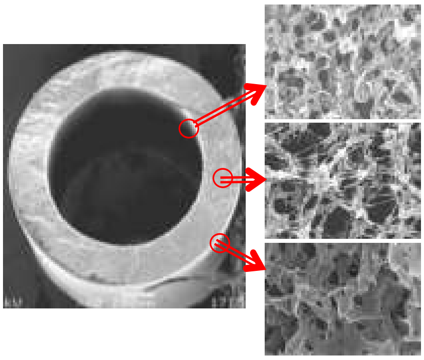


Figure 1: SEM Cross-section Photography

✧ **Robust membrane (patented technology)**

OLTRE$_{CAP}$ - V membrane is made by the c-TIPS technology which endows the membrane with high crystallinity. As a result, the membrane is good at chemical resistance, shows mechanical strength and has longer life time.

✧ **Permanently hydrophilic membrane (proprietary technology)**

The operation flux of most UF or MF membrane products is much lower than their initial flux resulting from the loss of membrane hydrophilicity by polymer reconfiguration. OLTRE$_{CAP}$ - V PVDF UF membrane remains permanently hydrophilic and thus, offers a steady flux.

✧ **Oxidation-inert membrane**

OLTRE$_{CAP}$ - V Series membrane modules can be cleaned thoroughly with strong oxidants because of the chemical inertness of the PVDF polymer.

✧ **Air lift recirculation (patented technology)**

An air diffuser is installed inside this series of Oltremare membrane modules so that air may be evenly distributed around membrane capillaries. Water is “carried” upward by this air flow and “drained” downward through a central pipe and such as to create a water recirculation current. This Air Lift Recirculation (ALR) current may greatly reduce membrane fouling.

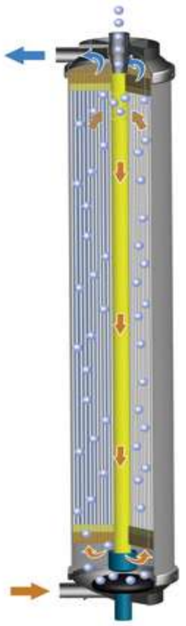


Figure 2: OLTRE$_{CAP}$ - V module structure

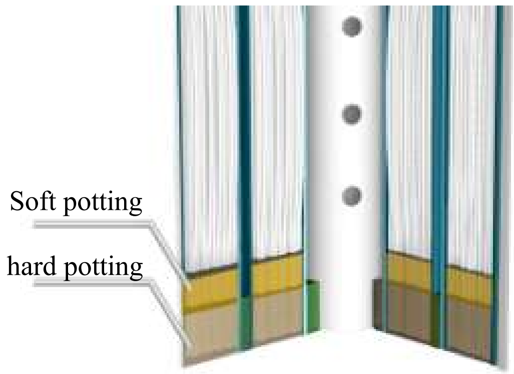


Figure 3: “Roots” of the OLTRE$_{CAP}$ - V module

✧ **Soft potting (patented technology)**

The “roots” of the capillaries (hollow fibers) are the weakest portions in membrane modules, and may be broken during operation. These portions of membranes in Oltremare UF modules are protected by a layer of soft potting material.

✧ **Low operation pressure**

Typically, Oltremare membrane is designed to be run at pressures as low as 0.02MPa (3.0 psi) to produce enough water.

- **Better permeate distribution(for steady flux)**

The "sub-unit" arrangement of the capillary membrane in a Oltremare UF module offers a better distribution of water flow in the module.

Figure 4: End-view of OLTRE$_{CAP}$ - V **UF module**

2.2 Type and specifications of $OLTRE_{CAP}$ - V series outside-in UF module

2.2.1 Membrane specification

Table 1: Membrane parameters of $OLTRE_{CAP}$- V series module

Module	Membrane area /m^2 (ft^2)	ID/OD / mm (inch)	Length / m (inch)	Pore size /μm	Material
$OLTRE_{CAP}$-1030-V	32.5(349.7)	0.9 / 1.5 (0.035/0.059)	0.75 (29.6)	0.075	PVDF
$OLTRE_{CAP}$-1060-V	70(753.2)	0.9 / 1.5(0.035/0.059)	1.5 (59.1)	0.075	PVDF
$OLTRE_{CAP}$-1080-V	95(1022.2)	0.9 / 1.5(0.035/0.059)	2.0 (78.7)	0.075	PVDF

Note: Please customize in advance if you need other types of module.

Table 2: Performance of $OLTRE_{CAP}$- V series module

Performance	Index/value
SDI_{15}	<3
Permeate turbidity①	<0.1NTU
Removal of more than 0.2μm diameter particles	99.99%
Removal of total coli forms	Not detected②
Removal of fecal coli forms	Not detected②
Removal of bacteria	Not detected③

Note：①Measured online;
②Detected with 100mL UF permeate;
③Detected with 1mL UF permeate.

2.2.2 Module Specification

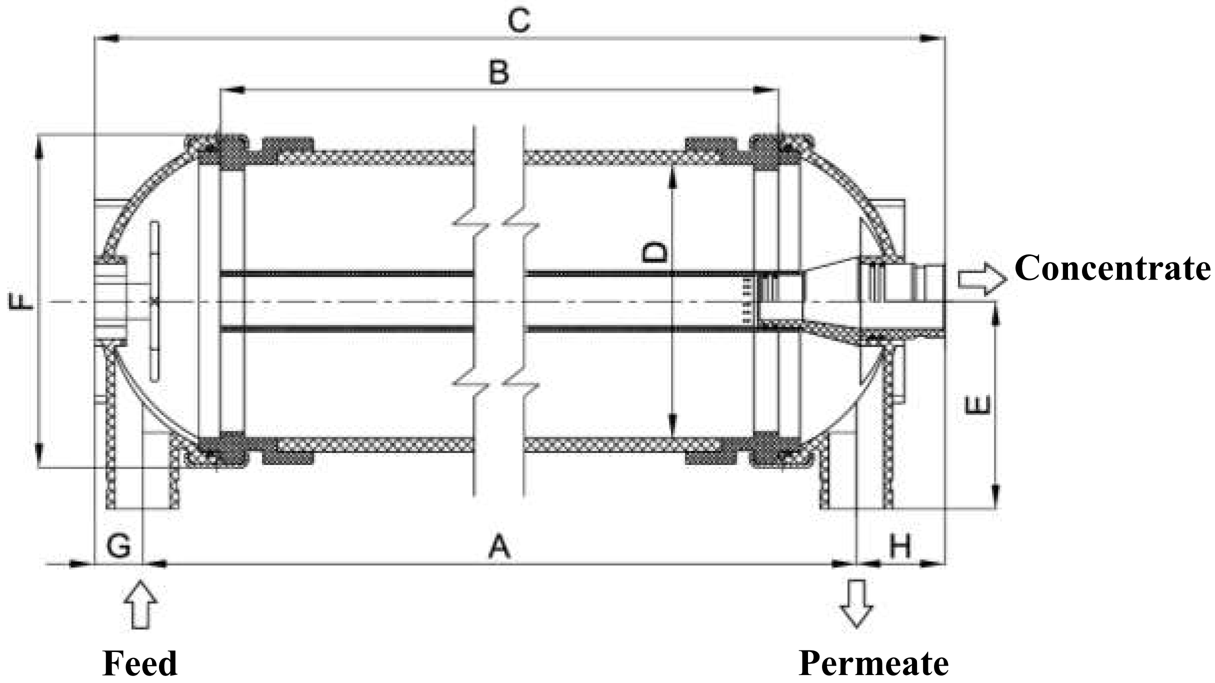


Figure 5: OLTRE$_{CAP}$- V module reference dimensions

Table 3: Dimensions of OLTRE$_{CAP}$- V Series Module

	A	B	C	D	E	F	G	H
OLTRE$_{CAP}$-1030-V	850mm (33.5″)	750mm (29.6″)	965mm (38.0″)	Φ250mm (Φ9.8″)	172mm (6.8″)	Φ277mm (Φ10.9″)	40mm (1.6″)	75mm (3.0″)
OLTRE$_{CAP}$-1060-V	1600mm (63.0″)	1500mm (59.1″)	1715mm (67.5″)	Φ250mm (Φ9.8″)	172mm (6.8″)	Φ277mm (Φ10.9″)	40mm (1.6″)	75mm (3.0″)
OLTRE$_{CAP}$-1080-V	2100mm (82.7″)	2000mm (78.7″)	2215mm (87.2″)	Φ250mm (Φ9.8″)	172mm (6.8″)	Φ277mm (Φ10.9″)	40mm (1.6″)	75mm (3.0″)

Table 4: SVF module housing material and connections

Module	**OLTRE$_{CAP}$-1030-V**	**OLTRE$_{CAP}$-1060-V**	**OLTRE$_{CAP}$-1080-V**
Housing material	PVC/ABS		
Potting material	Epoxy		
Feed, product and concentrate connections	VICTAULIC 2″		
Air inlet	3/8 inch threaded		

2.2.3 Application and typical process conditions

Table 5: Application data and typical process conditions

Module	OLTRE$_{CAP}$- V -1030-A/E	OLTRE$_{CAP}$- V -1060-A/E	OLTRE$_{CAP}$- V -1080-E
Operating temperature	5~45℃ (41~113℉)		
Operating pH range	1~10		
Operation mode	Cross-flow or dead-end Interval or continuous air scrubbing		
Typical filtrate flux	50~120 L/m^2·h (29 ~ 71 GFD)		
Backwash flux	70~150 L/m^2·h (41 ~ 88 GFD)		
Maximum applied feed pressure	0.5 MPa (73 psi)		
Maximum TMP①	0.2 MPa (30 psi)		
Air scrub flux	5 ~ 12 N m^3/h		
Air scrub pressure	≤1.0 bar，oil-free compressed air		
Backwash frequency	15~60 minutes		
Backwash duration	30~120 seconds		
CEB② frequency	Minimum one time per day		
CEB duration	2~20 minutes		
CEB chemicals	NaClO(≤1000ppm), NaOH（pH≤12）, HCl（pH≥1）		
CIP frequency	30-180 day		
CIP③ duration	60-180 min		
Cleaning chemicals	NaClO or H_2O_2, NaOH, HCl, citric acid or oxalic acid		
CIP flux	2.5 ~ 3.5 m^3/h		

Note: ①TMP is abbreviated formula of “trans-membrane pressure”
②CEB=chemical enhanced backwash
③CIP=cleaning in place

3. OLTRE$_{CAP}$ - V Outside-in ultrafiltration system design

This manual provides you information about our ultrafiltration system design guideline. You can design the ultrafiltration system according to the water resource, customers' requirements and your experience. If you need assistance, please contact us at Oltremare Srl.

3.1 Outside-in ultrafiltration system design guideline

Table 6: OLTRE$_{CAP}$ - V UF system design guideline

Parameter	Ground water	City water		Surface water		Treated industrial wastewater	Treated municipal wastewater	Sea water	
	NTU<5	NTU<3		NTU<25	NTU<5	NTU<5	NTU<20	NTU<50	NTU<5
Pretreatment	Optional	No	Yes	No	Yes	Yes	Yes	No	Yes
Filtrate flux	70~90	60~80	65~80	50~70	60~80	40~65	45~65	50~65	60~80
Particle size	<150								
Backwash frequency	30-60	30-45	30-60	20-40	25-50	20-50	20-50	20-45	30-50
Operation mode	Dead-end and cross-flow Interval or continuous air scrubbing								
CEB frequency	1-4	2-6	1-4	2-8	2-6	2-10	2-10	2-8	2-6
CIP duration	60-90	30-60	45-90	20-60	45-90	20-90	20-90	20-60	30-90

Note: This guideline only provides the reference value.

3.2 $OLTRE_{CAP}$ - V outside-in ultrafiltration system design

3.2.1 Components of UF system

Besides the ultrafiltration system, you should choose the pretreatment, dosing system of operational mode, backwashing, dosing system of backwash, CIP and so on, based on your water resource.

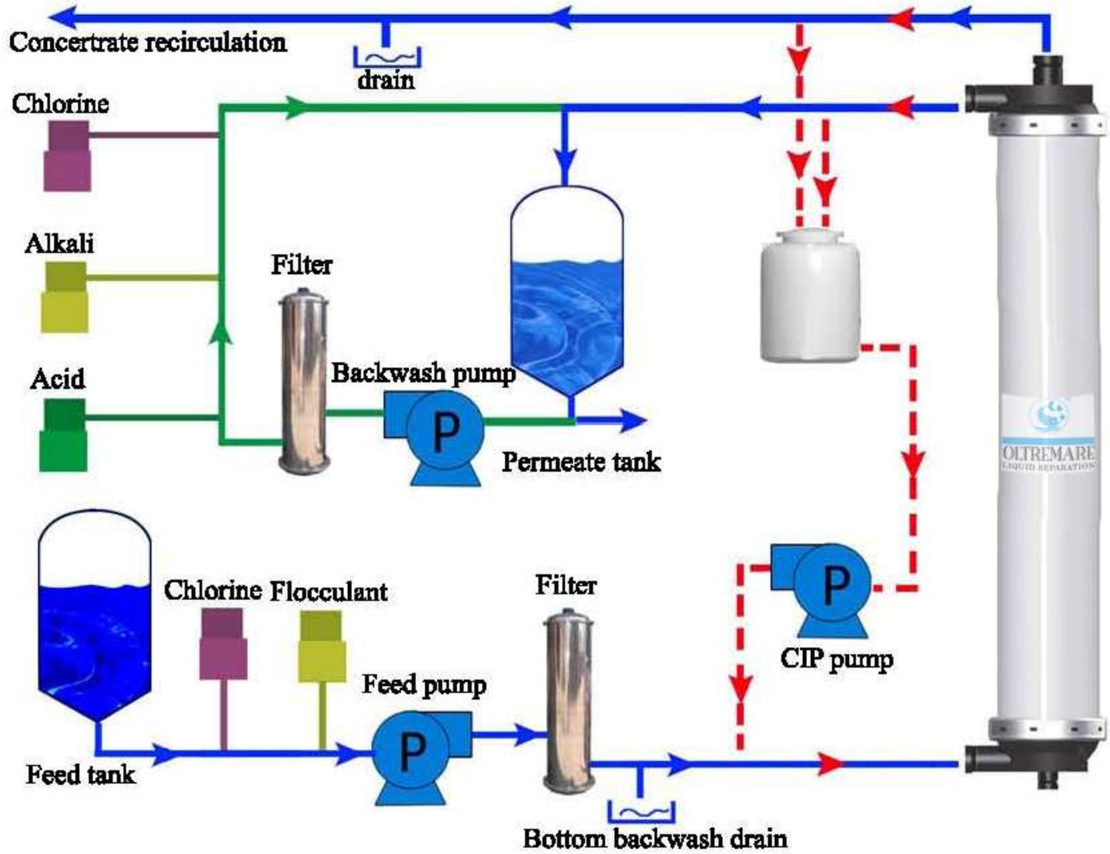


Figure 6: Components of the UF system

1. Pre-filter

The Pre-filter is always a key factor that determines the UF system to be successful or not. In order to prevent the UF membrane from getting scratched, a screen of 100μm~300μm is required.

2. Dosing system of operational mode

You can dose the disinfectant and flocculent into the water flow before it flows into UF membrane based on feed-in water quality. Commonly, the flocculent will benefit the formation of a layer of contaminant on the membrane surface and prevent the surface and pores of the membrane from being polluted.

The contaminants are easy to be removed. The quantities of disinfectant and flocculent are determined by the raw water quality, such as the turbidity, pH and so on. The disinfectant can prevent the membrane from being contaminated by microbes and organic substances. At the same time, the residue of disinfectant can inhibit from contaminating the pipeline and tank.

3. Backwash system

The Backwash system is very necessary. The Backwash can remove the contaminants and recover the performance of the membrane. The Backwash system consists of a permeate tank, a backwash pump, a pipeline, a valve, an air feed system and a dosing system. The Backwash system is controlled by an automatic controller. The backwash is divided into water backwash, air scrub and chemical enhanced backwash. During the chemical enhanced backwash, you can choose between low concentration disinfectant, acid and alkali. The optimized process is based on water quality. Regularly, a chemical enhanced backwash is a key solution to recover the performance of the membrane. It can prolong the duration of CIP.

4. CIP system

The CIP system consists of a cleaning tank, a cleaning pump, filter and heater. When the membrane is heavily contaminated or the TMP is beyond the permission, and the performance of membrane can not be recovered after chemical enhanced backwash, you should carry out CIP.

3.2.2 UF operation process

The UF operation process consists of a filtration, flush (with water and air) and CIP. The following is the filtration and flush process. CIP will be introduced in detail in the subsequent chapters.

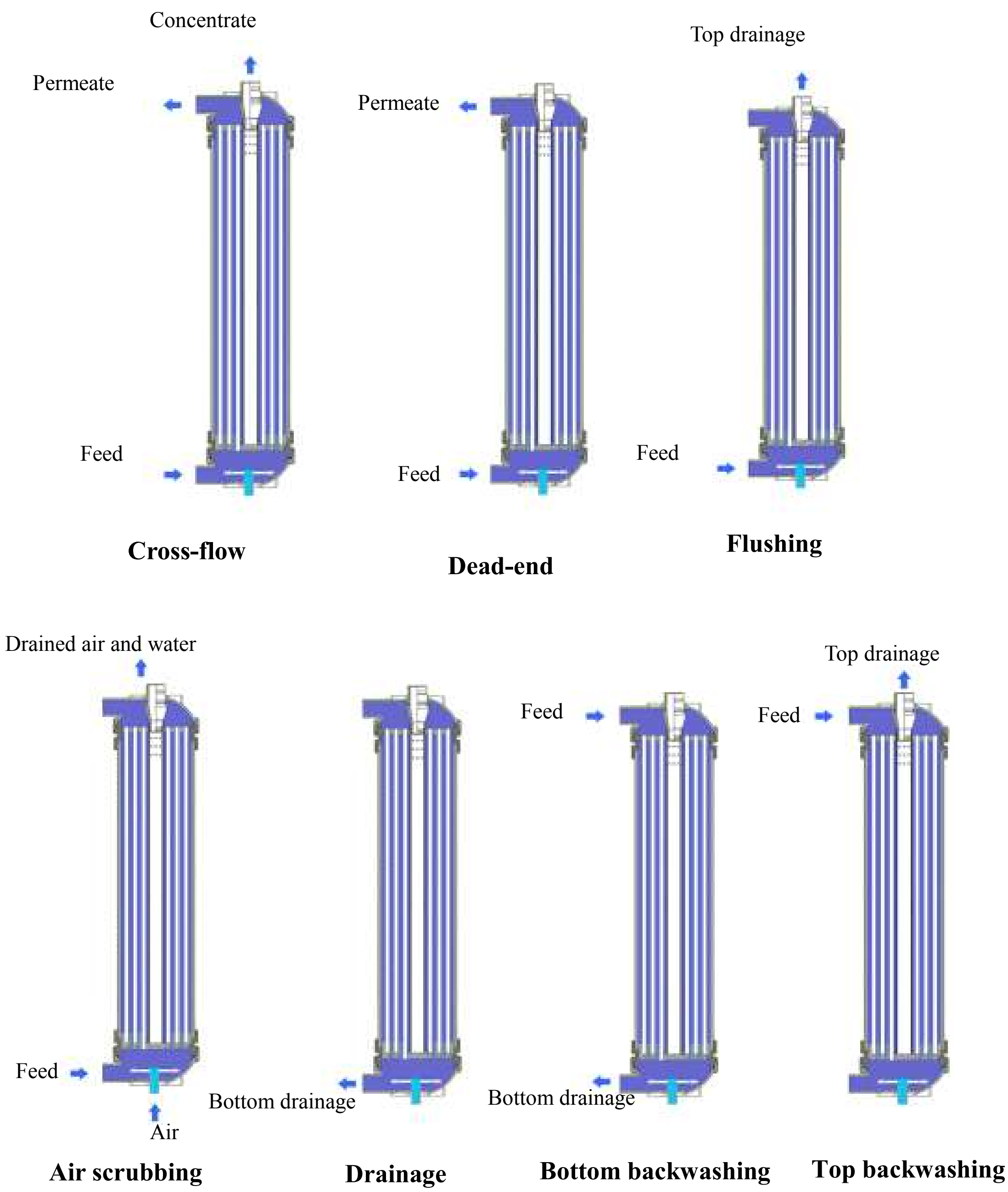


Figure 7: Operation process of the UF system

1. UF filtration mode

There are dead-end and cross-flow operation modes during the UF operation. The Dead-end operation model means that all of the feed water permeates through the membrane and most of suspended solids and colloids are barred at the feed water side of the membrane. After the setting time, the backwash mode occurs automatically and contaminants barred by the membrane will be flushed away. If the suspended solids, turbidity and COD are low, you can choose the dead-end operation mode.

Cross-flow means most of the water permeates through the membrane and the other water called concentrate is drained out of the membrane. The cross-flow can enhance the velocity of flow and reduce the contamination, but the energy consumption is higher to a certain extent. The concentrate flow depends on the feed water quality. We suggest that the concentrate flow accounts for 15~35% of all the feed flow. All or part of the concentrate flow comes back to the UF feed tank or pumped back to the UF membrane.

2. Flush process

The suspended solids, colloids and bacteria are barred by the membrane. All of the impurities will contaminate the membrane after operating sometime. In order to maintain the UF performances, a backwash occurs every 30~60 minutes.

The Flush process consists of forward flush, backwash and air scrub. The backwash is divided into top backwash, bottom backwash and both. You can choose different combination processes based on the quality of the water and the operation mode. Please refer to the table 7.

Table 7: Design guide of the UF system

Backwash mode	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Backwash	Flush	Top backwash	Bottom backwash			
Backwash and air scrub	Air scrub	Drained	Top backwash	Bottom backwash		
CEB	Air scrub	Drained	Dosing chemicals	Soak	Top backwash	Bottom backwash

The specific process of the washing procedure is described as follows:

Forward flush: You can choose UF feed water or permeate water to flush the membrane. The forward flush can remove most of the contaminants to reduce the backwash resistance and water consumption. The forward flush flow is drained through the concentrate pipeline but does not permeate through the membrane. The duration of the forward flush is 10~15 seconds.

Top backwash: We suggest users choose the permeate water as the backwash water. The water is pumped through the permeate pipeline and drained out though the concentrate pipeline. The Backwash can remove the contaminants present on the surface and in the pore of the membrane.

Top backwash makes the recovery of the top of the membrane more efficient. The suggested duration of the top backwash is 15~30 seconds.

Bottom backwash: The purpose is the same of the top backwash. But the backwash water is drained out through the bottom of the membrane. The Bottom backwash makes the recovery of the bottom of membrane more efficient. The suggested duration of bottom backwash is 15~30 seconds.

Air scrub: The air produced by oil-free air compressor flows into the membrane through the bottom of the module and then shakes the capillaries to remove the contaminants attached to the membrane. This step occurs only alone or combined with backwash. The suggested duration of air scrub is 30~60 seconds.

Both top and bottom backwash (mostly combined with CEB): In order to distribute the chemicals evenly and quickly, the water is pumped into the permeate pipeline and drained out though the concentrate pipeline and feed pipeline. The suggested duration of this step is 20~50 seconds.

Soak: In order to enhance the effect of CEB, we need to soak the membrane. The duration of soak is 60~120seconds.

A Backwash that uses low concentration chemicals solution is called chemical enhanced backwash (CEB). If most of the contaminant is organic substance, you should choose sodium hypochlorite or alkali. Moreover if the contaminants are metallic ions, you should choose acid. The operator can choose the duration of backwash, top backwash, bottom backwash and frequency of CEB according to the quality of the water.

3.2.3 Key points of design

Reasonable and efficient pretreatment is the key point of a UF system. Most of sewage water must be treated before flowing into the UF system. Flocculation deposition and filtration are all necessary. All of UF systems must install a filter which has a pore size much more finer than 150μm as a pretreatment to prevent the membrane from getting scratched.

The design should be completed by professionally trained and experienced engineers.

As a small design mistake is likely to make the overall system failure, so the engineers should conduct adequate research and analysis at the design stage in order to avoid design defects. The following are the common steps of design.

1. Collection of feed water information

The information about the feed water is very important for the system design. The type of water resource, turbidity, suspended solids, COD and BOD all have to be considered. Also, the designer has to gain enough knowledge about the variation of the feed water. Some other data, such as colloidal mater content, the types of organic pollutants and the contents of bacteria and their debris, are hard to determine but still important. The designer should investigate the case and gain even indirect information. As above mentioned, some information is difficult to collect usually, but still important for system design. The designer may estimate these data and design accordingly.

2. Selection of operation modes and the flux rate

Users can confirm the operation mode referring to the design guideline. The flux rate is determined by the feed water quality and by the membrane properties. For $\text{OLTRE}_{\text{CAP}}$ UF membrane modules, the flux rates are all suggested at 40-90 $L/m^2 \cdot hr$ in ordinary conditions when the membrane modules are selected according to the feed water qualities as described in the design guideline. The flux rates higher than 90 $L/m^2 \cdot hr$ are usually not suggested.

The Designer should determine the flux, duration of operation, backwash, etc. according to the quality of the feed water. If you encounter a special water, please carry out a pilot test first to gain the parameters.

3. Confirmation of number of modules

To determine the number of modules the system needs, another factor that must be considered is the idle time when the membrane is under backwashing and the amount of water needed for back washing.

For example, if a flux rate of 60 $L/ m^2 \cdot hr$ is selected for $\text{OLTRE}_{\text{CAP}}$ 1060 - V modules for a 100 m^3/hr system the following should be noted:

(1) Confirmation of parameters

The backwash program is designed as water washing every 45 min as air scrub 30seconds, bottom draining 15 seconds, top backwash 15seconds, bottom backwash 20seconds. Then the total washing time is 80 seconds.

The CEB program is designed as every ten times backwash as air scrub 20seconds, bottom draining 15seconds, backwash and dosing chemicals 25seconds, soak 60 seconds, top backwash 20seconds, bottom backwash 25seconds. Then the total CEB time is 165seconds.

(2) Calculation of service efficiency

The time efficiency is [operation time]/[operation time + washing time + CEB time]. Then the time efficiency is:

$(45\times10)/(45\times10+80/60\times9+165/60)= 96.83\%$

(3) Calculation of production efficiency (Supposing the backwash flow is 1.5 times of filtration)

The water production efficiency is [total production – backwash water consumption – CEB water consumption]/ total production.

Then the water production efficiency is:

$[10\times45\times4.5-9\times(15+20)/60\times1.5\times4.5-(25+20+25)/60\times1.5\times4.5]/10\times45\times4.5=97.86\%$

(4) Confirmation of the number of modules

The number of modules is: (required production)/ (production efficiency× service efficiency × production of each module).

Then the number of modules is:

$100/ (97.86\%\times96.83\%\times4.5) \approx24$

4. Backwash system design

Backwash occurs separately for each system according to the time setting. If it is a small scale system, the flow rate of backwash pump is chosen by the flow of UF unit backwash, and the backwash pump should be backed up.(?)

If it is a big scale system, we should choose two pumps as backwash pump. Each system should design a CEB system. We should avoid the water hammer during changing to other operation modes.

5. CEB chemicals

Chemicals may be added into the backwashing water in order to enhance the backwash effects. The following formulas are often used:

(1) Injection of HCl to make up the backwash water pH around 2.

HCl is often used when the hardness of feed water is high or when there is coagulant- related fouling of the membrane.

(2) Injection of NaOH to make up the backwash water pH around 12.

NaOH addition is often effective when feed water has organic pollutants.

(3) Injection of NaClO to make up the backwash water at residue chlorine of 500 ppm.

NaClO is often used when the feed water is polluted by organics and bacteria.

3.3 P&I diagram of a typical UF system

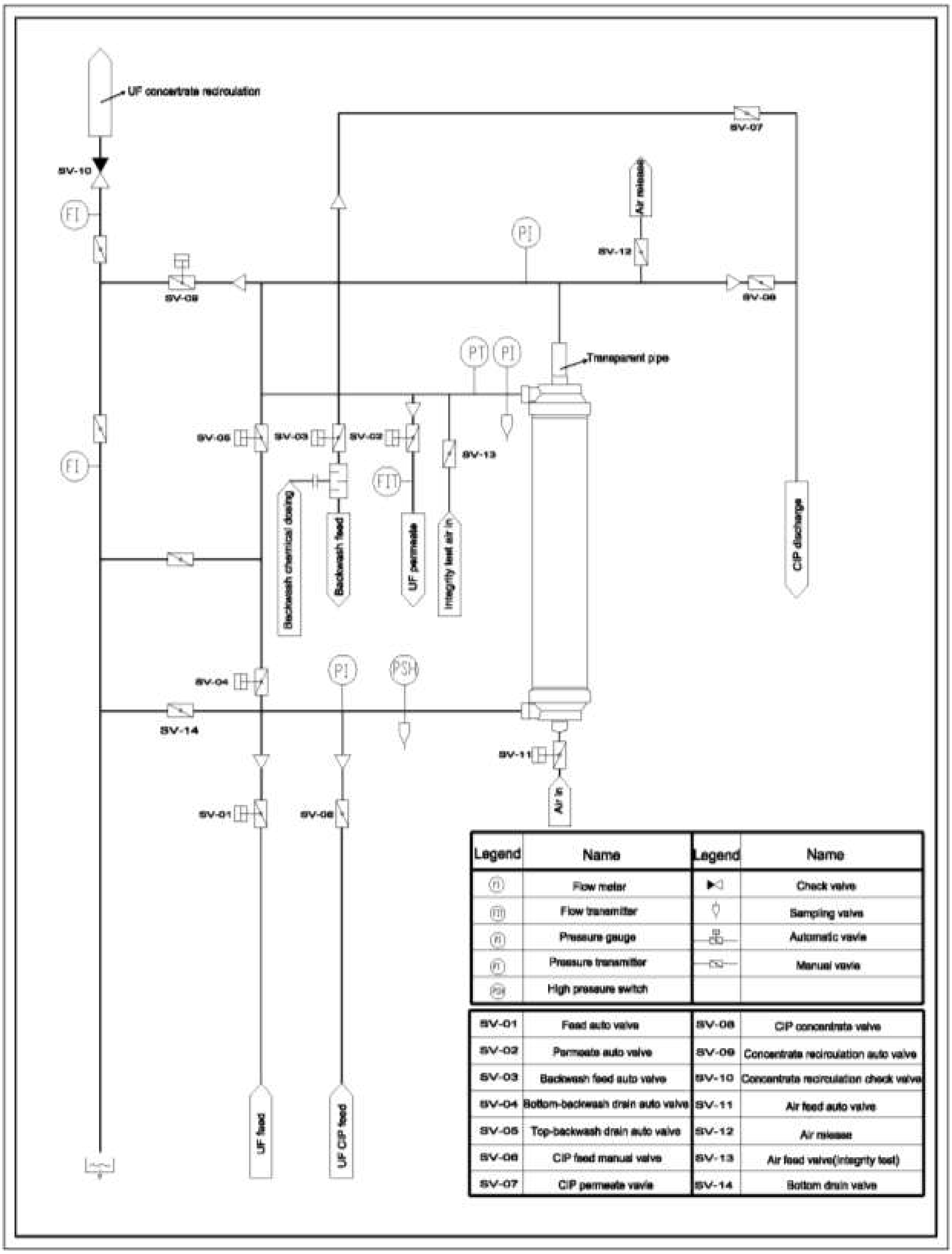


Figure 8: P&I diagram of a typical UF system

Table 8: Valve activities of the typical UF system

Process \ Series		SV-01	SV-02	SV-03	SV-04	SV-05	SV-06	SV-07	SV-08	SV-09	SV-10	SV-11	SV-12	SV-13	SV-14
	Stand-by	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Operation	Flush	1	0	0	0	1	0	0	0	0	0	0	0	0	0
	Operation （dead-end/cross-flow）	1	1	0	0	0	0	0	0	0/1*	0/1*	0	0	0	0
Backwash	Air scrub	0	0	0	0	1	0	0	0	0	0	1	0	0	1
	Drained out	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	Top-backwash	0	0	1	0	1	0	0	0	0	0	0	0	0	0
	Bottom- backwash	0	0	1	1	0	0	0	0	0	0	0	0	0	0
CEB	Dosing chemicals	0	0	1	1	1	0	0	0	0	0	0	0	0	0
	soaking	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Top-backwash	0	0	1	1	0	0	0	0	0	0	0	0	0	0
	Bottom- backwash	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Integrity test	Integrity test	0	0	0	0	0	0	0	0	0	0	0	0	1	0
CIP	CIP	0	0	0	0	0	1	1	1	0	0	0	0	0	0

NOTE：1=open 0=close “*” means the valve is optional.

4.OLTRE$_{CAP}$- V module installation, operation and maintenance

4.1 OLTRE$_{CAP}$- V module installation

Please pay attention to the following guidelines before module installation and adjustment:

1. Before installation, flush feed the pipeline thoroughly with water to make sure there are no rigid particles, such as iron filings, plastic filings or sands, etc.

2. Unpack the module carefully.

3. In order to prevent the damage caused by drying out, install the module as quickly as possible after unpacking.

4. Keep concentrate and permeate valves fully open and feed valve half open to allow the air to get out before the UF module starts up.

5. Flush the module until all of the preservative solution is completely out of the membrane.

4.2 System adjustment, running and maintenance

You can adjust the system after installation. Firstly, check the auto-valves, the switches and the alarm system to make sure that all of them are working normally. In addition, keep detailed records as reference for ultrafiltration normalization in future, including feed conditions, permeate quality, operation parameters, etc.

Start up after adjustment. Please pay attention to the following points during operation:

1. Check the meters, pumps and permeate quality regularly.

If there is something abnormal, stop the system immediately and eliminate the abnormal phenomenon.

2. Monitor the equipments and record the operation parameters.

We suggest the users to monitor the parameters including feed water quality (temperature, turbidity, COD, etc.), operation conditions (pressures and flows of feed, permeate, concentrate, flush and backwash, CEB chemicals, pH value, duration of CEB), and permeate quality (turbidity, SDI etc).

3. Clean and sterilize the UF system regularly.

4. Check the auto-valve of vent regularly to make sure the air exhausted.

4.3 Clean in place chemical cleaning

Periodically backwashing the membrane can remove most of the fouling matters, but sooner or later, the membrane may need chemical cleaning. At designed flow rate, when trans-membrane pressure (TMP) is higher than 0.15 MPa, and that cannot be reduced by CEB, a chemical cleaning is necessary. A Clean-In-Place (CIP) system should be installed with the UF system to facilitate chemical cleaning process.

The cleaning formulation may be selected according to the fouling matters and the operation experience. The following may be considered:

1) A HCl solution at pH≥1;

2) A caustic mixture solution of 0.04% NaOH with 200ppm NaClO at pH≤12;

3) Choose surfactant based on the feed water quality.

Notes: 1) Check the pH value with meter and avoid big error caused by the test paper.

2) Avoid the HCl and NaClO to get in contact with each other during cleaning.

	Warning HCl, NaOH, NaClO are corrosive, please respect the related regulations

The procedures are as follows:

1) Record the operating parameters before CIP chemical cleaning.

2) Open the CIP feed valve and the CIP concentrate recycle valve, circulate the chemical solution for 30minutes by turning the circulation pump on.

3) Check the pH of the solution, if there is a significant change, add appropriate chemical to resume the chemical concentration. Circulate the solution for another 30 minutes.

4) Repeat step 2 until there is no significant pH change. Change the cleaning solution if it gets too dirty or too much chemical is added.

5) Stop the circulation pump and let the membrane soak in the solution for 30 minutes.

6) Close the CIP concentrate recycle valve and open the CIP permeate recycle valve, circulate the chemical solution for 30minutes by turning the circulation pump on.

7) Repeat steps 2-4.

8) Drain the solution tank. And run the system by directing permeate to drain until the pH of permeate is neutral.

9) Record the operating parameters after chemical cleaning.

Compare the parameters before and after chemical cleaning, if the system is not resumed to its normal operation conditions, consider using another cleaning formulation or call membrane factory for further solutions. Make sure the feed pressure of CIP is lower than 0.08Mpa.

⚠	**Note** Treat the solution according to the standard of discharge

4.4 Integrity Test

During the operating phase, the membrane may be broken because of pollution, pressure variation and water hammer, as result, the integrity of the module is destroyed. Impurities will diffuse to the permeate by passing the broken membrane. To ensure the system to be in proper operating conditions, integrity tests should

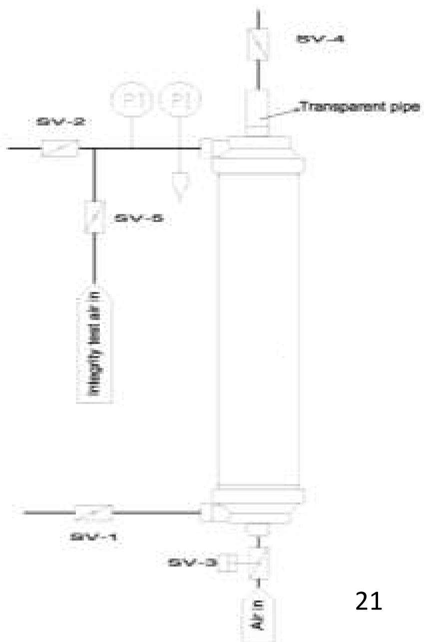


Figure 9 Integrity test of UF module

be run periodically to identify the problematic module(s).

The integrity test instruments includes oil-free pressurized air (>0.1 Mpa), air adjusting valve and a transparent pipe (>10cm) installed in the concentrate out-let pipe line on the top of each module.

Auto integrity test system can test the module system periodically. Integrity test includes the following steps:

1) Stop system. Close all valves.
2) Inflation air. Open the air adjust valve (V_5) slowly to let the air flow into the module from the permeate water pipe, close the air valve (V_5) when the pressure increases to 0.10Mpa.
3) Pressure holds or decays. The pressure change will record and analyze by monitoring system (PLC). The pressure decay is less than 5% in 2 minutes if there is no leakage and the membrane is complete as normal.
4) Check if there bubble in the concentrate pipe. Mark the module if there is continuous bubble, and repair the module off-line.

The integrity test is needed every day a for drinking water system.

4.5 Module repair

Note

Membrane repair needs special training and tools.

Contact the contractor to get membrane repair training, tools and plug.

5. $OLTRE_{CAP}$- V module storage and shipping

To control bacterial growth and prevent damage caused by drying out, the module must be stored with a preservative solution.

5.1 Module storage

5.1.1 New module

1. Prior to shipment, the module has passed the flux test and integrity test and has been stored in a preservative solution with sodium bisulfite, glycerin, water at a certain ratio, followed by a sealing using plastic discs.

2. The module must be kept wet. The new module should be kept in its original package until installation.

3. The module should be placed indoors at 5-40℃ horizontally and avoid direct sun exposure.

4. The modules should be kept at the appropriate temperatures to prevent from freezing.

5.1.2 Used module

1. Wash out the module before storage and add above sodium bisulfite preservative solution into the module.

2. Update the preservative timely.

3. Keep the module wet in any case.

The storage guidelines for new modules are suitable for the used module. Wash out the preservative before reuse.

5.2 Module preservation

When the system is turned off for less than 7 days, the module can be protected just by flushing the system for 10~30 minutes every day

When the system is turned off for a longer period, run the chemical cleaning and sterilizing procedure first, and then seal all of the out-lets to keep the module wet to prevent bacteria and algae growth. The formulation of preservative solution is the water and sodium bisulfite at a ratio of 99 to 1. Check the pH value of the preservative every three month. Replace the solution if pH value is lower than 4.

The module will irreversibly lose flux if the module is dried out, so bear in mind that the module must be kept wet to prevent bacterial and mould growth.

5.3 Module shipping

The module is shipped in a special cardboard and wooden box. Avoid collision, sun exposure, rain and mechanical damage. Please pay attention to prevent freezing in cold regions.

Appendix 1 OLTRE$_{CAP}$ -V UF membrane parameters

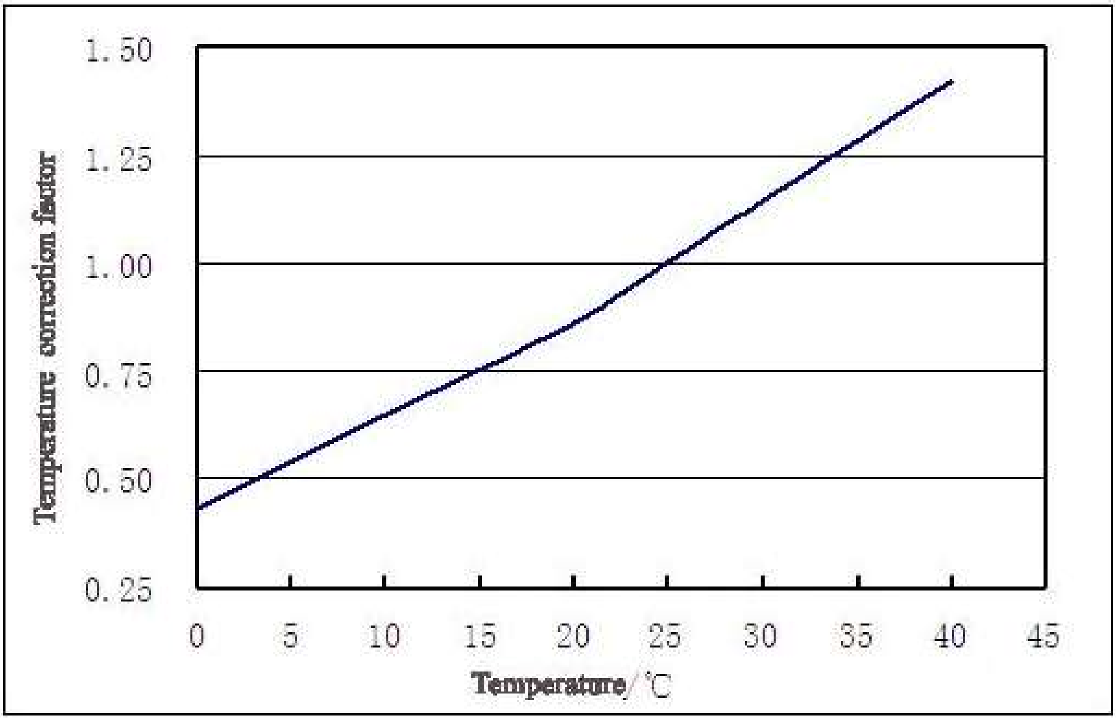
Specifications / Parameters	Dry weight (kg/lb)	Packing size (Length × width × height) mm (inch)
OLTRE$_{CAP}$-1030-V	23/51	1070×330×340 (42.1×13.0×13.4)
OLTRE$_{CAP}$-1060-V	35/77	1820×330×340 (71.7×13.0×13.4)
OLTRE$_{CAP}$-1080-V	50/110	2320×330×340 (91.3×13.0×13.4)

Notes: Dry weight of membrane means weight of membrane without preservative solution.
Wet weight of membrane means weight of membrane filled with water.

Appendix 2 Temperature calibration curve

The correction factor is 1, when the temperature is 25 ℃. You can get the correction factor from the table based on the actual temperature.

Actual flux = correction factor × design flux under 25 ℃.



Temperature – flux correction factor curve

Appendix 3 Ultrafiltration system running data sheet

Table Ultrafiltration system running data sheet

Time / Content		1	2	3	4	5	6	7	8	9
Feed temperature	℃									
Feed pH value										
Feed turbidity	NTU									
Feed COD	ppm									
Feed flow	m^3/h									
Concentrate flow	m^3/h									
Feed pressure	MPa									
Permeate pressure	MPa									
Concentrate pressure	MPa									
Permeate turbidity	NTU									
Permeate SDI										
Permeate COD	ppm									
Permeate ORP	ORP									
Air flow	Nm^3/hr									
Air drained duration	second									
Backwashing flow	m^3/h									
Backwashing	MPa									
Back washing cycle	minute									
Back washing	second									
CEB dosing	ppm									
CEB frequency	minute									
CED duration	second									
CIP frequency										
CIP temperature	℃									
CIP pH value										
CIP flow	m^3/h									
CIP pressure	MPa									
CIP chemical 1										
CIP chemical 2										
Others										