Water Treatment Membrane Module

MICROZA^{TM} UNA Series

OPERATING INSTRUCTIONS

Caution

To ensure safe and proper use of the module, carefully read these Operating Instructions and adhere to all of the safety instructions herein.
Keep the Operating Instructions in a convenient location for consultation.

Asahi Kasei agrees not to assert its own right under its patented invention about method for use of the membrane module(s) against the end-user of membrane module(s) manufactured by Asahi Kasei only to the extent necessary to use such module(s).

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PREFACE

Allow us to begin by expressing our appreciation for your adoption of our Microza^{TM} UNA series module. These Operating Instructions explain the installation of the module and discuss the treatment and operation precautions to be observed.
To ensure safe and proper use of the module, carefully read and adhere to all of the safety instructions therein. If you have any questions, please consult Asahi Kasei Corporation ("Asahi Kasei").
Maintain these operating instructions in a convenient location for consultation.
The UNA series modules are filled with calcium chloride solution. If these preservative solutions are subject to regulations on chemical substances in your country, please take appropriate procedures on your own initiative.
Asahi Kasei inspects every Microza module on its own standard and specification, and delivers only the modules that passed the inspection. However, even though adhering to operating parameters as outlined in this manual, there remains possibility for housing damage or membrane failure resulting in a breach, or leakage, between the feed and permeate sides of the membrane. It is therefore strongly recommended that the user of the module provide adequate detection equipment as described in this manual and embody quality control protocols and procedures to avoid damage caused by a membrane failure.
Please ensure that appropriate procedures are enacted to avoid contact with chemicals and leaking fluids resulting from module housing failure. Asahi Kasei shall not be held liable for consequential damages or losses caused by such noted membrane failure or by non-adherence of the above noted recommendations.

UNA SERIES APPLICATIONS

UNA series applications are:
  Water purification process
  Treatment of boiler condensate water
  Tertiary treatment of sewage and wastewater
  RO desalination pre-treatment
  Iron and manganese removal
  * In combination with pre-oxidation by oxidant, such as sodium hypochlorite
  Water clarification as an alternative to "sand filtration", "coagulation sedimentation" and/or "coagulation filtration"

Consult Asahi Kasei:
- If an application is not specifically noted in these Instructions.
- If there is a change in the application or in the system operation after the modules (or system) are deployed.

Asahi Kasei shall not be held liable for consequential damages or losses caused by such noted membrane failure or by non-adherence of the above noted recommendations.

UNA SERIES APPLICABILITY

These instructions include some typical applications and operating parameters. Should the application differ due to variant feeds and/or operating parameters, please first ensure the suitability of the module prior to use.

CONTENTS

1. SAFETY INSTRUCTIONS

Adhere to the Notes in these Operating Instructions when using the module to ensure correct and safe operation.
Asahi Kasei shall not be held liable for injuries, losses, or consequential damages caused by non-adherence to these Operating Instructions.

The Safety Notes and warning labels in these instructions are classified as follows. The meanings of the Safety Symbols used in these Instructions are also explained.

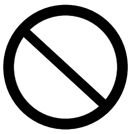
Warning
Incorrect handling or operation of the module by not adhering to the 'warning' may cause serious, and possibly, fatal injury and/or damage the module.

Caution
Incorrect handling or operation of the system by not adhering to the 'caution' may cause injury to personnel and/or damage and loss of equipment.

Safety Symbol Legend

There are three types of signals in these Operating Instructions.

	WARNING or CAUTION.

	NO or DO NOT.

	MUST DO.

Safety Guidelines

Warning

When handling hazardous chemicals, always wear protectors such as safety goggles and rubber gloves. The chemicals include, but are not limited to, sodium hypochlorite and sodium hydroxide. If the solution comes in contact with eyes or skin, immediately rinse thoroughly with water. Then seek professional medical attention as soon as possible as there may be serious injury to eyes and skin.

Do not mix sodium hypochlorite and acids when both are used in a cleaning protocol. Mixing of these chemicals may generate lethal chlorine gas.

Do not use the module for liquids containing an organic solvent as it may cause cracks in the module housing. Hot water may blast out from such cracks during operation.

Caution

The membrane is wetted with a 30% calcium chloride solution. Always wear protectors, such as safety goggles and rubber gloves, to prevent skin contact and eye contact.

Ensure adequate measures are in place to avoid damage to peripheral units and/or environmental contamination from exposure to leaking or splashing liquid.

Do not allow the module to come in contact with organic solvents, or solvent vapors, including cleaning agents which contain organic solvents, or with paints, labels or tapes with adhesive backings. Failure to observe these precautions could cause housing cracks.

When installing modules, put a chain round each of them for falling prevention as a falling module may cause injury or damage to the module. Do not fasten the chains too tightly as such action may cause module damage. Keep the chains slack as shown in the following photo. Keep a distance of 5 to 10mm between the module and the angle bar on which a chain is fixed.

2. Spec

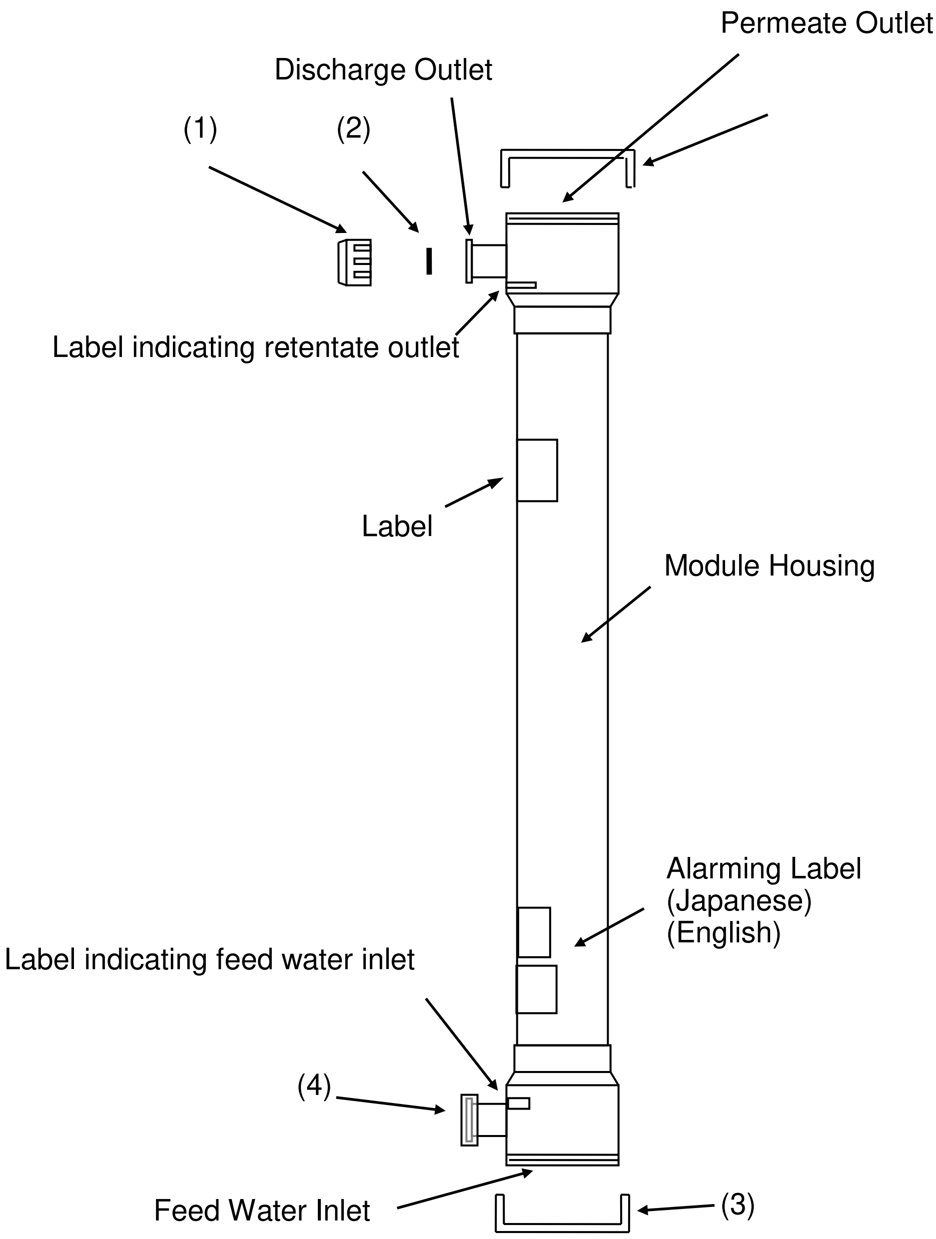
2.1 Module Standard Specification

Item	UNA-600A	UNA-660A	UNA-620A
Membrane Material	High-bonding network structured polyvinylidene fluoride		
Effective membrane area (outer surface (m^2))	23	40	50
Performance			
Nominal pore size (micro meter)	0.1	0.1	0.1
Use Conditions			
Max. feed pressure (kPa)	300 *1	300 *1	300 *1
Max. TMP (kPa)	300	300	300
Max. Temperature (°C)	40	40	40
pH Range	1 - 10*2	1 - 10 *2	1 - 10 *2
Parts Material			
Housing	ABS resin	ABS resin	ABS resin
Potting resin	Polyurethane	Polyurethane	Polyurethane
Gasket, O-ring	EPDM	EPDM	EPDM
Dimensions (mm)			
Use of End cap B at both ends	1.314L × φ165	2,018L × φ165	2,418L × φ165
Use of End caps B and A at upper and lower ends respectively	1,234L × φ165	1,938L × φ165	2,338L × φ165
Weight (kg)			
Filled with water	30	50	60
Without water	15	25	30

*1 Consult Asahi Kasei for system operation under a pressure of up to 400kPa.

*2 See Section 9.1.1 "Contaminants and Applicable Cleaning and/or Disinfecting Agents" for chemical cleaning.
See Section 7. "STANDARD OPERATING PARAMETERS FOR THE UNA SERIES" for the details of operating parameters.

2.2 Module and Parts Shipped as Standard



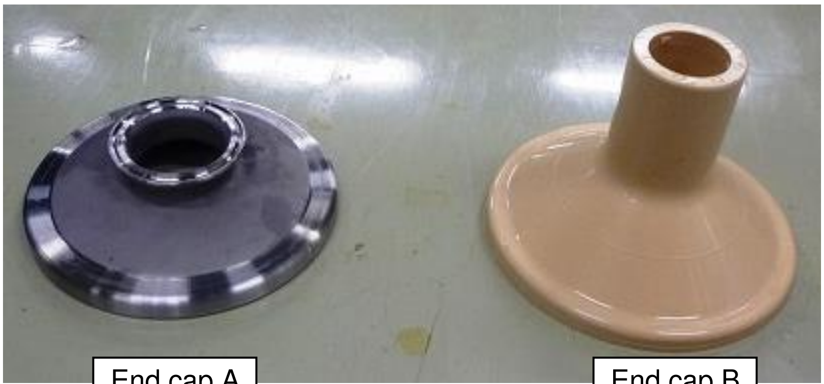
No.	Description	Qty.
(1)	Blind cap	1
(2)	Gasket	1
(3)	End cap	2
(4)	Protection cap	1

2.3 Module Connection

The UNA series modules are connected online at three sections: 1) permeate outlet on top of the module, 2) feed inlet at the bottom of the module, and 3) discharge outlet side nozzle.
The permeate outlet on top of the module is connected through of a combination of End cap B and an expansion joint.
The feed inlet at the bottom of the module is connected through of a combination of End cap B and an expansion joint or a combination of End cap A, a ferrule, and a clamp.
The discharge nozzle on the side of the module is connected through a combination of a union socket and sold separately a cap nut come with the module.

2.3.1 List of Module Connection Parts

Module Section		Parts to Which to Connect	Parts through Which to Connect	Connection Pipe Diameter
Top of Module	Permeate outlet	End cap B	Expansion joint	50A
Bottom of Module	Feed water inlet	End cap B	Expansion joint	50A
		End cap A	Ferrule	2.5S
Module Side	Discharge outlet	Union socket	Cap nut	40A



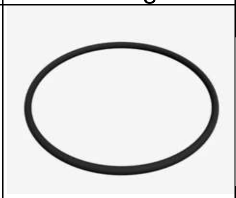
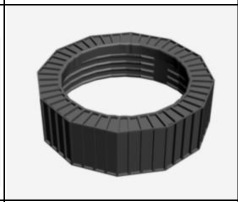
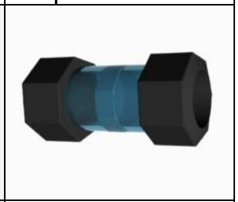
End cap A

End cap B

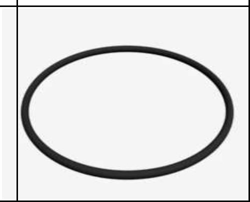
2.3.2 Module Connection Types and Required Parts

The following are the parts to connect the module. The estimated replacement period is based on operation with a 30-minute filtration cycle. This estimated period depends on the use condition, so that the period is not guaranteed.

Cap B connection

Parts	O-ring	End cap B	Nut	Expansion Joint
				
Estimated replace-ment period [*3]	Consumable items Replaced when its cap is loosened	5 - 10 years[*4]	5 - 10 years[*4]	5 years

Cap A connection

Parts	O-ring	End cap A	Nut	2.5S Sanitary Gasket	2.5S Clamp
					
Estimated replace-ment period [*3]	Consumable items Replaced when its cap is loosened	5 - 10 years[*4]	5 - 10 years[*4]	Consumable items Replaced when its cap is loosened	5 - 10 years[*4]

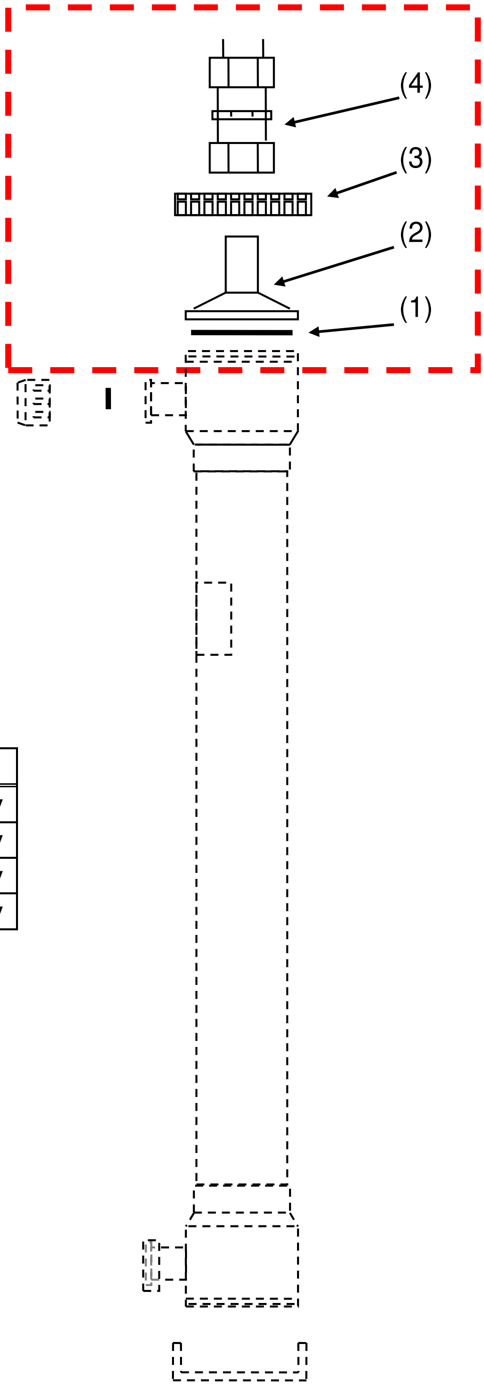
Union socket connection

Parts	Cap nut	Gasket	Union socket	Expansion Joint
				
Estimated replace-ment period [*3]	5 - 10 years[*4]	Consumable items Replaced when its nut is loosened	5 - 10 years[*4]	5 years

*3 For operation with a 30-minute filtration/backwash cycle
*4 Dependent on the use condition

2.3.3 Connection of Module Upper Part

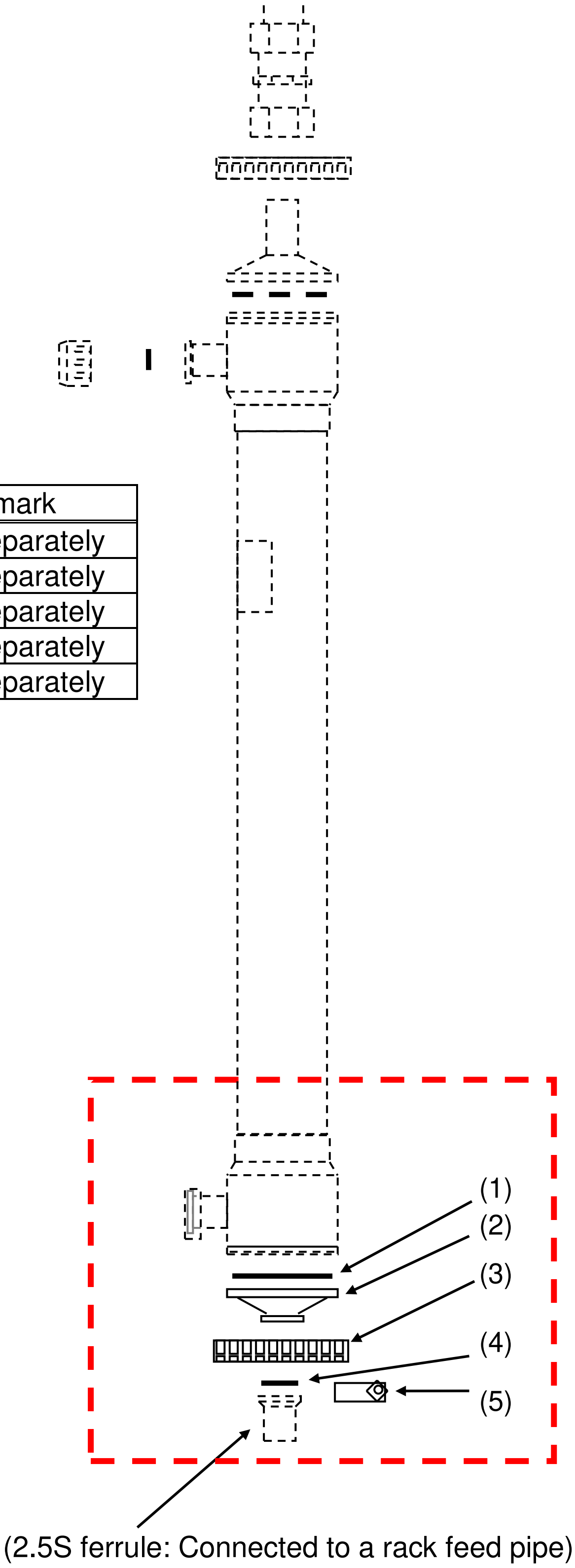
The permeate outlet on top of the module is connected to a rack permeate pipe through a combination of End cap B and an expansion joint.



No.	Parts	Qty.	Remark
(1)	O-ring	1	Sold separately
(2)	End cap B	1	Sold separately
(3)	Nut	1	Sold separately
(4)	Expansion joint	1	Sold separately

2.3.4 Connection of Module Lower Part, Using Cap A

The feed water inlet at the bottom of the module is connected to a rack feed pipe through a combination of End cap A, a ferrule, and a clamp.

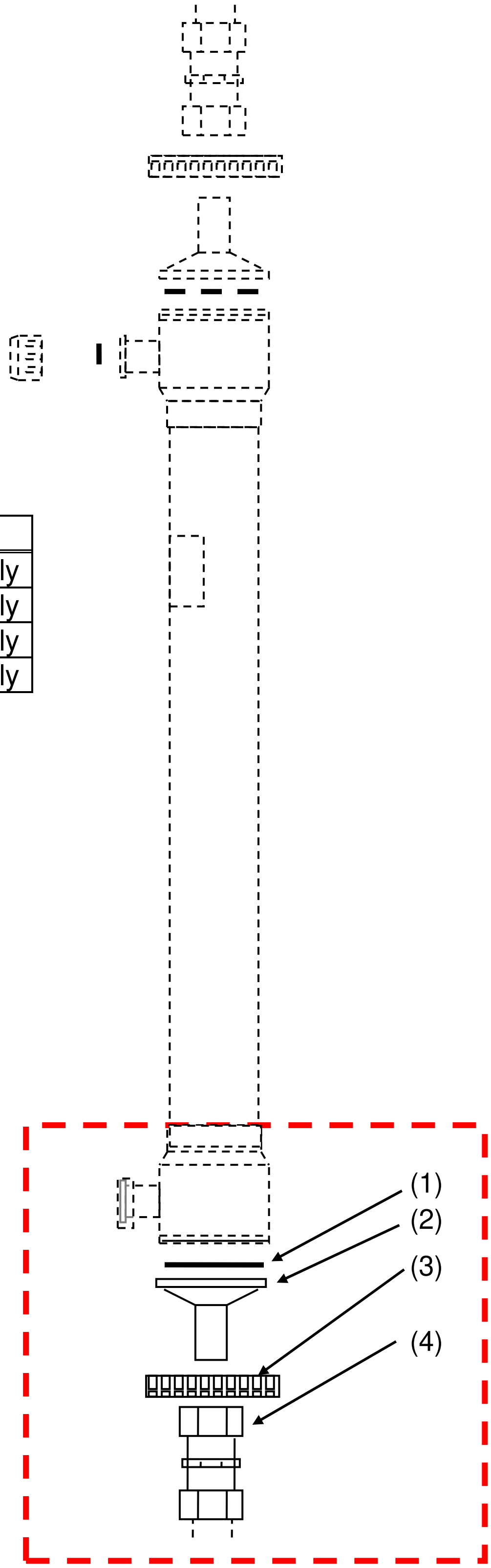


No.	Parts	Qty.	Remark
(1)	O-ring	1	Sold separately
(2)	End cap A	1	Sold separately
(3)	Nut	1	Sold separately
(4)	Sanitary gasket	1	Sold separately
(5)	Clamp	1	Sold separately

2.3.5 Connection of Module Lower Part, Using Cap B

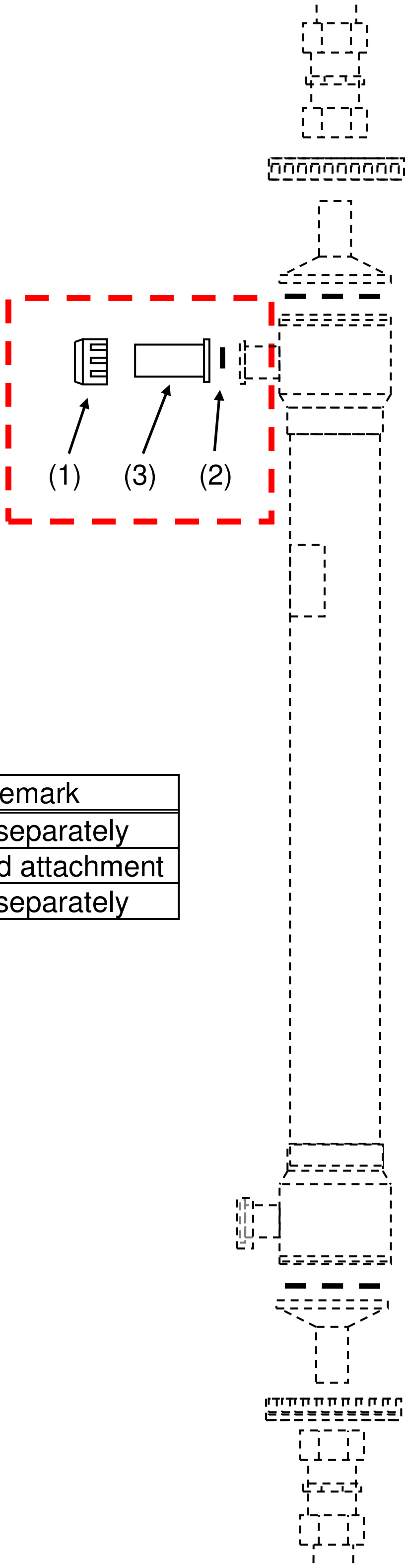
The feed water inlet at the bottom of the module is connected to a rack feed pipe through a combination of End cap B and an expansion joint.

No.	Parts	Qty.	Remark
(1)	O-ring	1	Sold separately
(2)	End cap B	1	Sold separately
(3)	Nut	1	Sold separately
(4)	Expansion joint	1	Sold separately



2.3.6 Connection of Module Side Nozzles

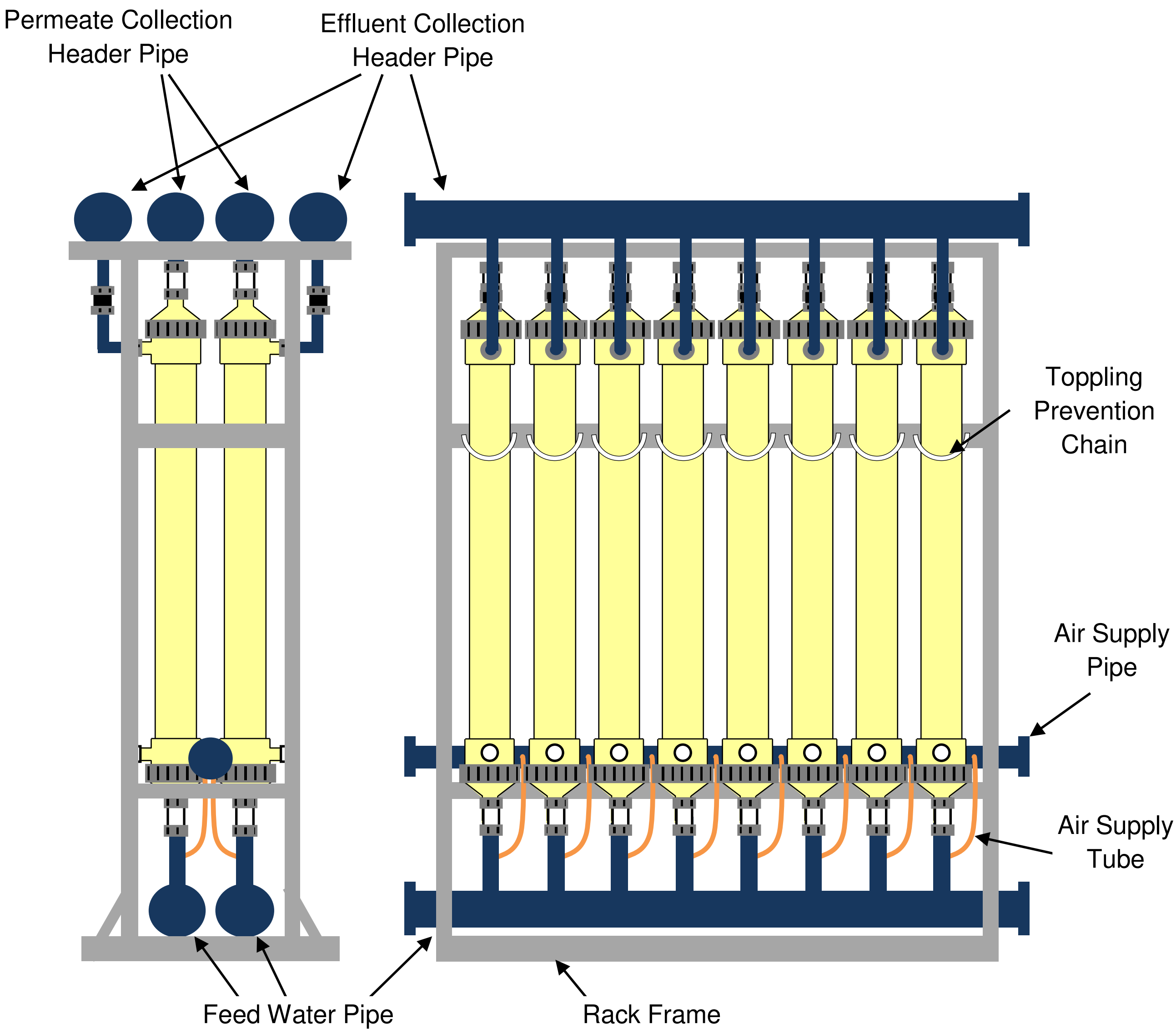
The discharge nozzle on the side of the module is connected to a rack discharge pipe through a union socket.



No.	Parts	Qty.	Remark
(1)	Cap nut	1	Sold separately
(2)	Gasket	1	Standard attachment
(3)	Union socket	1	Sold separately

2.4 Rack Specifications

The following figure illustrates a type of rack for which the feed inlet at the bottom of the module is connected to a rack feed pipe through an expansion joint:



Caution

When installing modules, put a chain round each of them for falling prevention as a falling module may cause injury or damage to the module. Do not fasten the chains too tightly as such action may cause module damage. Keep the chains slack as illustrated in the above figure. Keep a distance of 5 to 10mm between the module and the angle bar on which a chain is fixed.

3.MODULE PRECAUTIONS

3.1 Notes on Solvents and Chemical Agents

As notice on solvents, Asahi Kasei affixes the following warning label to resin module housings:

Chemical resistance characteristics of the ABS housing are as follows:

◆ **Precautions**

Do not come to contact with the following solvents and/or chemicals or vapors of them to prevent stress cracking of module housing:

Classification	Typical Examples
Fatty series halogen carbon hydride	Methylene chloride, Trichloroethylene, Tetrachloroethylene, Chloroform, etc.
Aromatic series halogen carbon hydride	Chlorobenzene, etc.
Fatty series amine, Amides	Dimethylformamide (DMF), Dimethylacetamide (DMAC), etc
Cyclic amine, Aromatic series amine	Pyridine, etc.
Nitriles	Acetonitrile, N-methyl-2-pyrrolidone (NMP), etc
Cyclic ketone	Cyclohexanone
Thinners	Thinners
Esters	Ethyl acetate, Butyl acetate, Diethyl phthalate, etc.
Ethers	Isopropyl Ether, Ethyl ether, etc.
Ketones	Acetone, Methyl ethyl ketone (MEK), etc.
Aromatic series carbon hydride	Benzol, Toluene, Xylene, etc.
Alcohols	Methanol, Ethanol (high concentration) *5
Fatty series carbon hydride	Hexane, Heptane, Kerosene, Gasoline, etc.
Strong acids, Strong bases	Concentrated nitric acid, Concentrated sulfuric acid, Chromic acid, Concentrated ammonia, Ethyl amine, etc.

*5 Please consult Asahi Kasei for using a liquid containing ethanol.

◆ Other Notices

- Do not contact module with rubber sheet that contains ester plasticizer or with soft PVC hose. Trace plasticizer or solvent may cause crack on module housing
- Do not wipe off module with solvent wet cloth, or paste PVC tape or gum tape. Do not mark on the module housing with a felt pen.
- Wash module with water and wipe it with dry cloth to remove dust/stain on the module.

◆ Examples of Past Accidents

- Paint stuck to a module and the section with the paint cracked.
- An adhesive used to fix a heat insulator to a module caused module cracks.
- In a case where hot water is fed to modules, soft PVC sheets used as a cushion when modules are fixed with U-bolts caused module cracks (migration of plasticizer).

Organic solvents may be used depending on their types and concentrations. Consult Asahi Kasei about solvents or chemical agents other than, or the details of, the above chemicals.

Warning	
	Do not allow the module to come in contact with organic solvents or solvent vapors, including chemicals that contain an organic solvent, or with rubber sheets, soft PVC hoses, PVC tapes, gum tapes with adhesive backings, or with felt pen ink, paints, adhesives, or cushioning materials. Otherwise, housing cracks may occur and liquid may spout from such cracks.

3.2 Notes on Feed Water to the Module

Note the following precautions on feed water for stable operation:

3.2.1 Raw Water to the Module

Raw water to modules refers to a liquid that is pretreated by sand filtration, coagulating sedimentation, or with activated carbon as required before being passed through strainers installed upstream of modules.

3.2.2 Hazardous Materials

Do not feed to the module any raw water containing the substances shown in the following table.

Substance	Effect
Activated carbon particle, Diatomaceous earth, Pigment, Fluidized carrier, Metal powder, Rust, etc.	These substances are hard, so that they can damage the membrane, leading to membrane rupture.
Fibrous substance, Film-like substance, String-like substance, Wire, String, Straw, Resin film, Resin fragment, etc.	These substances entwine the membrane, which defeats the purpose of air scrubbing inducing membrane clogging.
Large substances such as metal piece, resin fragment, wood splinter, tree branch, and nut (>0.5mm)	These substances get stuck in the membrane bundle, which can damage the membrane leading to membrane rupture.
Hair, Fiber, Pulp debris, Elastic particles, etc.	These substances entwine the membrane, which defeats the purpose of air scrubbing inducing membrane clogging.
Organic solvents such as aromatic compound, phenol, and alcohol	Organic solvents can cause cracks in module components such as housing.

◆ **Substances that Require Attention**

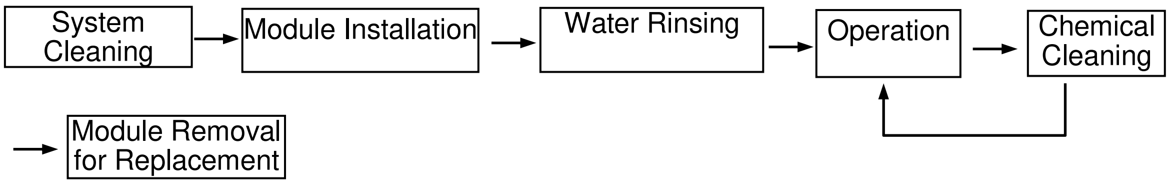
Metals such as iron and manganese, oils, and an excessive amount of coagulant may clog the membrane. Consult Asahi Kasei if such a substance is expected to enter feed water to the membrane.

4.MODULE PRECAUTIONS

Carefully adhere to the Operating Instructions for proper and safe use of the module.

4.1 Module Use Sequence

Operational steps from system commissioning to module replacement is shown graphically below.



4.2 General

System Cleaning before Test Operation

Thoroughly clean the entire system prior to trial operation. Foreign matter, such as metal shards in the tank or in pipe lines, may seriously damage the membranes. Residual oils may cause membrane fouling.

Locating the System

Protect the modules from direct sunlight and ultraviolet light as they may degrade and damage plastic components such as the housing, module head, skirt, and membrane. Please contact us if outdoor use is intended.

Warning	
	Protect the modules from direct sunlight and ultraviolet light as they may degrade plastic components leading to their cracks, from which liquid may spurt.

Preservative Solution

The module is shipped, filled with an aqueous preservative solution of 30% calcium chloride. Adhere to the precaution below when handling the module. Also, if these preservative solutions are subject to regulations on chemical substances in your country, take appropriate procedures on your own initiative. Prior to module use, raise the module upright to fully drain preservative solution from the module. Rinse thoroughly with clean water before use, should preservative solution adhere to the module housing and equipment. Refer to the rinse data below when rinsing out calcium chloride.

Caution	
	The membrane is wetted with a 30% calcium chloride solution. Always wear protectors, such as safety goggles and rubber gloves, to prevent skin contact and eye contact.

◆ **Precautions**

This solution is highly corrosive to metals and should be thoroughly rinsed off with water (e.g., tap water) if contacted with peripheral piping or metallic frame components. If End cap A (stainless steel) is used at the bottom of the module for connection as illustrated in Figure 9, ensure that the calcium chloride solution is fully drained and take extra care not to allow the solution to adhere to any metal portion. Clean water, such as tap water, is defined as water having low turbidity and low organic content. Use to avoid impacting membrane filtration capacity (flux).

Caution	
	A solution containing calcium chlorite is highly corrosive to metals and should be thoroughly rinsed off with water (e.g., tap water) if contacted with peripheral piping or metallic frame components.

Preservative Solution Flushing Method

Modules and amounts of their preservative solution and calcium chlorite contained

	UNA-600A	UNA-660A	UNA-620A
Preservative solution (kg)	6.0 – 7.0	8.0 – 10.0	11.0 – 13.0
Calcium chlorite (kg)	2.0	3.3	4.0

◆ Rinsing Procedure

Rinsing can be performed one of the following two ways:

◆ Batch Method

(1) Install the modules in the unit.

(2) Feed rinse water to the raw water tank.
  - Use clean water for the rinse water.
  - Use raw water if clean water is not readily available.

(3) As illustrated in Fig.1, fill the feed tank with rinse water and rinse the modules until a uniform chemical concentration is achieved throughout the entire system--about 10 minutes.

(4) Then drain the water in the tank and modules.

(5) Repeat Steps (3) and (4) several times.

(6) Completion of rinsing is determined by measuring the Ca concentration or the hardness. Alternatively, rinse completion may be determined by observing the conductivity difference between the rinse water and permeate.
  - See pages 23 and 24 for standard conductivity vs. hardness.

(7) Perform ordinary filtration upon completion of rinsing.

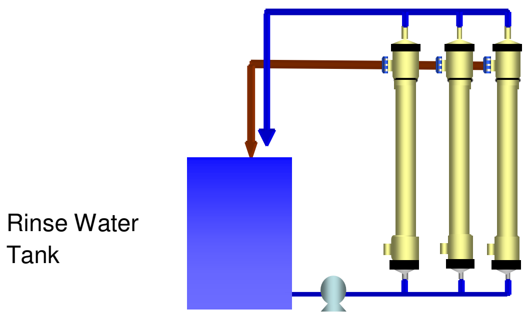


Figure 1 Example 1 of Rinsing Out the Preservative Solution of the **UNA series** Modules (Batch Method)

◆ Method to Supply Rinse Water Continually

(1) Install the modules in the unit.

(2) Feed rinse water to the raw water tank.

- Use clean water for the rinse water.
- Use raw water if clean water is not readily available.

(3) As illustrated in Fig.2, continuously feed rinse water to the modules with the water being discharged from the retentate and permeate outlets.

- Be sure not to return the rinse water to the raw water tank but to discharge it from the unit.
    - ＊ If raw water is used as rinse water (where the membrane is rendered susceptible to fouling), set a permeate rate lower than the design value to prevent membrane fouling during rinsing. When the permeate volume in one cycle (permeate flux x filtration duration time) has reached the design volume, perform physical cleaning (backwashing with air scrubbing).

(4) Completion of rinsing is determined by measuring the Ca concentration or the hardness. Alternatively, rinse completion may be determined by observing the conductivity difference between the rinse water and permeate.

- See the next two pages for standard conductivity vs. hardness.

(5) Perform ordinary filtration upon completion of rinsing.

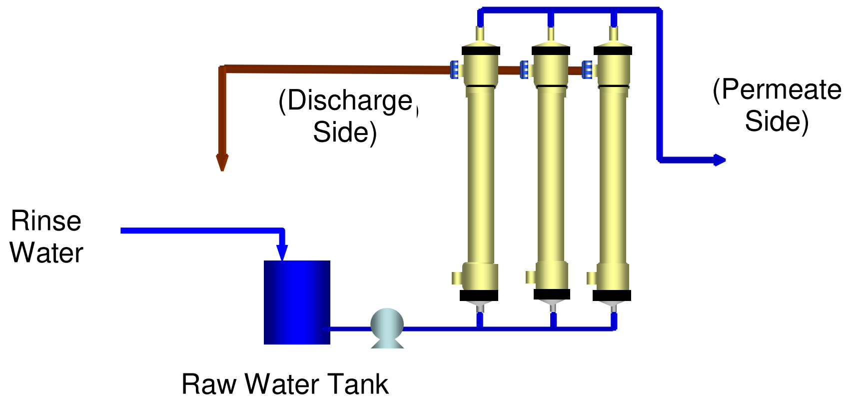


Figure 2　Example 2 of Rinsing Out the Preservative Solution of the UNA series Modules

◆ Relationship between Ca Concentration/Hardness and Electric Conductivity

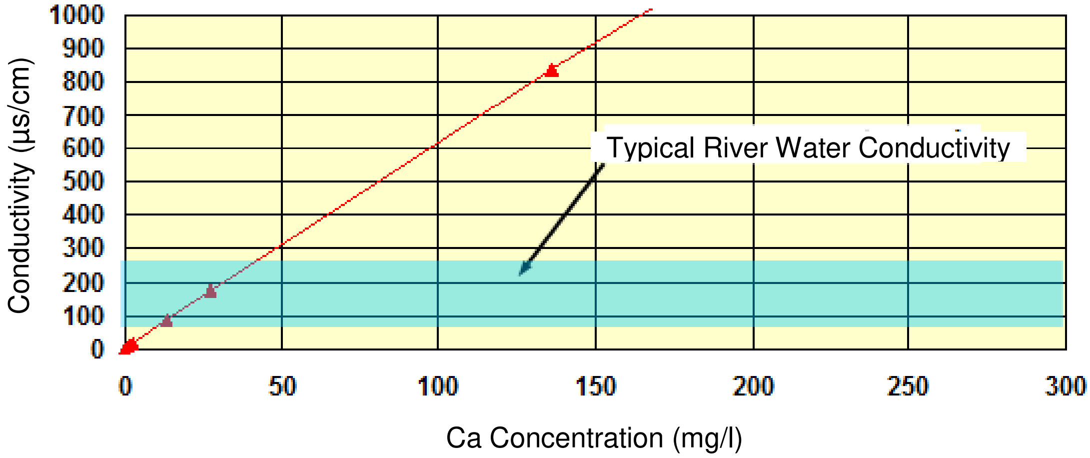


Figure 3　Relationship between Ca Concentration and Electric Conductivity

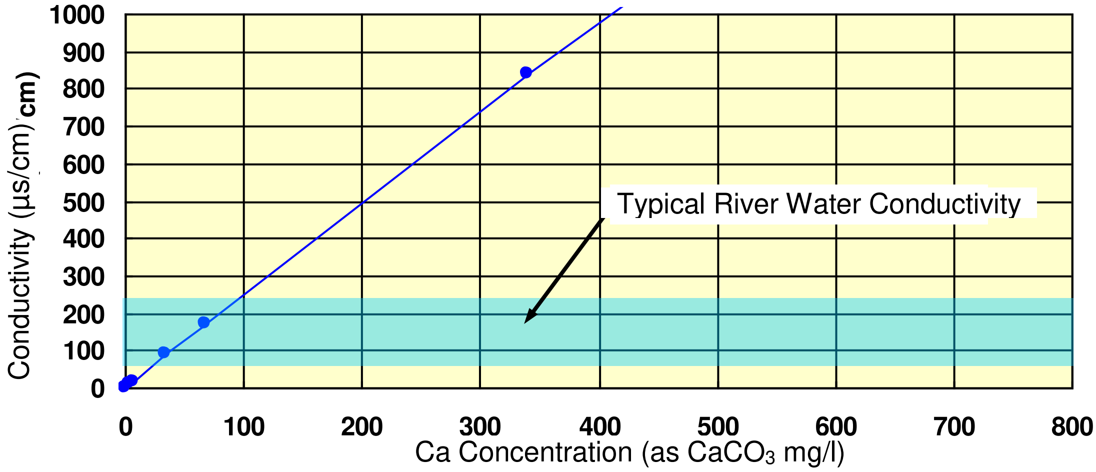


Figure 4　Relationship between Ca Concentration and Electric Conductivity

◆ Reference

Hardness

Hardness is a measure of calcium and magnesium ion concentration in the water. Water with too low a hardness is void of taste. Water with elevated hardness is harsh, has poor soap foaming/lathering capability, and could also cause dysentery.

	Tap Water Standard	Recommended range for drinking water in Japan	Soft Water	Hard Water
Hardness (mg/l)	300	10 - 100	≤100	≥100

Conductivity

Electrical conductivity in water increases with impurities in the water. The higher the conductivity of water, the more ion component the water contains.

	Rain Water	River Water	River Water with High Ion Component Content
Conductivity (µs/cm)	10 - 30	50 - 100	200 - 400

◆ Rinse example

Figures 5 and 6 show rinse test results for a single UNA series module.

<Rinse conditions>

Rinse water flow rate on permeate side: 0.5m^3/hr

Rinse water flow rate on discharge side: 0.5m^3/hr

<Rinse results>

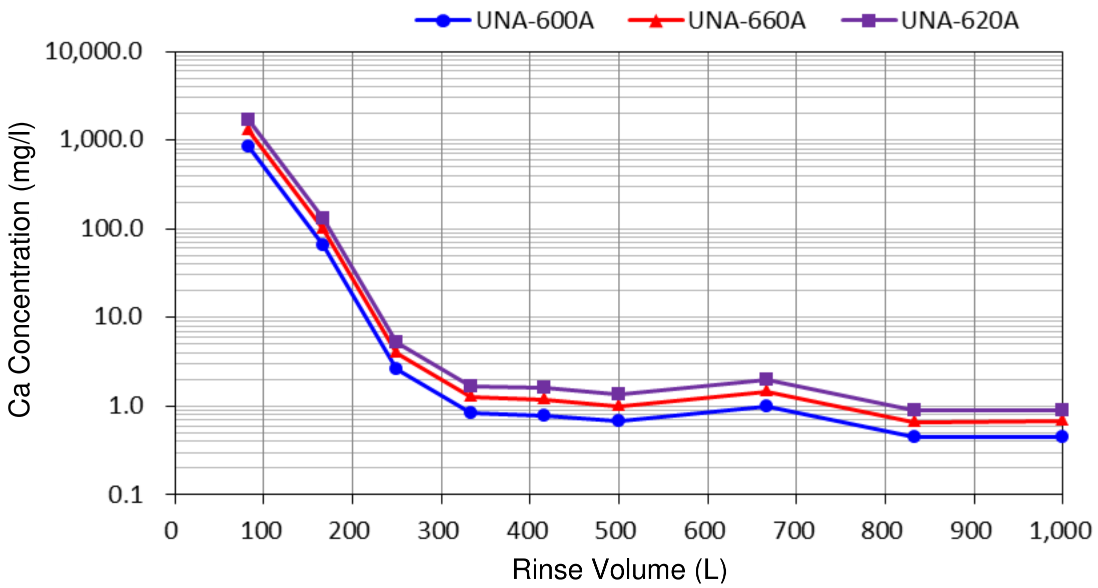


Figure 5 Relationship between Rinse Volume and Ca Concentration

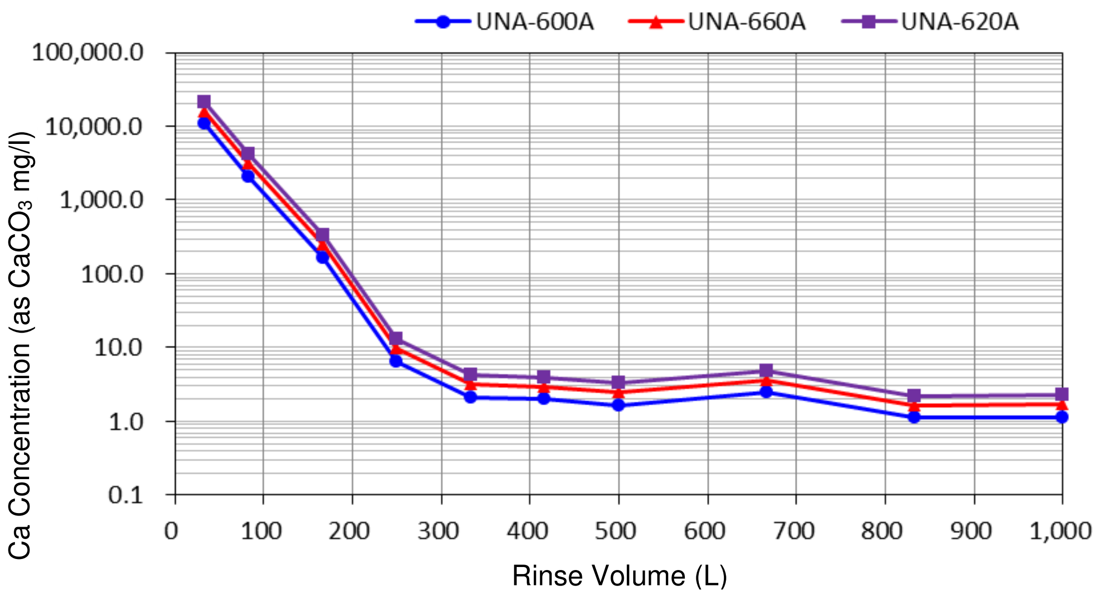


Fig.6

Figure 6 Relationship between Rinse Volume and Ca Hardness

4.3 Storage & Transportation

Transportation Precautions

- When only several modules are transported, they are packaged in cardboard boxes individually. When many modules are transported, they are placed on dunnage. (See the photo below.)
- Use a forklift to carry the dunnage.
- When using a forklift, pay attention to the tooth length.
- If the teeth are longer than the dunnage length, the teeth may stick out of the dunnage and damage adjacent pieces of dunnage.

◆ Reference

Item	Unit	UNA-600A	UNA-660A	UNA-620A
Capacity of 1 Piece of Dunnage	Module	20	16	16
Dunnage Size W D H	mm mm mm	1,340 1,160 1,647	1,180 1,900 1,235	2,290 1,170 1,275
Dunnage Weight	kg	About 70	About 70	About 120
Dunnage Weight with Modules Held at Full Capacity	kg	About 380	About 450	About 570

◆ Precautions

- Modules must not be subjected to sudden impact, mechanical shock, or vibration as it may result in damaged membranes even if there is no damage to the housing.
- Up to two pieces of dunnage can be piled up as shown in the photo.

Caution

Modules can only be piled up two high on dunnage. Do not pile dunnage more than two high as it may cause load shifting.

Protect from Freezing

Although the module must be stored in a dark and cool location, ensure that the membrane is not allowed to freeze, as freezing may damage the membrane due to water/ice expansion.

Avoid UV Light and High Temperature Exposure

Store the module under an ambient temperature of below 40°C. Do not expose modules to direct sunlight, other UV light sources, or high temperatures for extended periods as the plastic components may be degraded.

Avoid Mechanical Impact

Modules must not be subjected to sudden impact, mechanical shock, or vibration as it may result in damaged membranes even if there is no damage on the housing.

Avoid Transporting the System with Modules Installed

Remove the modules from the system for transportation. Transportation induced vibration, mechanical shock, or impact may damage the membranes. It is recommended that dummy modules be installed in place of modules for system transportation.

System Cleaning before Test Operation

Thoroughly clean the entire system prior to trial operation. Foreign matter, such as metal shards in the tank or in pipe lines, may seriously damage the membranes. Residual oils may cause membrane fouling.

Locating the System

Protect the modules from direct sunlight and ultraviolet light as they degrade and damage plastic components such as the module head, skirt, and membrane.

Storing the Module and Restarting Operation

◆ Precautions

- Conduct chemical cleaning of the module to be stored.
- When storing the modules, ensure that the modules are filled with sodium hypochlorite solution of about 50mg/l to prevent membrane drying, which may result in the loss of membrane filtration performance.

Warning
When handling sodium hypochlorite, always wear protectors such as safety goggles and rubber gloves. If the solution comes in contact with eyes or skin, immediately rinse thoroughly with water. Then seek professional medical attention as soon as possible as there may be serious injury to eyes and skin.

Case 1 Storing the Module off the System

For a short period less than one month

(1) After removing the module from the system, plug the feed inlet such as with a blind plate. If no blind plate can be used for a structure or a contour reason, the feed inlet may be plugged with a plastic sheet and tape *6.

Feed Water Inlet

Example of Blind Plate Attachment

Sealing with a Plastic Sheet

Permeate Outlet

Sealing with a Plastic Sheet

---

*6 Ensure that the tape to fix the plastic sheet does not contact the module housing. Contact of tape with the housing may cause crack.

(2) Feed sodium hypochlorite solution of about 50mg/l from the discharge side and fill the module with it. Fig.7 shows the module sections relating to solution filling.

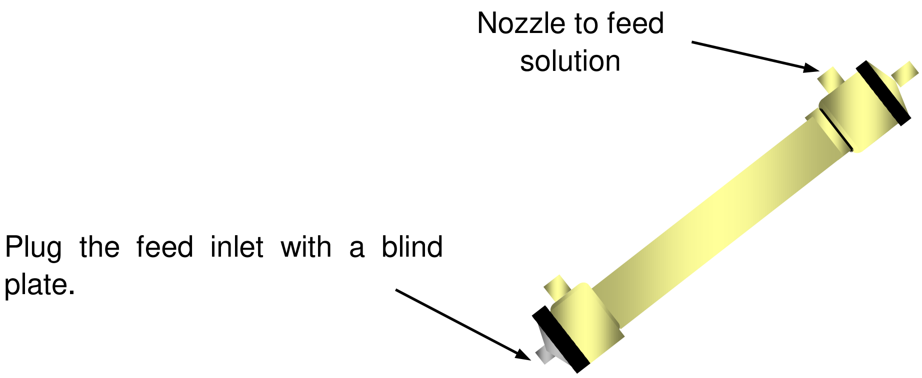


Figure 7 Example of Filling the Module with Sodium Hypochlorite Solution

(3) When the module is filled with the solution, remove the blind plate of the feed inlet (bottom of the module) to discharge all the solution.
(4) Upon discharging the solution, remove the cap nuts from both ends of the module.
(5) Attach an end cap to each end of the module and wrap the following tape*7 7 to 8 times around the junctions between the caps and the housing pipe.
(Tape used: Shinetsu-Kogyo-made Fitwrap SF-0530 with a width of 50mm and a length of 300m)

Example: End Cap Attachment (Feed Inlet)

(6) Put the module in a PE bag specifically for the UNA series and seal the mouth of the bag with tape, etc.

----

*7 Use tape designated by Asahi Kasei to attach the end caps. Non-designated tape may cause cracks in the module housing.

For a storage period more than one month

Method 1: Use of sodium hypochlorite solution
Follow the procedure for "For a short period less than one month"
Repeat the same procedure every other month for solution displacement thereafter.

Method 2: Use of calcium chloride solution
Solution displacement is unnecessary if the module is filled with a solution of 30% calcium chloride concentration for wetting. Use the procedure for "For a short period less than one month"
Also be aware that calcium chloride solution is corrosive to metals.

Caution	
	When handling calcium chloride solution, always wear protectors, such as safety goggles and rubber gloves, to prevent skin or eye contact.

Method 3: Use of pure water or membrane permeate
Microorganisms are expected to grow in the membrane. It is accordingly necessary to fill the module with sodium hypochlorite solution of about 100 ppm or circulate the solution through the module with the solution returning to the feed tank before actual operation, to clean the module [*8].

Case 2: Storing the Module Online

Filling the module with water and sealing it for storage ⇒Cleaning

(1) Fill up the module with water and close the valves around the module to seal [*9].
(2) Before starting actual operation, circulate solution with about 100 mg/l sodium hypochlorite through the module with the solution returning to the feed tank for cleaning.

Periodic Backwash with Sodium Hypochlorite

If the system has two or more trains of modules and the operation of a part of them is suspended, add sodium hypochlorite to permeate produced by other trains and perform periodic backwash using this solution.
Although the frequency of backwash depends on the storage state, perform it once a day as a guide.

If the module is to be stored while being connected to the system, one method is to fill the module with sodium hypochlorite solution. In this case, take appropriate measures to prevent the corrosion of stainless-steel piping as the solution can give rise to corrosion of stainless steel.

[*8] This rinsing method is a guideline. It is recommended that membrane permeate be examined before actual operation.

[*9] If the water in the piping freezes, the module or other parts may be damaged. Ensure that the water does not freeze.

4.4 Module Disposal

Modules are to be disposed of in accordance with applicable local ordinances and adhering to applicable regulatory requirements.

Note

Dispose of the module as industrial wastes and adhere to applicable regulatory requirements. Ensure that proper measures are taken when there is possibility of remaining hazardous material in the module.

- When modules are to be incinerated (at temperatures in excess of 800°C), ensure that the system is capable of treating and neutralizing exhaust gases which may contain hydrogen fluoride.
- Alternately, modules may be disposed of at an appropriate industrial waste landfill facility.

Warning

Wear protectors when cutting the module for disposal as flying fragments could cause injury.

5.MODULE INSTALLATION

Follow the below installation procedure for modules (or dummy modules).
When old modules (or dummy modules) are to be removed, follow the procedure in the MODULE REMOVAL section.
The module is shipped as shown in 2.2. A separate order is required for parts shown in 2.3.

◆ Precautions

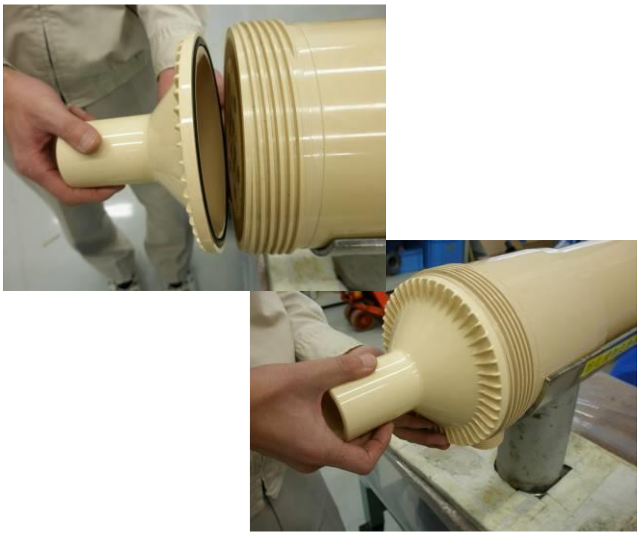
- Implement work protocols that avoid leaving the module exposed to air for extended periods during assembly and installation. Be cognizant of the differences between the top and bottom of the module. The module head marked "Feed" should be placed at the bottom and the head marked "Reject" at the top.
- Modules must not be subjected to sudden impact, mechanical shock, or vibration as it may result in damaged membranes even if there is no damage to the housing.

5.1 Installing Module Parts

1. Unpack the module from the shipping carton and remove the plastic bag.
2. Remove the top and bottom End Caps and the cap nut of the upper retentate nozzle.
3. Raise the module upright to drain the preservative. * 100 - 500ml
4. If the solution comes in contact with eyes or skin, immediately rinse thoroughly with water.

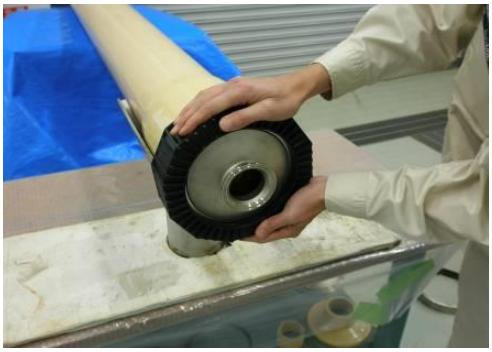
Caution	
	The membrane is wetted with a 30% calcium chloride solution. Always wear protectors, such as safety goggles and rubber gloves, to prevent skin contact and eye contact.

5.1.1 End Cap B Attachment

Step	Work	Description
1		Attach an O-ring to End cap B. Note: Check that the O-ring is snugly placed in the groove without any displacement.
2		Align End cap B with the module end face on the permeate side. Note: Check that the O-ring is snugly placed in the groove without any displacement.
3		Tighten the nut while pressing End cap B against the module. Note: End cap attachment requires a special torque wrench and an assembly fixture.
4		Set the tightening torque of the torque wrench to 120N-m.

5		Tighten the cap with a torque wrench until the torque wrench clicks. Note ・ Pay attention to the direction in which to rotate the torque wrench. ・ Note that a different tightening torque is used for dummy module. (For dummy modules: 200N-m)

5.1.2 End Cap A Attachment

Step	Work	Description
1		Attach an O-ring to End cap A. Note: Check that the O-ring is snugly placed in the groove without any displacement.
2	 	Align End cap A with the module end face on the feed side. Note: Check that the O-ring is snugly placed in the groove without any displacement.
3		Tighten the nut while pressing End cap A against the module. Note: End cap attachment requires a special torque wrench and an assembly fixture.
4		Set the tightening torque of the torque wrench to 120N-m.

5		Tighten the cap with a torque wrench until the torque wrench clicks. Note: ・Pay attention to the direction in which to rotate the torque wrench. ・Note that a different tightening torque is used for dummy module. (For dummy modules: 200N-m)

5.2 Connecting Modules Online

This section explains two ways of module installation to racks: 1) Use of End cap A at the bottom of the module; and 2) Use of End cap B at both the top and bottom of the module.

◆ **Precautions**

Caution	
	Due to the high weight of modules, they should be handled by two or more workers to prevent injury.

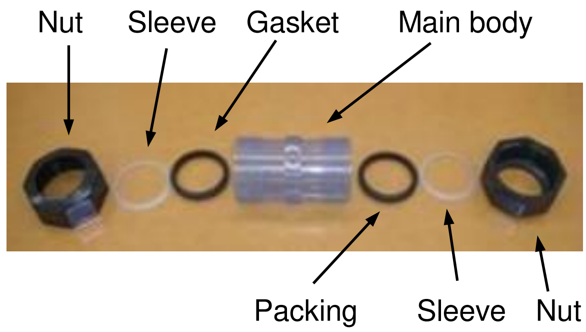
Caution	
	Put a chain round each module for falling prevention as a falling module may cause injury or damage to the module.

Caution	
	Do not tighten the module toppling prevention chains too firmly but keep them loose. Overtightening the chain may damage the module housing. Keep a distance of 5 to 10mm between the module and the angle bar on which a chain is fixed.

Caution	
	Use expansion joints specified by Asahi Kasei. Using other types may cause leaks or damage to the module.

Expansion Joint Assembly Order

The expansion joint consists of nuts, sleeves, gaskets, and a main body.



Put a gasket on one end face of the main body.

Put a sleeve on the gasket.

Put a nut on the sleeve and lightly tighten it.

Put a gasket on the other end face of the main body.

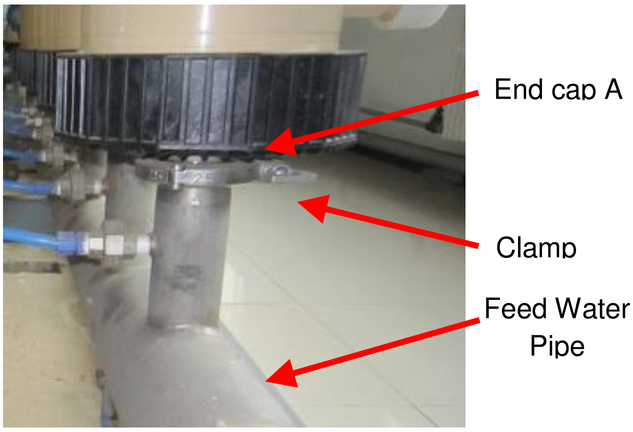
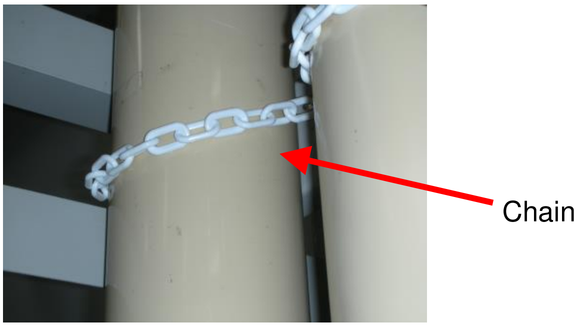
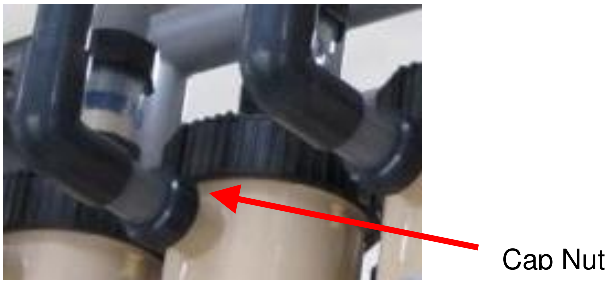
Put a sleeve on the gasket.

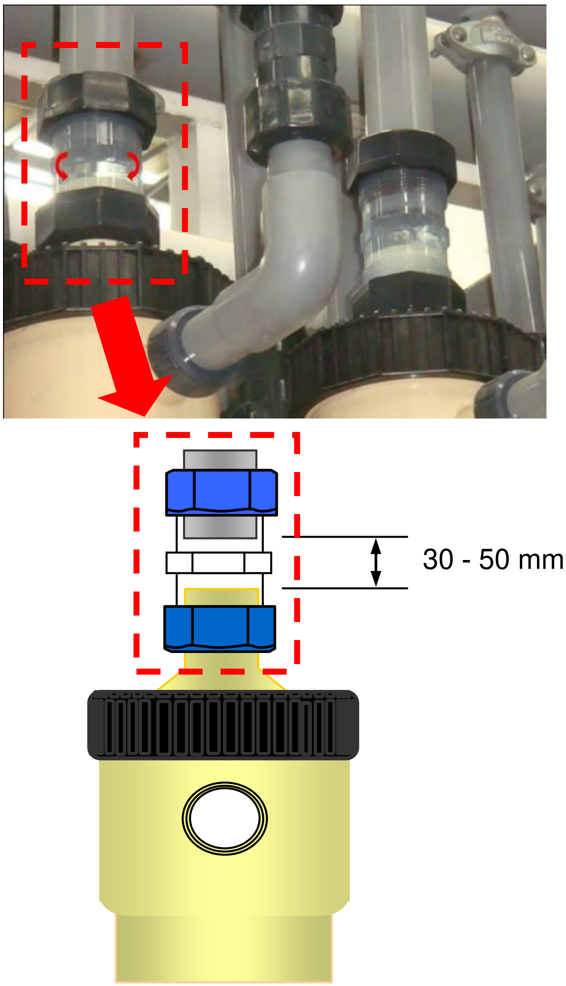
Put a nut on the sleeve and lightly tighten it.

◆ Precautions on work

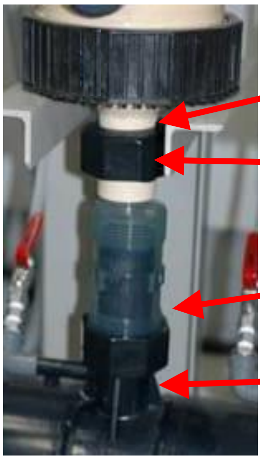
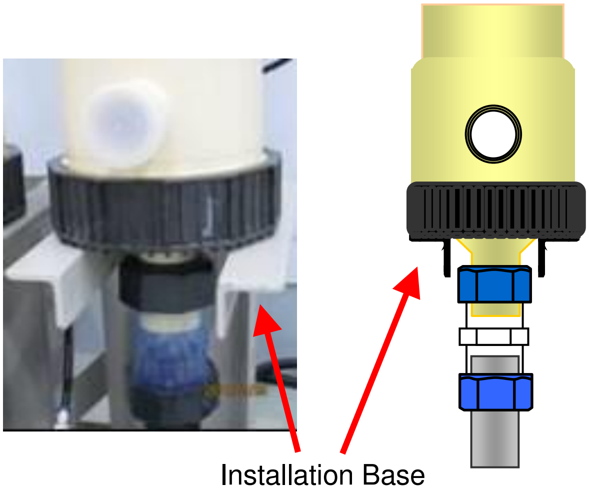
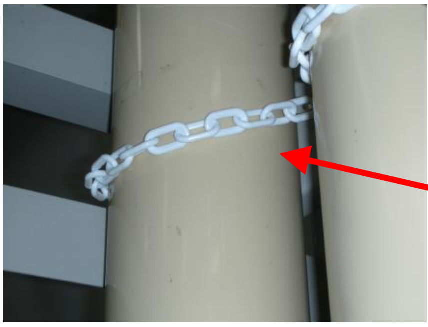
- The role of the sleeve is to prevent kinking of the gasket. The reverse order of packing and sleeve installation may cause gasket damage or water leakage.
- Tighten the nuts of the expansion joint by hand. Tightening the nuts with a tool may force them and deform the gasket, causing leakage.
- Check for leak after tightening the nuts. If leak is observed, tighten the nuts further.

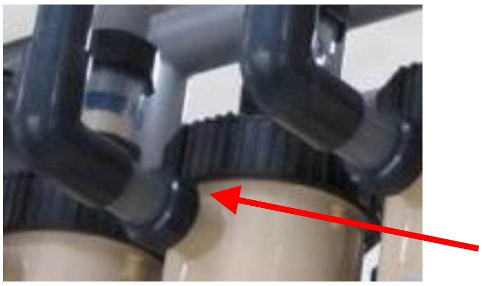
5.2.1 Use of End Cap A for the Feed Water Inlet

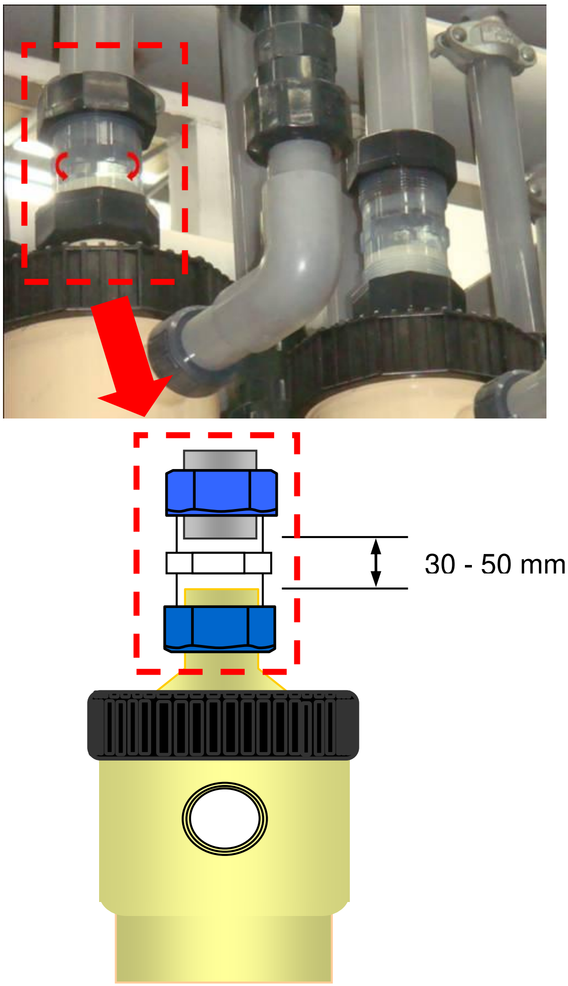
Step	Work	Description
1		1) Place a sanitary gasket on the feed water pipe ferrule and then place End cap A of the module on the ferrule. 2) Position the discharge nozzle of the module in line with the discharge pipe. 3) Align End cap A with the ferrule and temporarily fix them with a clamp. Note: Ensure that the work is performed by two or more workers and they take precautionary measures against back trouble.
2		After mounting the module, put a chain round the module to prevent module falling. Note: · Be sure not to tighten the chains too firmly but rather make them slack. · As a rule, do not use U-shaped bands to fix the module.
3		1) Mount a gasket on the rejection side nozzle of the module. Orient the nozzle with the rejection pipe and fasten the cap nut (ensure gasket remains in position). 2) Connect the discharge nozzle to the discharge pipe of the rack. Note: Ensure that the gasket is not misaligned.

4		1) Loosen the expansion joint nut on the permeate side, insert the expansion joint onto a permeate pipe of the rack, and lightly tighten the nut so that the expansion joint does not fall. 2) Set the module in place, loosen the expansion joint nuts, slide the entire joint downward onto the End cap B nozzle, and lightly tighten the nuts. Note ・Ensure that the permeate pipe and the End cap B nozzle are sufficiently inserted into the expansion joint. ・Leave a clearance of 30 to 50 mm between the nozzle end and the permeate pipe end. ・If the cap nozzle and the permeate pipe are not sufficiently inserted, leakage may occur from the nut sections.
5	 	1) Tighten the clamp sufficiently to seal. 2) Operate the system and run water through the expansion joint to check for leakage.

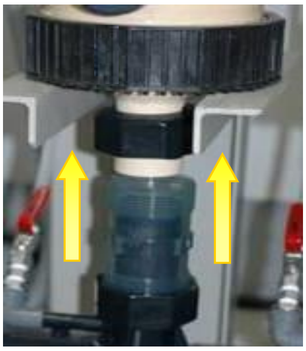
5.2.2 Use of End cap B at Both Ends

Step	Work	Description
1	 End cap B Nut, Sleeve, Packing Nut, Sleeve, Packing, Main body Feed Water Pipe	Attach a nut, a sleeve, and a gasket of the expansion joint to End Cap B. Attach a nut, a sleeve, a gasket and the body pipe of the expansion joint to the feed pipe. Note: ・Lightly tighten the nut on the feed pipe side so that the expansion joint will not move. ・Since the parts on the lower cap are lightly held by a gasket of the expansion joint, ensure that the parts do not fall.
2	 Installation Base	Place the module on the installation base, with the flat surface of the lower cap making contact with the base. Note: ・Position the discharge nozzle of the module in line with the discharge pipe. ・Ensure that the work is performed by two or more workers and they take precautionary measures against back trouble.
3	 Chain	After mounting the module, put a chain round the module to prevent module toppling. Note: ・Be sure not to tighten the chains too firmly but rather make them slack. ・As a rule, do not use U-shaped bands to fix the module.

<table>
<tr>
<td>4</td>
<td>
</td>
<td>1) Attach a gasket to the discharge nozzle of the module. Align the nozzle with the discharge pipe and fasten the cap nut.
2) Connect the discharge nozzle to the discharge pipe of the rack.

Note:
Ensure that the gasket is not misaligned.</td>
</tr>
<tr>
<td>5</td>
<td>
</td>
<td>1) Loosen the expansion joint nut on the permeate side, insert the expansion joint onto a permeate pipe of the rack, and lightly tighten the nut so that the expansion joint does not fall.
2) Set the module in place, loosen the expansion joint nuts, slide the entire joint downward onto the End cap B nozzle, and lightly tighten the nuts.

Note
・Ensure that the permeate pipe and the End cap B nozzle are sufficiently inserted into the expansion joint.
・Leave a clearance of 30 to 50 mm between the nozzle end and the permeate pipe end.
・If the cap nozzle and the permeate pipe are not sufficiently inserted, leakage may occur from the nut sections.</td>
</tr>
</table>

6	 	1) Loosen the expansion joint nuts, slide the entire joint upward onto the End cap B nozzle, and tighten the nuts by hand. 2) Operate the system and run water through the expansion joint to check for leakage.

◆ **Precaution on the connection of End cap B through an expansion joint**

As illustrated in Figure 8, there must be space between the end cap and the expansion joint. Otherwise, the module cannot be placed on its installation base from the side as the cap and the expansion joint interfere with each other.

The pipe onto which the expansion joint is inserted must be long enough to allow the expansion joint to slide along the pipe more than 135mm.

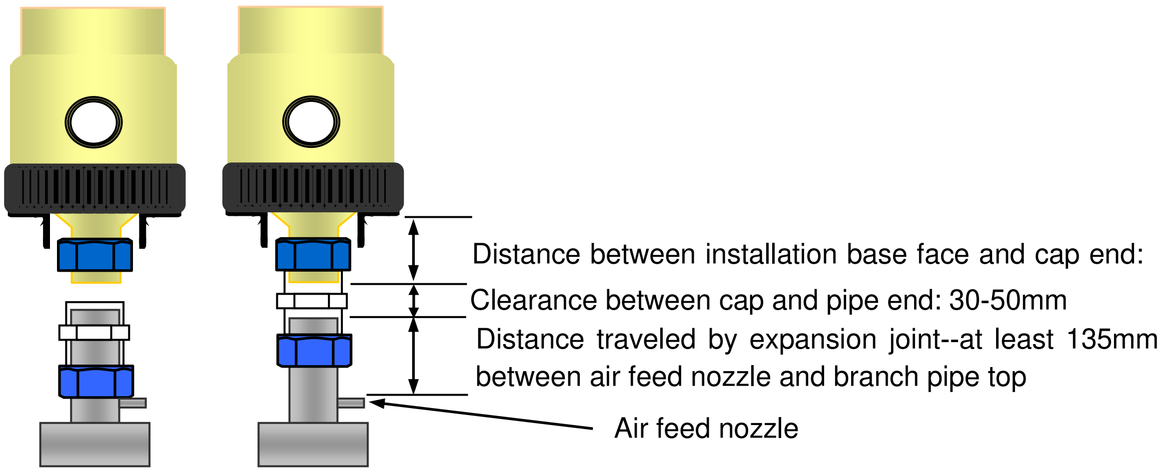


Figure 8 Expansion Joint Connection

6.MODULE REMOVAL

Follow the below procedure to remove modules (or dummy modules).

1. Displace the liquid in the piping and the modules (or dummy modules) with water.
2. Drain the water in the piping and module with the drain valve.
3. Manually loosen the cap nut of the discharge nozzle at the upper part of the module, and disengage the discharge pipe from the nozzle.
4. Loosen the cap nuts of the upper expansion joint and slide the joint upward and temporarily fix it to the connection pipe.
5. Loosen and remove the connection parts (ferrule clamp for End cap A and expansion joint nuts for End cap B) at the bottom of the module while ensuring that the module remains upright (does not fall).
6. Remove the chain from the module.
7. Remove the module.

Caution

Due to the high weight of modules, they should be handled by two or more workers to prevent injury.

Caution

Be sure to fix the expansion joint. Should the expansion joint dislodge, it may cause injury as well as damage to the joint itself.

◆ **Precautions**

First thoroughly remove any foreign material from the ferrule's sealing surface to preclude membrane contamination and/or a seal leak.

7.STANDARD OPERATING PARAMETERS FOR THE UNA SERIES

Observe the following operating parameters when using the UNA series:

Outside-in filtration mode

Ensure that the modules are installed appropriately with the label on the housing indicating 'feed inlet' located downward (on the bottom).

Installing the module upside down (with the label "Feed Inlet" located downward) causes raw water to be fed to inside the hollow fibers, so that filtration is not performed.

Raw Water Temperature: 40°C or less

Raw water temperature higher than 40°C may cause deformation or degradation of constructional elements such as the housing.

Raw Water Feed Pressure: 300 kPa or lower

TMP (Transmembrane Pressure): 300 kPa or lower

The feed inlet pressure is the pressure the module housing withstands. Note that, even when the feed inlet pressure is less than 300 kPa, if a negative pressure is formed on the permeate side such as that due to siphon effect, the transmembrane may exceed 300 kPa. Use the following formula to obtain TMP:

TMP = (Pi + Po) /2 - Pp

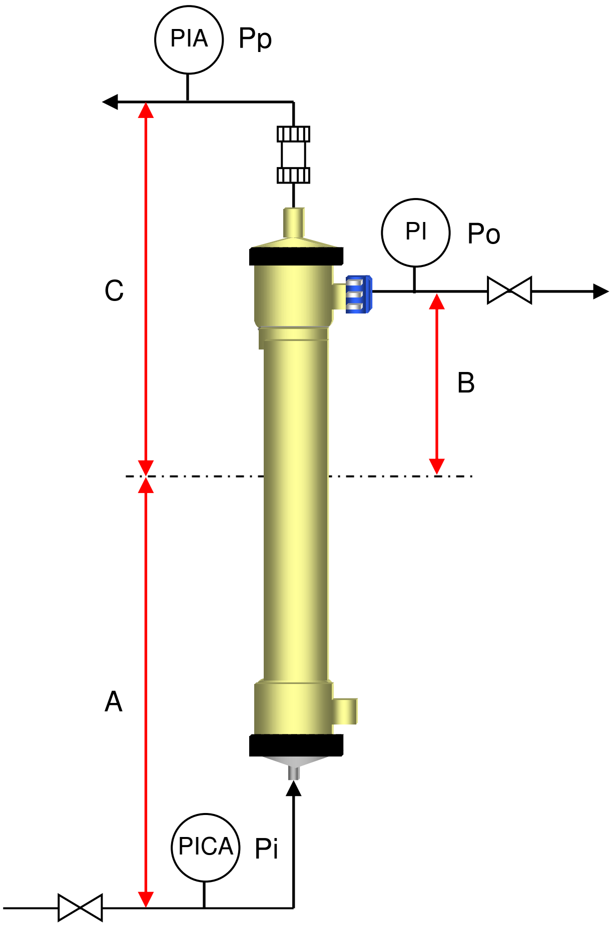
Pi Pressure on inlet side
Po Pressure on discharge side
Pp Pressure on permeate side

To make a height correction, use the following formula assuming 10 kPa for every increase of 1m:

TMP = ((Pi – A)+ (Po + B)) /2 – (Pp + C)

When filtration is performed in dead end mode without Po, use the formula TMP = (Pi - A) + (Pp + C), or use TMP = (Pi - x) - Pp as a simplified formula.

	UNA-600A	UNA-660A	UNA-620A
X	5	8	10



Backwash Pressure: 300 kPa or less

◆ **Note**

- Avoid any pressure increase during backwash.
- Extended operation with sudden pressure increases during backwash may cause degradation of the membrane's physical properties and result in failure of the resin at the permeate outlet end of the module.

Flow Rate Limit for Backwashing with Air Scrubbing (AS/BW): 8m^3/hr/module[*10]

(AS: Air Scrubbing, BW: Backwash)

Air Flow Rate: 5 Nm^3/hr/module

Ensure that the air feed pressure falls within the range of 180 to below 200 kPa. Low air pressure will not overcome the water pressure, failing to generate a sufficient amount of air. Be sure to adjust the air flow rate within plus and minus 10% of 5Nm^3/hr.

Flow Rate Limit for Flushing (FL): 6m3/hr/module

Caution
Avoid shocks of temperature and/or pressure or repeated up-and-down of them, even if they are within the above service conditions.

[*10] Dependent on operating parameters

7.1 Standard Operating Parameters

Standard Operation Mode

Filtration ⇒ Simultaneous air scrubbing and reverse filtration (AS/BW) ⇒ Flushing (FL)

Standard Operating Parameters

<table>
<tr><th colspan="2">Item</th><th>Requirement/Standard Value</th><th>Note</th></tr>
<tr><td colspan="2">Pretreatment</td><td>Filters or strainers (500 µm or less, or 200 µm for seawater) used</td><td>Do not use slit screens as they let film-like substances pass through but use perforated strainers.</td></tr>
<tr><td colspan="2">Flow Rate</td><td>0.2 m^3/hr</td><td>0 - 0.5m^3/hr/module</td></tr>
<tr><td colspan="2">Concentration of Sodium Hypochlorite (NaClO) in Backwash Water</td><td>1 - 5mg/L at module inlet</td><td>Should be suppressed below 0.1mg/L in backwash wastewater. (An amount larger than that consumed for contaminants on the membrane needs to be added.) However, since the membrane is clean for a while after the start of use, add about 3mg/L of sodium hypochlorite from the module inlet during this period.</td></tr>
<tr><td colspan="2">Filtration Cycle</td><td>30min/cycle</td><td>(Filtration + AS/BW + FL)/cycle
20 - 60 min</td></tr>
<tr><td rowspan="3">AS/BW</td><td>Duration</td><td>1 min</td><td></td></tr>
<tr><td>Backwash flow rate</td><td>3m^3/hr/module</td><td>Backwash flow rate = 0.5 to 1.5 times the permeate flux
<table>
<tr><th colspan="3">Minimum flow rate (m^3/hr/ module)</th></tr>
<tr><td>UNA-600A</td><td>UNA-660A</td><td>UNA-620A</td></tr>
<tr><td>1.0</td><td>1.6</td><td>2.0</td></tr>
</table>
Flow rate limit for backwash: 8m3/hr
Dependent on operating parameters</td></tr>
<tr><td>Air flow rate</td><td>5Nm^3/hr/module</td><td></td></tr>
<tr><td rowspan="3">FL</td><td></td><td>30 sec.</td><td>30 - 60 sec.</td></tr>
<tr><td>Required amount</td><td>23～45L/ module</td><td>
<table>
<tr><th></th><th>UNA-600A</th><th>UNA-660A</th><th>UNA-620A</th></tr>
<tr><td>Required amount (L)</td><td>23</td><td>30</td><td>45</td></tr>
</table></td></tr>
<tr><td>FL flow rate</td><td>1.5～6.0 m^3/hr/ module</td><td>
<table>
<tr><th rowspan="2">FL duration (sec)</th><th colspan="3">FL flow rate (m^3/hr/ module)</th></tr>
<tr><th>UNA-600A</th><th>UNA-660A</th><th>UNA-620A</th></tr>
<tr><td>30</td><td>3.0</td><td>4.0</td><td>6.0</td></tr>
<tr><td>60</td><td>1.5</td><td>2.0</td><td>3.0</td></tr>
</table></td></tr>
<tr><td colspan="2">Temperature</td><td>< 40°C</td><td></td></tr>
<tr><td colspan="2">pH Range</td><td>1 - 10</td><td>For the maximum concentrations of cleaning agents, see Section 9.1.1 "Cleaning Agent Concentration".</td></tr>
</table>

7.2 Operation Processes

UNA series operation consists of the following processes performed in this order as one filtration cycle:

1. Pretreatment
2. Filtration process
3. Simultaneous Air scrubbing/Backwash (AS/RF)
4. Flushing (FL)

Each process is explained below.

7.2.1 Pretreatment

If foreign substances such as chips generated during piping installation, sands, and activated carbon enter the module, they may damage hollow fibers and cause leaks from those hollow fibers. Be sure to pass raw water through strainers or screens with the following mesh sizes or punched hole sizes before feeding raw water to the modules.

Mesh/hole sizes

Raw Water Type	Mesh/Hole Sizes (μm)
Natural Water	500
Sewage Secondary Effluent	500
Seawater	200

7.2.2 Filtration Process

A constant flow filtration operating protocol is usually employed.
Permeate flux is constantly monitored with a flowmeter (not shown in Fig.9) on the permeate side and maintained constant by sending feedback to the filtration pump and controlling its rotation speed with an inverter.
The following outlines equipment operation:

(1) In the filtration process, the raw water feed valve AV-1, return valve AV-2, and permeate valve AV-3 open.

(2) Then the filtration pump P-1 starts.

∗ For dead end filtration, the return valve AV-2 and the piping for it are unnecessary.

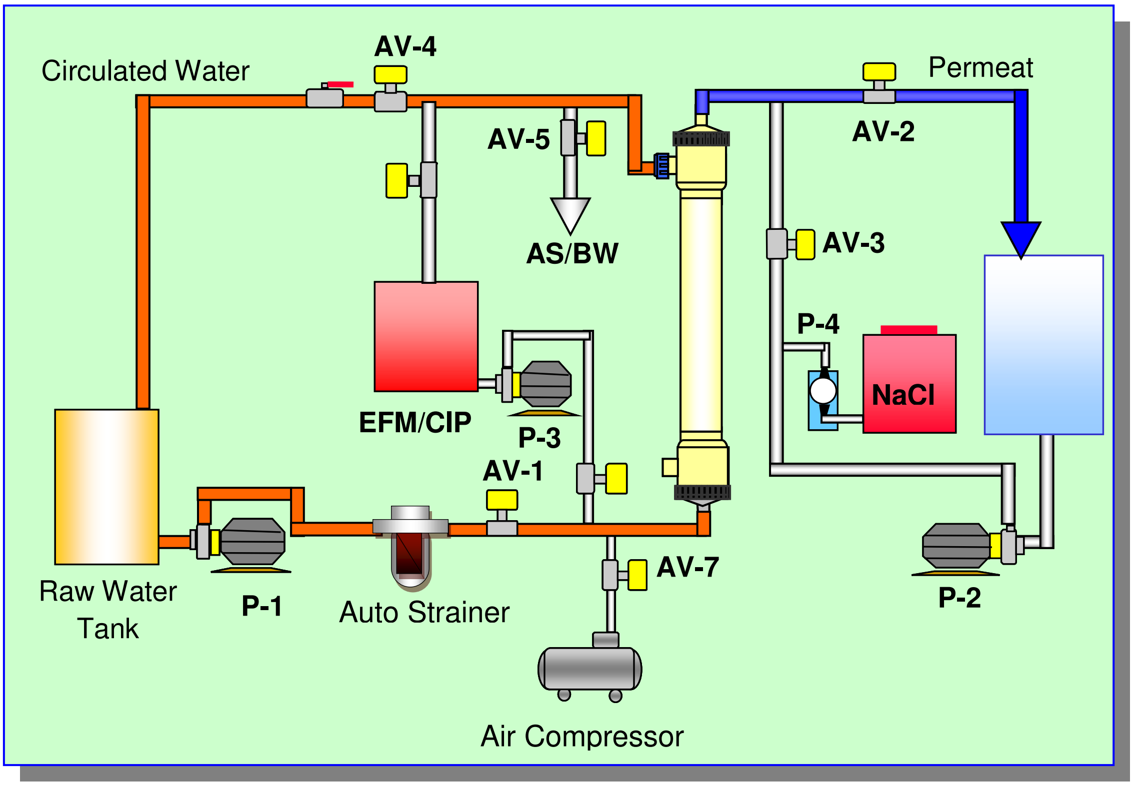


Figure 9 Filtration Process Flow Diagram

Timing Chart (Reference)

Filtration Cycle			30-min (1,800 seconds) Cycle					
Process			Filtration	Valve Opening/Closing	AS/BW	Valve Opening/Closing	Flushing	Valve Opening/Closing
Process Duration		min	28.0	0.2	1.0	0.2	0.5	0.2
		sec.	1,680	10	60	10	30	10
AV-1	Raw water feed valve							
AV-2	Filtration valve							
AV-3	Backwash valve							
AV-4	Return valve							
AV-5	AS/BW drain valve							
AV-7	Air supply valve							
P-1	Filtration pump							
P-2	Backwash pump							
P-4	Sodium hypochlorite injection pump							
Air Compressor			Turns on and off in accordance with pressure settings					

	ON or Valve opens
	OFF or Valve closes

7.2.3 Pressure on the Permeate (Treated Water) Side

The pressure on the permeate side fluctuates depending on factors such as the diameter of the pipe through which permeate flows, the distance to a permeate storing tank, and module and rack heights. As the permeate-side pressure rises high due to pressure loss, higher pressures are required for filtration, leading to high electric power costs. Since such a high pressure on the permeate side becomes close to the upper limit pressure, minimize the permeate-side pressure as low as possible.
More specifically, set the permeate-side pressure to 70kPa or below (Maximum pressure: 100kPa).

Example 1: Case where the pressure on the permeate side of UNA-620A is 50kPa
When the system is operated with the module inlet pressure being 260 kPa,

$$\text{TMP} = \left(\frac{\text{Module inlet pressure + Pressure on discharge side}}{2} \right) - \text{Pressure on permeate side}$$

$$= \left(\frac{260\text{kPa} + 240\text{kPa}}{2} \right) - 50\text{kPa} = 200\text{kPa}$$

In this case, the allowable TMP is 200kPa, the maximum pressure recommended.
A filtration system under this condition can therefore produce the design permeate flux stably.
* The basic design of membrane filtration facilities (such as flux and module count) proposed by Asahi Kasei calls for operation under a transmembrane pressure of up to 200kPa.

Example 2: Case where the pressure on the permeate side of UNA-620A is 150kPa
When the system is operated with the module inlet pressure being 300 kPa, the maximum module inlet pressure,

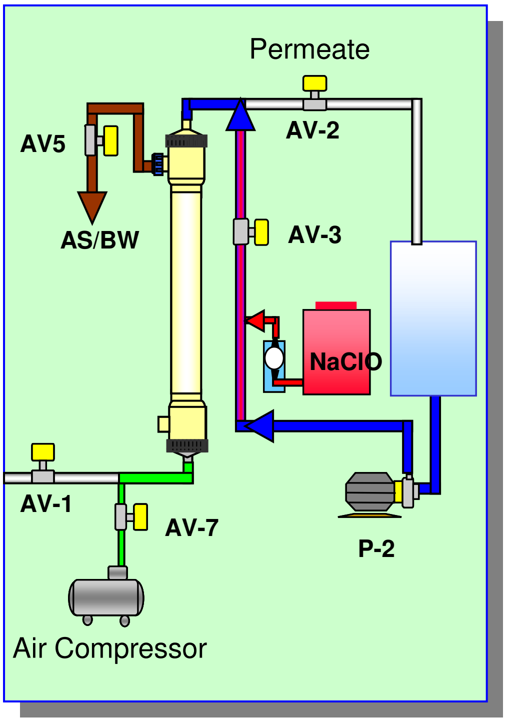
$$\text{TMP} = \left(\frac{300\text{kPa} + 280\text{kPa}}{2} \right) - 150\text{kPa} = 140\text{kPa}$$

This TMP is far below 200 kPa, a precondition for a system design with the module. A filtration system under this condition cannot therefore produce the design permeate flux stably.

Please consult Asahi Kasei if it is difficult to set the permeate-side pressure to 70kPa or lower. We will review the design flux, pipe diameters, etc.

7.2.4 Simultaneous Air Scrubbing/Reverse Filtration (AS/BW)

Upon completion of filtration, AS/BW starts. Permeate is used as backwash (BW) water in order to preclude possible contamination of the system permeate side.
The following outlines equipment operation:
The backwash valve AV-4, AS/BW drain valve AV-5, and air supply valve AV-6 open.
Then the backwash pump P-2 and sodium hypochlorite adding pump start simultaneously.



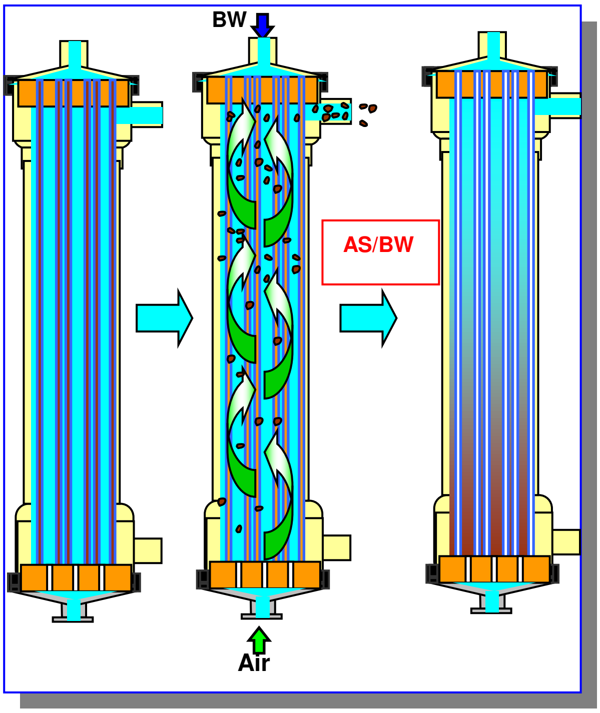


Figure 10　AS/BW Process Flow Diagram　　　　　Figure 11 Concept of AS/BW

Backwash

As the following table shows, backwash flow rates required for modules should be such flow rates that results in backwash water volumes 0.5 to 1.5 times the volumes of water held by the modules. If the volume of backwash water is insufficient, sodium hypochlorite added for backwash does not reach modules, leading to insufficient backwash effect. Ensure that the backwash water volume is larger than the volume of water held by the modules (holdup volume). Also ensure that the port to add chemicals to backwash water is as close to a rack as possible since the position of the port is also a factor to determine backwash efficiency. If raw water contains a lot of contaminants, the flow rate for backwash may be raised for stable operation.

Item	UNA-600A	UNA-660A	UNA-620A
Holdup volume (L/module)	15	20	30
Minimal backwash flow rate (duration of 60 sec.) (m^3/hr/module)	1.0	1.6	2.0

$$\text{Water recovery rate} = \frac{(\text{Permeate flux} \times \text{Filtration time}) - (\text{Backwash flow rate} \times \text{Backwash time})}{(\text{Permeate flux} \times \text{Filtration time}) + (\text{Flushing flow rate} \times \text{Flushing time})} \times 100\ (\%)$$

Sodium Hypochlorite Concentration

Sodium hypochlorite is added to backwash water until its concentration in the backwash water is 1 to 5 mg/L.

When membranes are not contaminated (during initial operation), the sodium hypochlorite added is minimally consumed and will be discharged with backwash wastewater. However, as the membranes become increasingly contaminated, the residual chlorine concentration in backwash wastewater is reduced.

Monitoring this residual chlorine concentration (in the backwash wastewater to maintain a concentration of 0.1 to 1 mg/l) will ensure effective cleaning and avoid excessive chlorine addition.

Air Scrubbing

Designing an Air Scrubbing Unit

"Simultaneous Backwash and Air Scrubbing", a big operational advantage of Asahi Kasei's membrane modules, exerts greater cleaning effect than when backwash and air scrubbing are performed separately.

Adhere to the unit configuration illustrated in Fig.12 when designing an air scrubbing unit.

Failure to observe the standard may prevent the required cleaning effect, leading to operation that fails to meet facility designs (flux, module count, etc.) specified by Asahi Kasei.

Air Supply Unit Flow Diagram

Refer to the following flow diagram when designing an air supply unit:

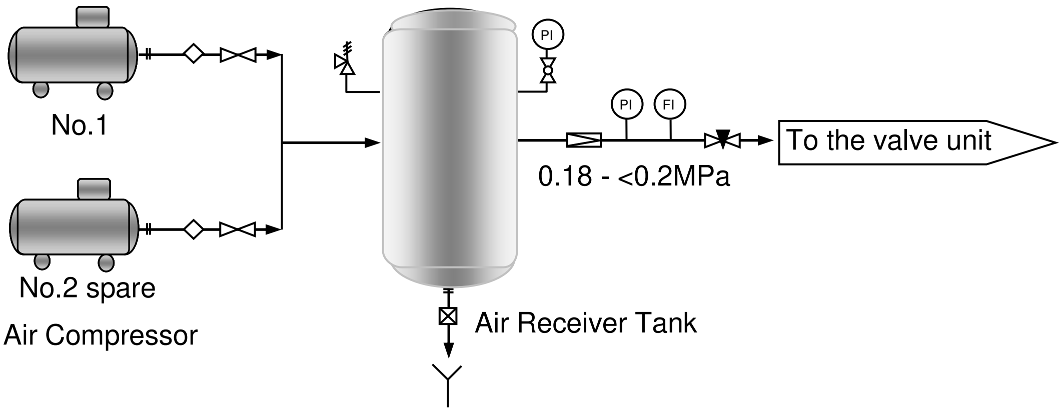


Figure 12 Air Flow of Air Supply Unit

Equipment Necessary for Air Supply Unit

- Oil-free air compressor
- Air filter
  5μm or smaller
- Air receiver tank
- Pressure gauge
  Should be capable of measuring the specified air pressure

- Regulator
  Should an air receiver tank be also used to supply air to air valves for their operation, an additional regulator (adjustable to 400 to 500kPa) is necessary for the valves
- Air flowmeter
  Flowmeter capable of measuring air flow rates under a pressure set and for one entire rack.
- Needle valve
  For adjusting air scrubbing air flow rate

◆ Note on Selecting Airflow Meters

Aeration air flow rate is indicated as a normal flow rate under the base condition (0°C, 0.10MPa). Select air flowmeters that meet the pressure, temperature, and density used as air flow rate varies with these conditions.
Pressures and temperatures are mentioned in the specifications of an air flowmeter. Check your flowmeter for the pressure and temperature at which it is supposed to be used. If the air flowmeter is to be used at pressures or temperatures outside the ranges mentioned, the following correction is required.

$$Q_1 = Q_0 \times \sqrt{\frac{(0.10332 + P_1) \times (273.2 + T_0)}{(0.10332 + P_0) \times (273.2 + T_1)}}$$

Q_1: Actual flow rate
Q_0: Reading on the scale
P_1: Actual measurement pressure (MPa)
P_0: Designated measurement pressure (MPa)
T_1: Actual measurement temperature (°C)
T_0: Designated measurement temperature (°C)

Example
The designated measurement pressure and temperature are 1.9 bars and 20°C but the actual measurement pressure and temperature are 1 bar and 15°C, respectively.

Q_1: Actual flow rate
Q_0: Reading on the scale = 800 Nm^3/hr
P_1: Actual measurement pressure = 0.10 MPa
P_0: Designated measurement pressure = 0.19 MPa
T_1: Actual measurement temperature = 15°C
T_0: Designated measurement temperature = 20°C

$$Q_1 = Q_0 \times \sqrt{\frac{(0.10332 + 0.10) \times (273.2 + 20)}{(0.10332 + 0.19) \times (273.2 + 15)}} = 0.84Q_0$$

To produce an air flow rate of 800 Nm^3/hr when a pressure of 0.10 MPa is actually applied to the flowmeter at 15°C, the flowmeter should read 964 Nm^3/hr, which is obtained as follows:
Q1 = 800Nm^3/hr = 0.84Q0 $\Rightarrow$ Q0 = 800 / 0.84 = 952m^3/hr.

Flushing Process

Contaminants removed from the membrane in AS/BW process are discharged from the upper module nozzle. However, this discharge is insufficient to discharge the liquid remaining in the lower part of the module.

Flushing is implemented to discharge this dirty water from the modules with raw water. The following outlines equipment operation at this time:

(1) Raw water feed valve AV-1 and AS/BW drain valve AV-5 open.

(2) The filtration pump P-1 starts immediately after (1).

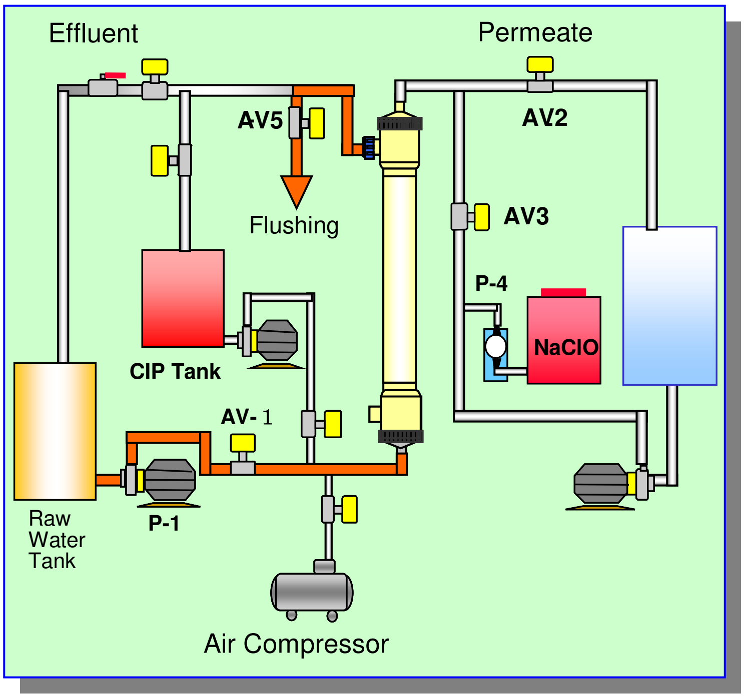


Figure 13 Flushing Flow Diagram

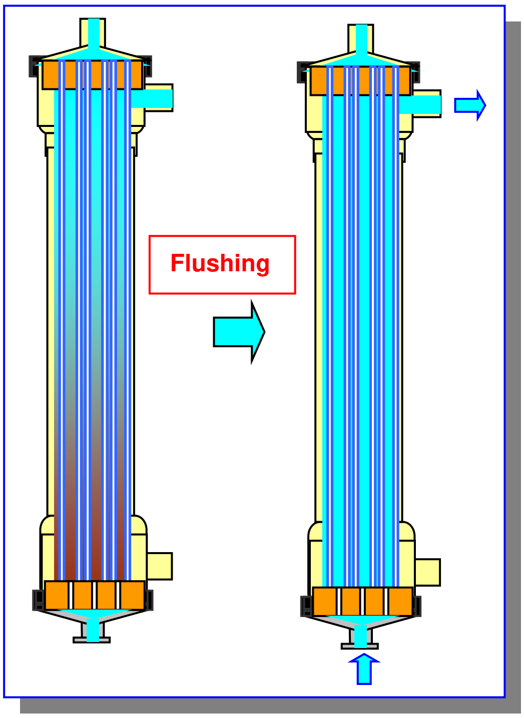


Figure 14 Flushing Principle

The purpose of the flushing process is to discharge with raw water the contaminants removed from membranes during AS/BW process.

Hence, the volume of raw water fed must be ≥ 1.5 the amount of the water contained in the modules.

With the standard cleaning protocol, filtration pumps are used for flushing, so that the flushing water volume is the sum of permeate and discharged water volumes. If the amount of water used for flashing is small, the turbid water in the modules is not sufficiently discharged. Ensure that the amount of water used for flashing is at least 1.5 times the volume of water held in the modules.

This table shows flushing water volumes required for some types of modules.

Item	UNA-600A	UNA-660A	UNA-620A
Holdup Volume (1.5 times the volume) (L)	15 (22.5)	20 (30.0)	30 (45.0)
Flushing Volume Required (for 30 sec.) (m^3/hr/module)	3.0	4.0	6.0
Flushing Volume Required (for 60 sec.) (m^3/hr/module)	1.5	2.0	3.0

8. MEMBRANE INTEGRITY TEST AND REPAIR

Module is to be tested for integrity when:

- A new module is deployed
- Leakage is suspected

◆ Precautions

Module leak testing utilizes pressurized air which could result in filtration performance degradation due to membrane drying and/or from contamination from dirty air. Follow the below precautions when checking the integrity of modules.

- Apply an air pressure of than 180 kPa or higher but lower than 200 kPa to the permeate side (inside the hollow fiber) and hold the pressure for 3 minutes or less.
- If a contaminant is present on the feed side, applying pressure to the feed side may cause membrane consolidation, leading to an increased filtration pressure after testing.
- More specifically, perform the following steps:
  1) Pressurize the module (drainage of water from the module and piping)
  2) Hold an air pressure of 180 kPa or higher but lower than 200 kPa for not more than 3 minutes
  3) Perform filtration to prevent membrane drying. Perform Steps 1) to 2) within 10 minutes.
- Upon completion of testing, immediately fill the module with water and run water through the module such as by performing filtration. Further, performing a pressure hold test or an air leak test continuously may dry the membrane. Perform filtration for more than 10 minutes at appropriate intervals during the test.
- Also, when pressuring the module in air leak test, do not pressurize it for more than 3 minutes. It may take more than 3 minutes to repair leaking fibers. In this case, perform filtration in midstream to prevent membrane drying or reduce the test pressure to about 50 kPa. Finish the repair work within 10 minutes even in this case.
- If the membrane dries out, it will lose the performance of membrane.
- Use clean and oil free filtered air.

8.1 Pressure Hold Test (PDT)

In addition to a permeate water quality monitoring system, the Asahi Kasei membrane systems are designed with capability for conducting both pressure hold test and air leak tests in order to establish the integrity of the membranes. See below test protocol flow chart.

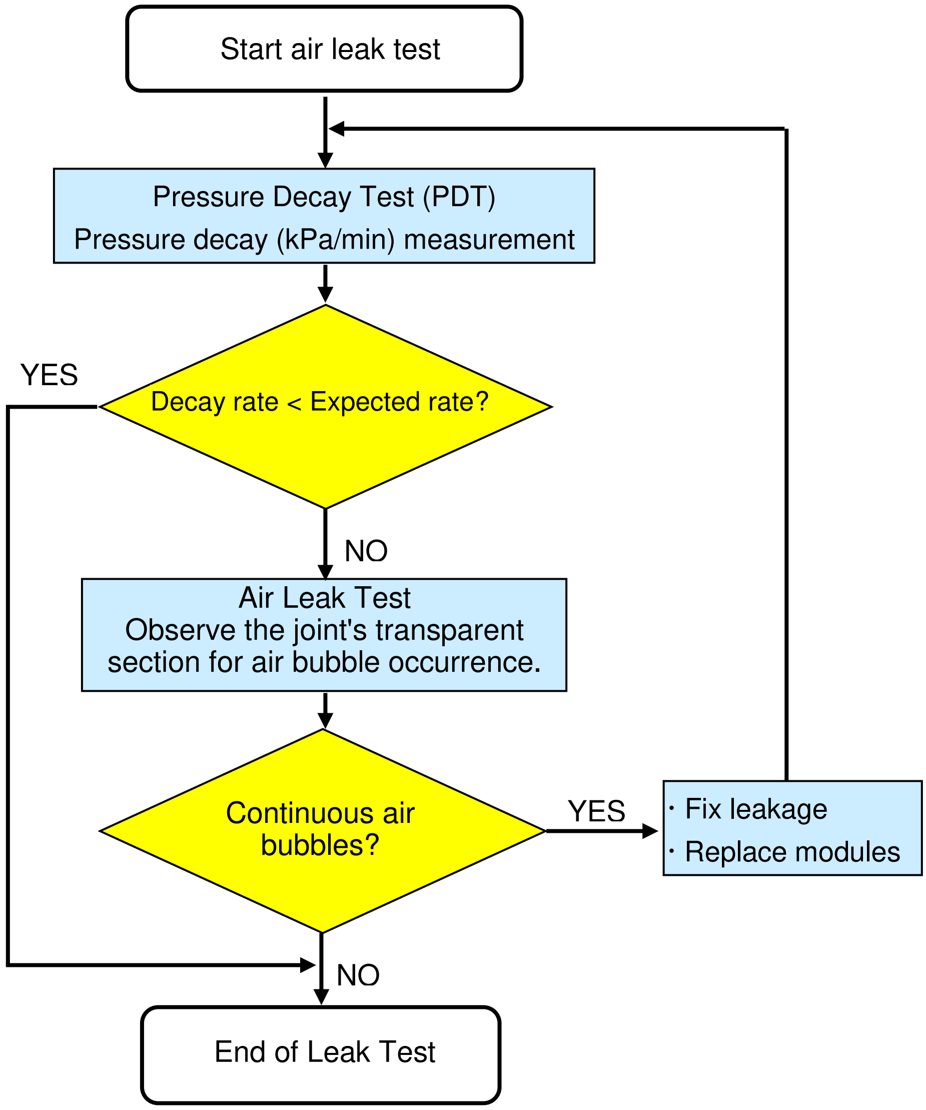


Figure 15 Leak Test Flow

Pressure hold tests may also be performed automatically or manually by an operator as required. The small membrane pores will not allow air to pass through the membrane due to the surface tension of the water being held in the membrane pores. This results in the air pressure in the system to remain almost constant when the membranes have integrity. The pressure will decay if there is a defect (such as broken fibers) as air can pass through such defects.

Leak judgment criterion

Item	Pressure Decay Rate	Amount of Pressure Decay (after 3 min)
No Leak	Slower than 5 kPa/min	Less than 15 kPa
Leak Present	5kPa/min or faster	15 kPa or more

The following is the leak test procedure:

● Step 1

(1) Open drain valve AV-5.

(2) Open the air supply valve for leak testing (AV-11) to pressurize the module's permeate side with air.

(3) The water in the permeate side of the module will be displaced by the air. When all the water is displaced, PIA (permeate pressure gauge) should read the set pressure (180 to below 200 kPa).

(4) Maintain the air pressure (PIA) until the pressure gauge reading stabilizes.

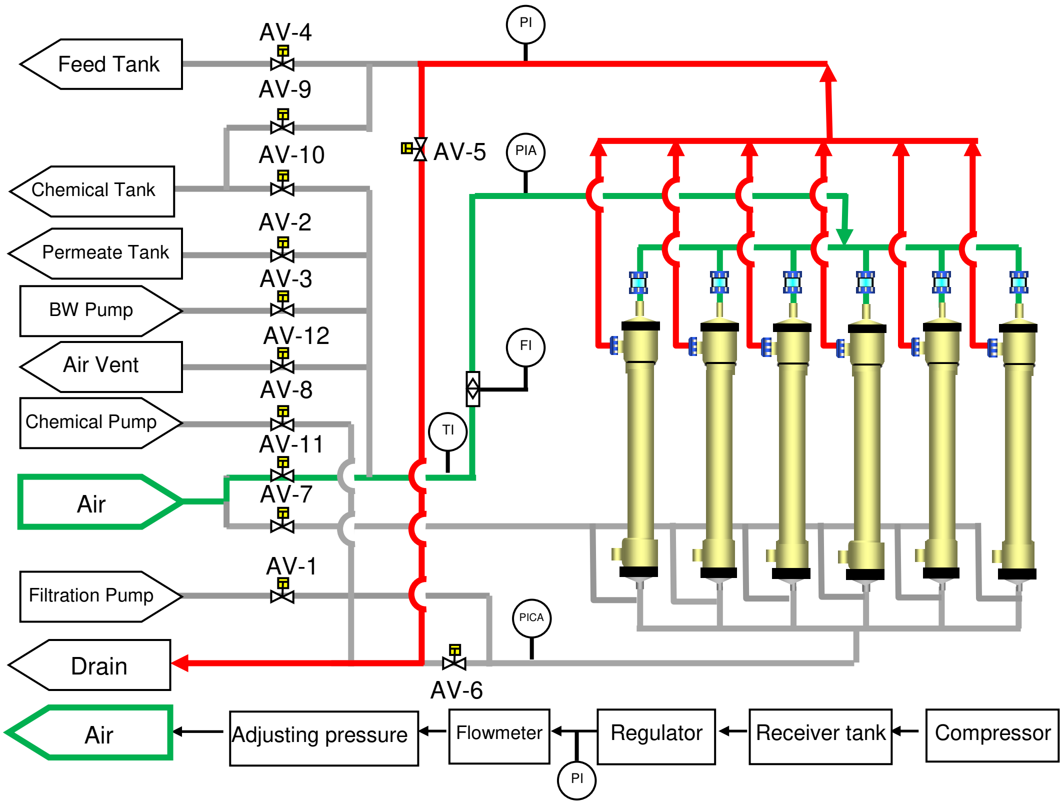


Figure 16 Step 1 for PDT

No.	Parts	No.	Parts
AV-1	Raw water feed valve	AV-7	Air supply valve
AV-2	Filtrate valve	AV-8	Chemical supply valve
AV-3	Backwash valve	AV-9	Return valve on chemical drain side
AV-4	Return valve	AV-10	Return valve for chemical drain on permeate side
AV-5	Drain valve	AV-11	Air supply valve for leak testing
AV-6	Drain valve	AV-12	Air-bleeding valve for leak testing

● Step 2

(5) Once the pressure reading of PIA has stabilized, close the air supply valve for leak testing (AV-11).

(6) Hold the pressure for 3 minutes and check for pressure decay.

(7) Pressure decrease of 15 kPa (5 kPa/min) or more: leak present
Pressure decrease of less than 15 kPa (5 kPa/min): no leak

(8) If there is a leak, an air leak test is conducted to identify the modules that have a leak.

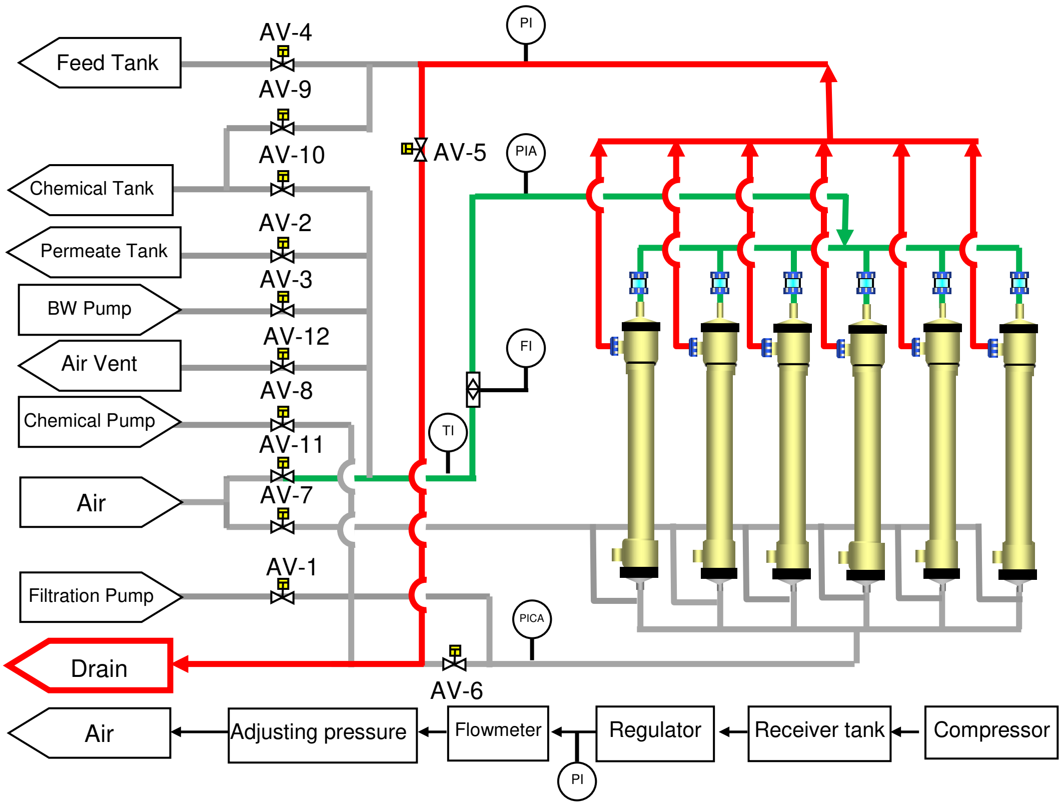


Figure 17 Step 2 for PDT

No.	Parts	No.	Parts
AV-1	Raw water feed valve	AV-7	Air supply valve
AV-2	Filtrate valve	AV-8	Chemical supply valve
AV-3	Backwash valve	AV-9	Return valve on chemical drain side
AV-4	Return valve	AV-10	Return valve for chemical drain on permeate side
AV-5	Drain valve	AV-11	Air supply valve for leak testing
AV-6	Drain valve	AV-12	Air-bleeding valve for leak testing

- Step 3
  (9) Upon completion of testing, open the air bleeding valve AV-12 to release the pressure. To avoid sudden pressure release, open and close AV-12 alternately at intervals of one second until the pressure (PIA) drops to about 10 kPa.

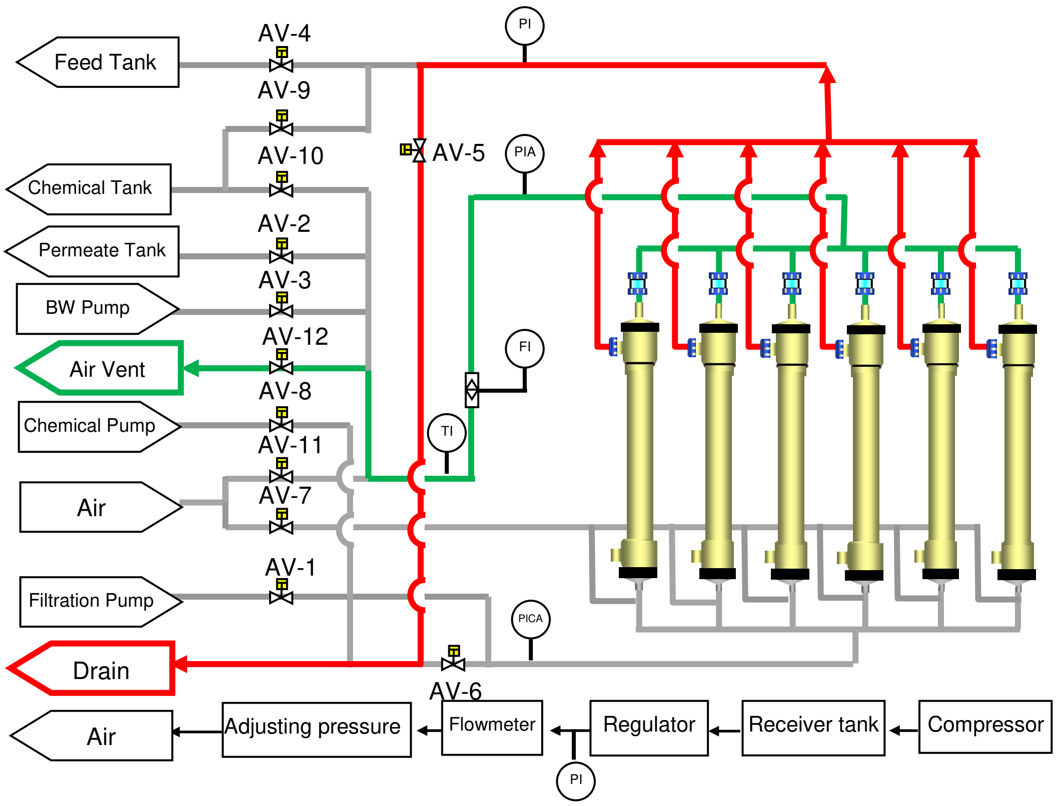


Figure 18 Step 3 for PDT

No.	Parts	No.	Parts
AV-1	Raw water feed valve	AV-7	Air supply valve
AV-2	Filtrate valve	AV-8	Chemical supply valve
AV-3	Backwash valve	AV-9	Return valve on chemical drain side
AV-4	Return valve	AV-10	Return valve for chemical drain on permeate side
AV-5	Drain valve	AV-11	Air supply valve for leak testing
AV-6	Drain valve	AV-12	Air-bleeding valve for leak testing

● Step 4

(1) Filtration process resumes after the air pressure drops below 10 kPa (reading of PIA).

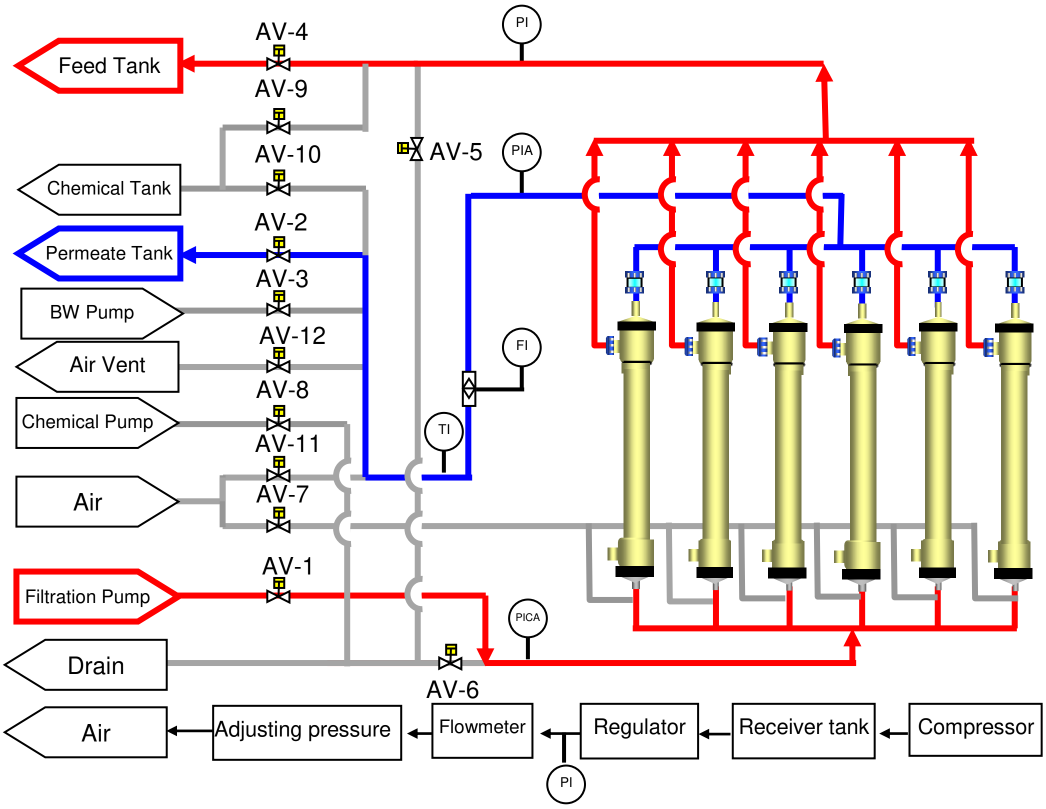


Figure 19 Step 4 for PDT

No.	Parts	No.	Parts
AV-1	Raw water feed valve	AV-7	Air supply valve
AV-2	Filtrate valve	AV-8	Chemical supply valve
AV-3	Backwash valve	AV-9	Return valve on chemical drain side
AV-4	Return valve	AV-10	Return valve for chemical drain on permeate side
AV-5	Drain valve	AV-11	Air supply valve for leak testing
AV-6	Drain valve	AV-12	Air-bleeding valve for leak testing

8.2 Air Leak Test

An air leak test may be performed by an operator as required or in cases such as where air pressure drops at a higher rate than the reference rate during a pressure hold test and a module(s) is judged to have a leak.
In the standard air leak test of Microza modules, Asahi Kasei's unique transparent expansion joint enables leaking modules to be identified very easily and quickly (patented).
The air leak test leverages membrane characteristics where the small membrane pores do not allow air to pass through due to the surface tension of the water held in the pores.
If the membrane has a problem such as rupture, air bubbles are observed through the expansion joint, otherwise no bubbles are observed.

If one hollow fiber breaks, several liters of air leaks from the breakage per minute. Note that small air bubbles observed through the expansion joint may be due to the air remaining in hollow fibers.

Example: Air bubble occurrence from one broken fiber (100kPa)

The following is the leak test procedure:

● Step 1
(1) Open the filtrate valve AV-2.
(2) Open air supply valve AV-7 to pressurize the module feed side with air.
(3) The raw water in the module is filtered out of it.
(4) When all the raw water has been filtered, check that the pressure gauge (PICA) on the feed side reads 200kPa.
(5) Check whether continuous air bubbles are observed through the expansion joint on the permeate side of the module.
(6) The following are the leak criteria: *11

Item	Continuous Air Bubble Occurrence
No Leak	None
Leak Present	Air bubbles occur.

(7) If a leak is found with a module, repair the module's leaking section or replace the module.

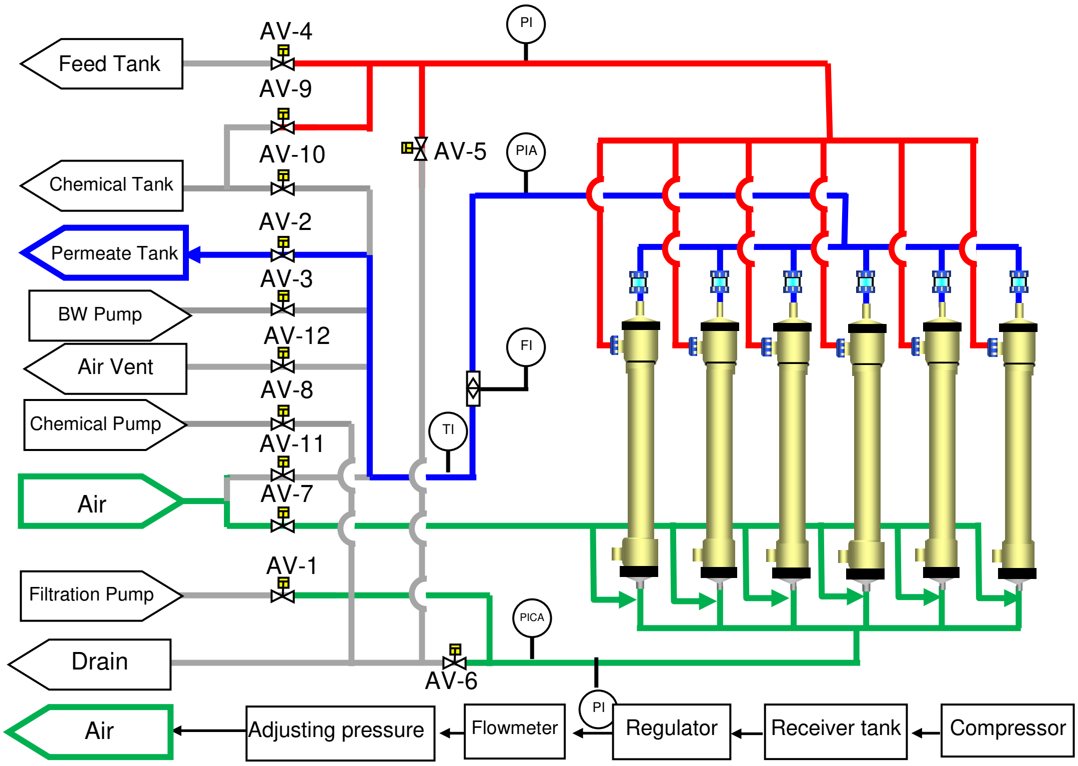


Figure 20 Step 1 for Air Leak Test

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*11 Note that small air bubbles observed through the expansion joint may be due to the air remaining in hollow fibers.

● Step 2

(8) Close the air supply valve AV-7 to stop air supply.

(9) Close the filtrate valve AV-2.

(10) Open the drain valve AV-5 to bleed compressed air. To avoid a sudden release of a large amount of air, open and close drain valve AV-5 alternately at intervals of about one second until the applied pressure decreases to below 10 kPa.

(11) Filtration process resumes after the air pressure drops below 10 kPa (reading of PICA).

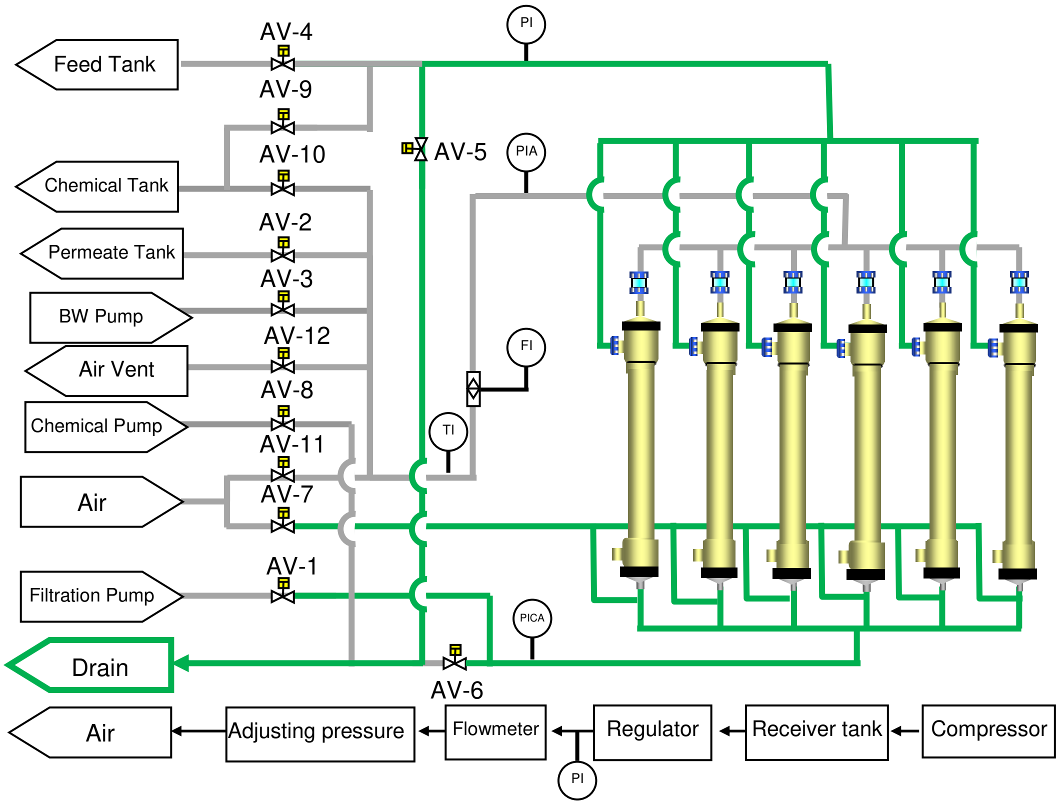


Figure 21 Step 2 for Air Leak Test

◆ Precautions

Fill the feed and permeate sides with water for integrity testing.

Pressurizing the feed side causes the water on the feed side to be filtered, pushing the air inside the hollow fibers out. If air bubbles remain on the permeate side, it is difficult to determine whether or not air bubbles are from a leaking section. In this case, perform filtration to completely push the air in the hollow fibers out before integrity testing.

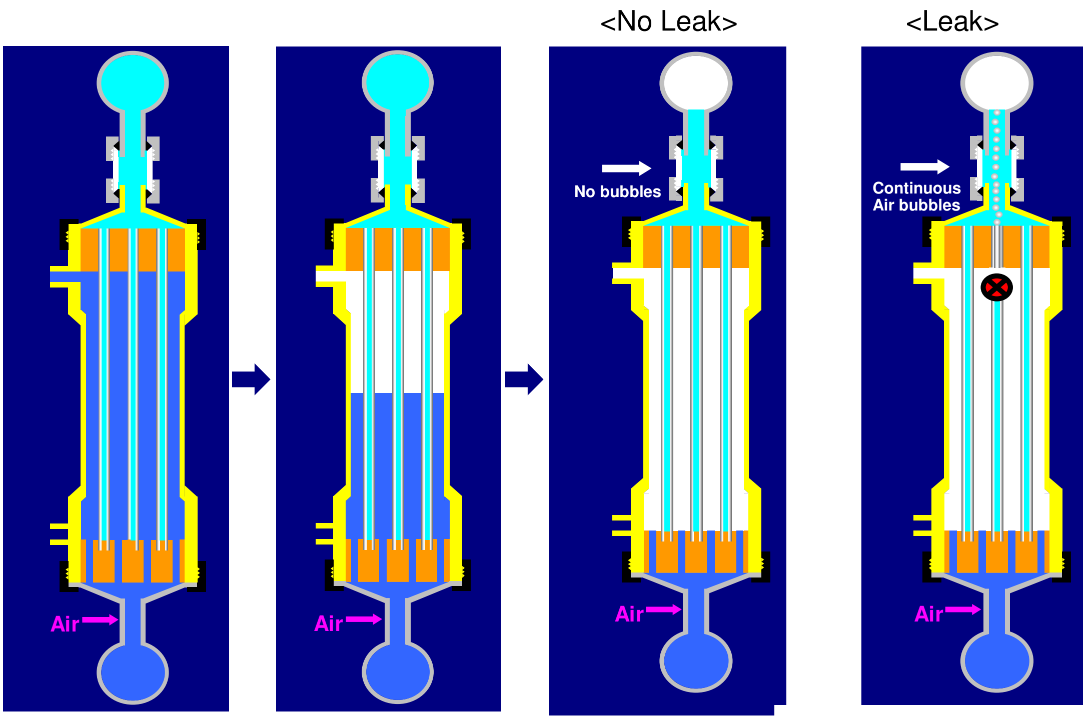
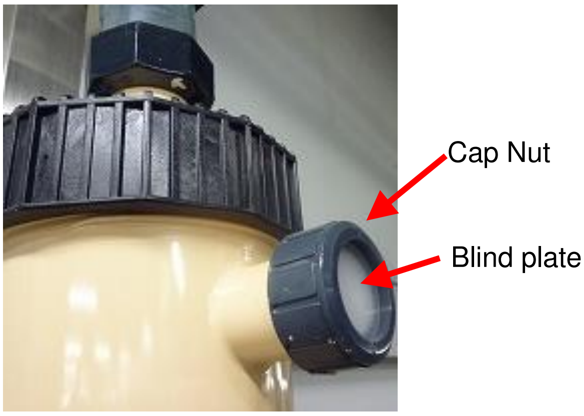


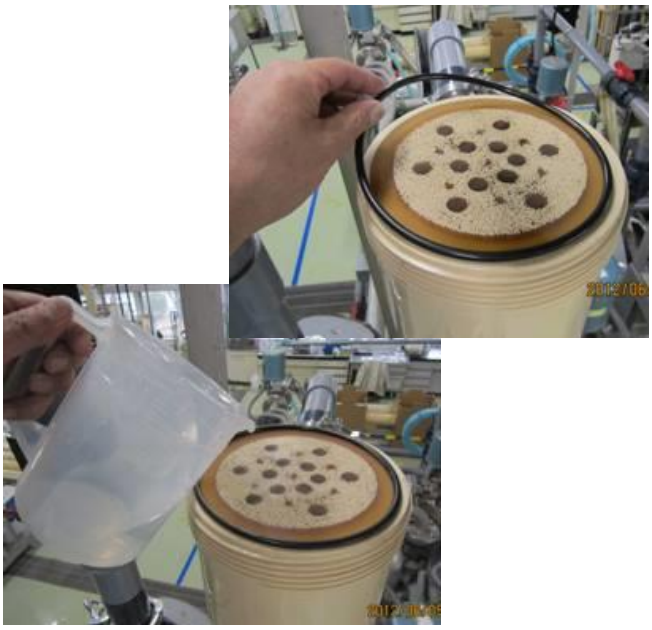
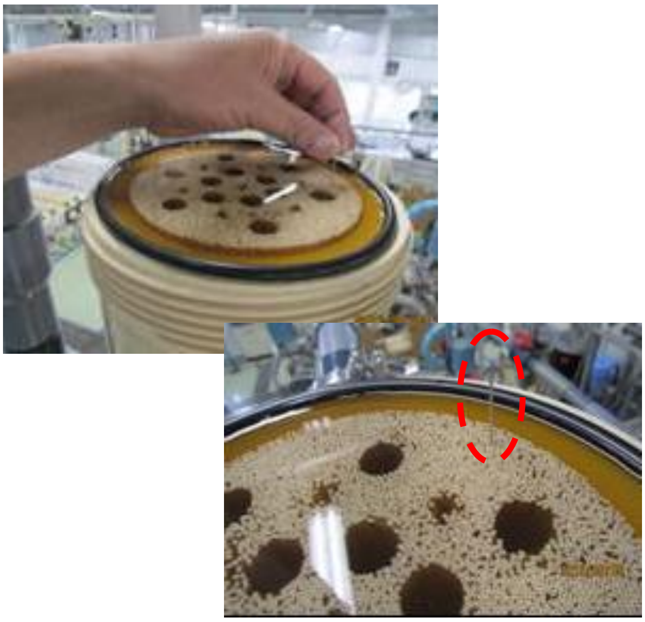
Figure 22 Air Leak Test Process

8.3 Membrane Leak Repair Method for the UNA Series

Use the SUS nail exclusively for membrane leak repair. Shown below is the membrane leak repair procedure.

◆ Inspection Procedure

Step	Work	Description
1	 	Remove the module from the system and remove the end cap only on the permeate side.
2		1) Install the module back in the system. 2) Secure the feed water inlet end to the unit. 3) Install a blind plate to the discharge nozzle and secure the blind plate with a cap nut. * If no cap nut is available, close the valve on the discharge side.

3		Fit an O-Ring onto the module end face on the permeate side. Pour clean water (e.g., permeate) on the permeate end of the module until water completely covers the surface.
4		1) Gradually pressurize the module using the air scrubbing unit. 2) Observe for a continuous stream of bubbles that would identify a leaking membrane. 3) Repair/isolate the leaking membrane by inserting a special stainless steel brad into the leaking fiber's end. Note: ・ Ensure that the air pressure during testing is below 200 kPa. Membrane may be dried with higher pressures. ・ Repair work is easier at lower pressures. Adjust air valve as required.
5		Insert (hammer in) the nail to a depth of about 1cm.

6		Cut off the nail 2 to 3 mm above the module's end surface.
7		Feed air again and raise the air pressure to 180 to 200 kPa (the maximum allowed) for the final check and observe. Note To ensure safety, do not observe the module end face from directly above when pressurizing.
8	Check that no consecutive air bubbles are present. • Consecutive air bubbles ⇒ Module is defective. • Absence of consecutive air bubbles ⇒ Module has integrity. (Note: Intermittent bubble occurrence during the initial stage of pressurization is not abnormal.)	

9.CHEMICAL CLEANING AND STERILIZATION OF UNA SERIES

Use the following procedures should there be a decline in membrane permeate flux caused by contaminants (organic or inorganic) or when it proves necessary to clean and/or sterilize the system.

* Perform chemical cleaning when the transmembrane pressure (TMP) has reached around 200 kPa.

$$\mathrm{TMP} = \left(\frac{\text{Module inlet pressure} + \text{Module discharge-side}}{2} \right) - \text{Permeate-side pressure}$$

9.1 Chemical Selection

Refer to the below table for selection of cleaning and/or disinfecting agents with attendant concentrations. Consult Asahi Kasei when cleaning is not effective with these solutions.

9.1.1 Contaminants and Applicable Cleaning and/or Disinfecting Agents

Contaminants and applicable cleaning and/or disinfecting agents

Contaminant	Cleaning Agent	Cleaning Agent Concentration
Fungi, Organic Compound	Sodium hypochlorite	Less than 5,000mg/l (0.5%) *
Organic Substance, Colloidal Silica	Sodium Hydroxide	< 4%
Inorganic Colloid	Nitric Acid, Hydrochloric Acid, Sulfuric Acid Oxalic acid Citric Acid	< 10% < 2% < 10%
Sanitization	Sodium hypochlorite Hydrogen Peroxide Solution	10 - 100mg/l* < 1%

* Effective chloride concentration

9.1.2 Acid Selection

Acids to remove inorganic substances should be selected from various points of view such as cleansing effect, waste chemical solution treatment, toxicity, corrosive nature, and costs.

Classification of acid cleaning solutions

Chemicals	Substance Difficult to Remove	Effluent Treatment	Toxicity	Corrosive Nature
Nitric Acid (HNO_3)	Mn cannot be removed.	Easy (only neutralization)	Poison	Corrosive
Hydrochloric Acid (HCl)	Mn cannot be removed.	Easy (only neutralization)	Poison	Corrosive
Sulfuric Acid (H_2SO_4)	Mn and Ca cannot be removed.	Easy (only neutralization)	Poison	Corrosive
Oxalic acid	Ca can hardly be removed.	Difficult (Neutralization + Organic substance treatment required)	Poison	None
Citric Acid	Ca can hardly be removed.	Difficult (Neutralization + Organic substance treatment required)	None (food additive)	None

◆ **Precautions**

- According to our experience, the chemical most effective to remove all kinds of inorganic matter is a mixture of nitric acid and oxalic acid. This mixed acid is used when the membrane is tested for flux retention by removing the contaminants on the membrane as much as possible.
- In many cases, flux is better recovered by cleaning the membrane with alkali to remove organic substances and then with acid.

Standard chemical cleaning:

(2,500mg/l NaClO +1% NaOH) × 6 to 8 hrs ⇒ Rinse ⇒ 1% Citric acid × 1 to 2 hrs ⇒ Rinse

9.2 Types of Chemical Cleaning (EFM, CEB, and CIP)

There are two kinds of chemical cleaning: 1) light cleaning performed with chemical solution of low concentration for a short time at frequent intervals; and 2) heavy cleaning performed in an opposite manner to 1) to completely clean membrane for higher flux recovery.
With Asahi Kasei's standard cleaning protocol, EFM (Enhanced Flux Maintenance) or CEB (Chemical Enhanced Backwash) is performed for light cleaning, and CIP (Cleaning In Place) for heavy cleaning.
Performing EFM or CEB enables operation at higher permeate fluxes and lower pressures as compared with the implementation of CIP only. The following figure shows general ideas of EFM and CIP:

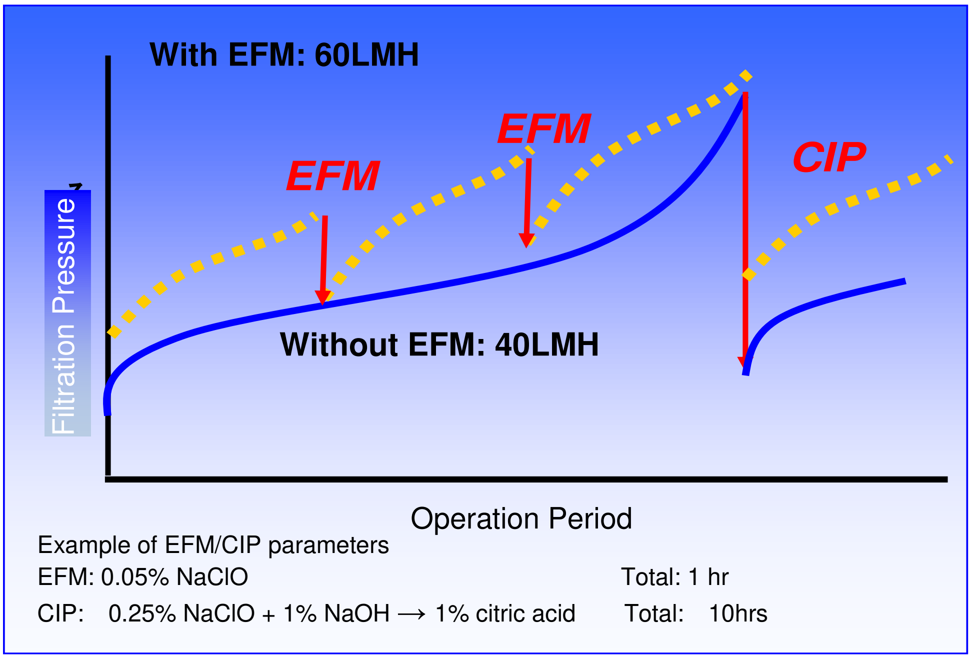


Figure 23 Conceptual Illustration of EFM and CIP

As illustrated in Figure 24, chemical cleaning can be performed in one of two ways: 1) CEB in which chemical solution is infused directly into a backwash pipe; and 2) EFM in which chemicals are prepared in a chemical tank and chemical solution is fed from the feed side.
Also, EFM can be implemented either by circulating chemical solution through modules and a chemical tank or by holding chemical solution stationary in modules for membrane soaking. Further, in the former case, chemical solution can be discharged only from the discharge outlets of modules or from both the discharge and permeate outlets of modules.
Which method to employ depends on the raw water type.

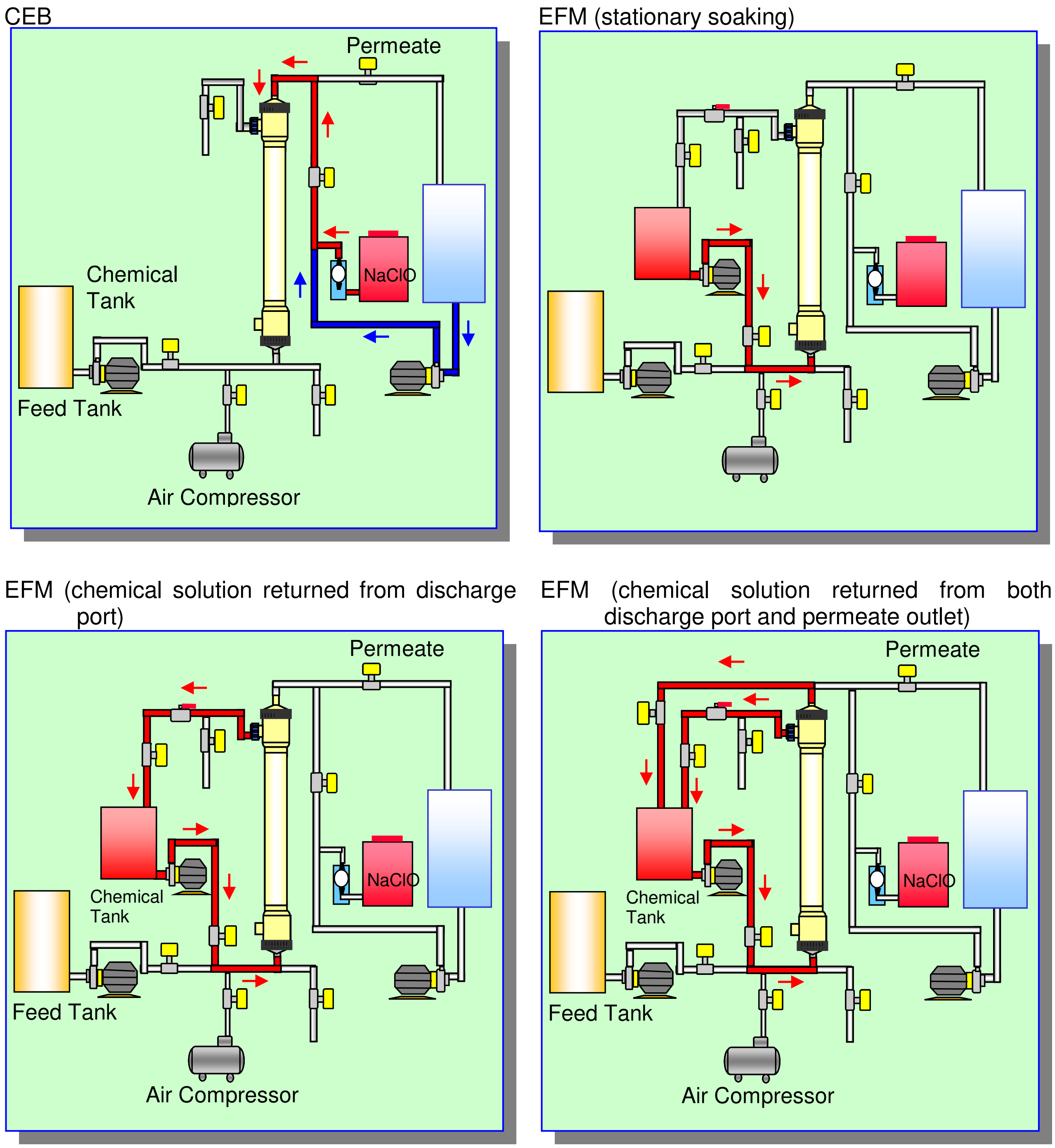


Figure 24 Examples of Chemical Cleaning Flows

Example of method selections

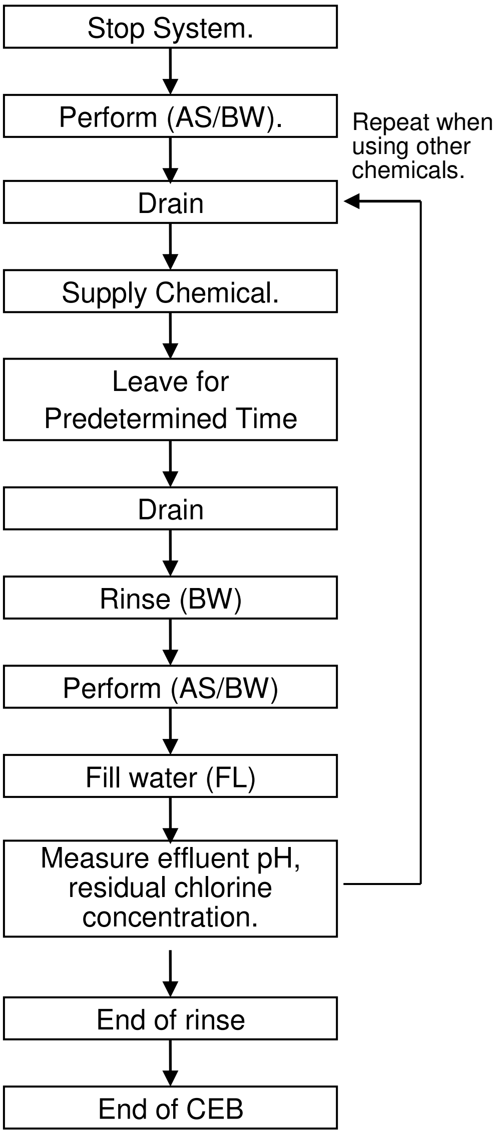
Raw Water Type	EFM			CEB
	Chemical solution discharged from discharge port and permeate outlet to chemical tank	Chemical solution discharged from discharge port to chemical tank	Stationary soaking	
Natural water	OK	OK	OK	OK
Sewage secondary effluent	OK	OK	OK	OK
Seawater	OK	▲	▲	▲

▲: Contact Asahi Kasei.

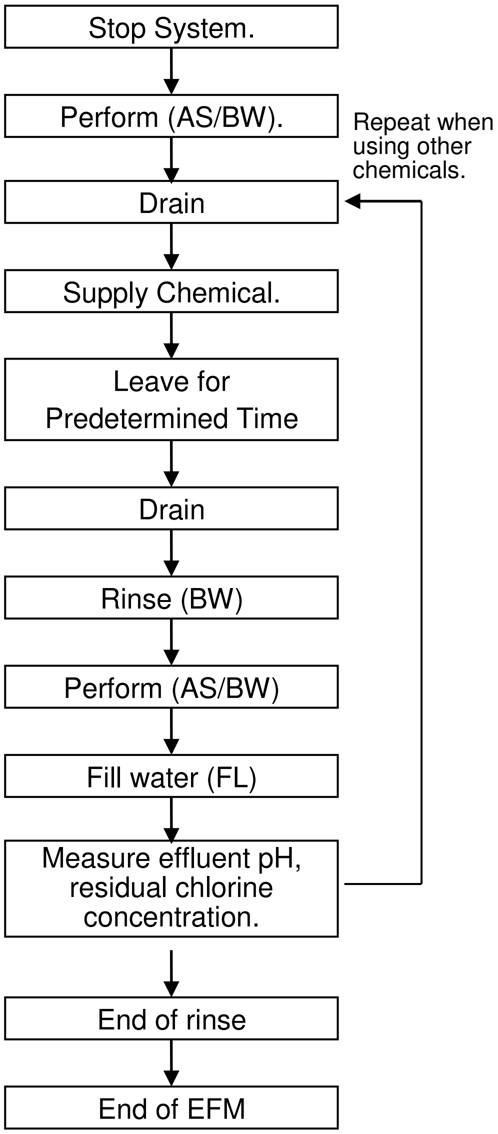
9.3 Chemical Cleaning Sequences of EFM, CEB, and CIP

Adhere to the below sequences for EFM, CEB, and CIP. For CIP, follow the procedure for EFM or CEB, whichever is chosen.

<CEB Flow>



<EFM Flow>



CEB

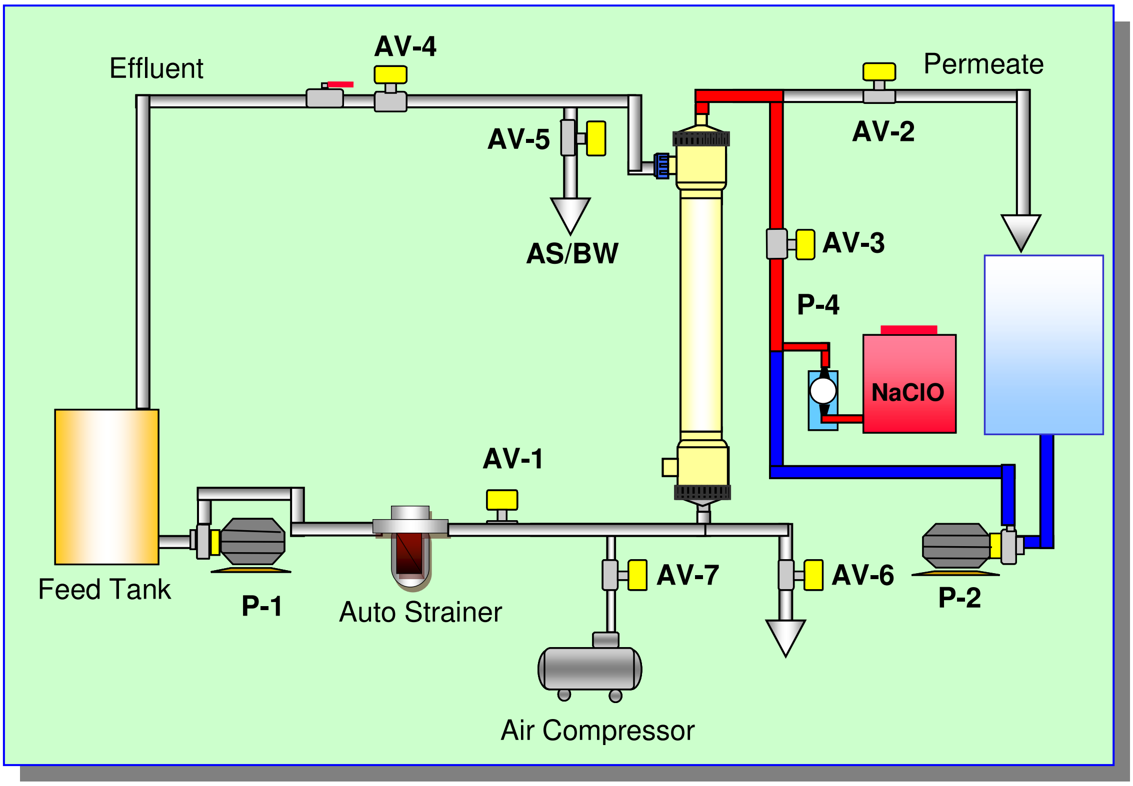


Figure 25 CEB Process Flow Diagram

Reference) CEB Timing Chart (* Valve open/close duration excluded)

CEB Process		60 min at a time							
Process		AS/BW	Drain	Chemical Supply	Soaking	Drain	Rinse (BW)	AS/BW	FL
Duration (min)		1	2	5	42	2	6	1	1
AV-1	Raw water feed valve								■
AV-2	Return valve								
AV-3	Filtrate valve	■						■	
AV-4	Backwash valve			■	■		■		
AV-5	AS/BW drain valve	■	■	■	■	■	■	■	■
AV-6	Drain valve		■			■			
AV-7	Air supply valve								
P-1	Filtration pump								■
P-2	Backwash pump	■		■			■	■	
P-3	Chemical pump								
P-4	Sodium hypochlorite injection pump	■		■					
Air compressor									

* The processes and durations shown here are typical examples. What processes and durations to employ depends on the system. Be sure to employ appropriate processes and durations for your system.

■	ON or Valve opens
□	OFF or Valve closes

Reference) CIP (CEB method) Timing Chart (* Valve open/close duration excluded)

CIP Process	480 min (8 hr) at a time														
Process	AS/BW	Drain	Chemical Supply	Soaking	Drain	Rinse (BW)	AS/BW	FL	Drain	Chemical Supply	Soaking	Drain	Rinse (BW)	AS/BW	FL
Duration (min)	1	2	5	360	2	10	1	1	2	5	77	2	10	1	1
AV-1 Raw water feed valve															
AV-2 Return valve															
AV-3 Filtrate valve															
AV-4 Backwash valve															
AV-5 AS/BW drain valve															
AV-6 Drain valve															
AV-7 Air supply valve															
P-1 Filtration pump															
P-2 Backwash pump															
P-3 Chemical pump															
P-4 Sodium hypochlorite injection Pump															
P-5 Acid injection pump															
Air compressor	Turns on and off in accordance with pressure settings														

* The processes and durations shown here are typical examples. What processes and durations to employ depends on the system.
Be sure to employ appropriate processes and durations for your system.

	ON or Valve opens
	OFF or Valve closes

EFM (chemical solution returned from both discharge port and permeate outlet)

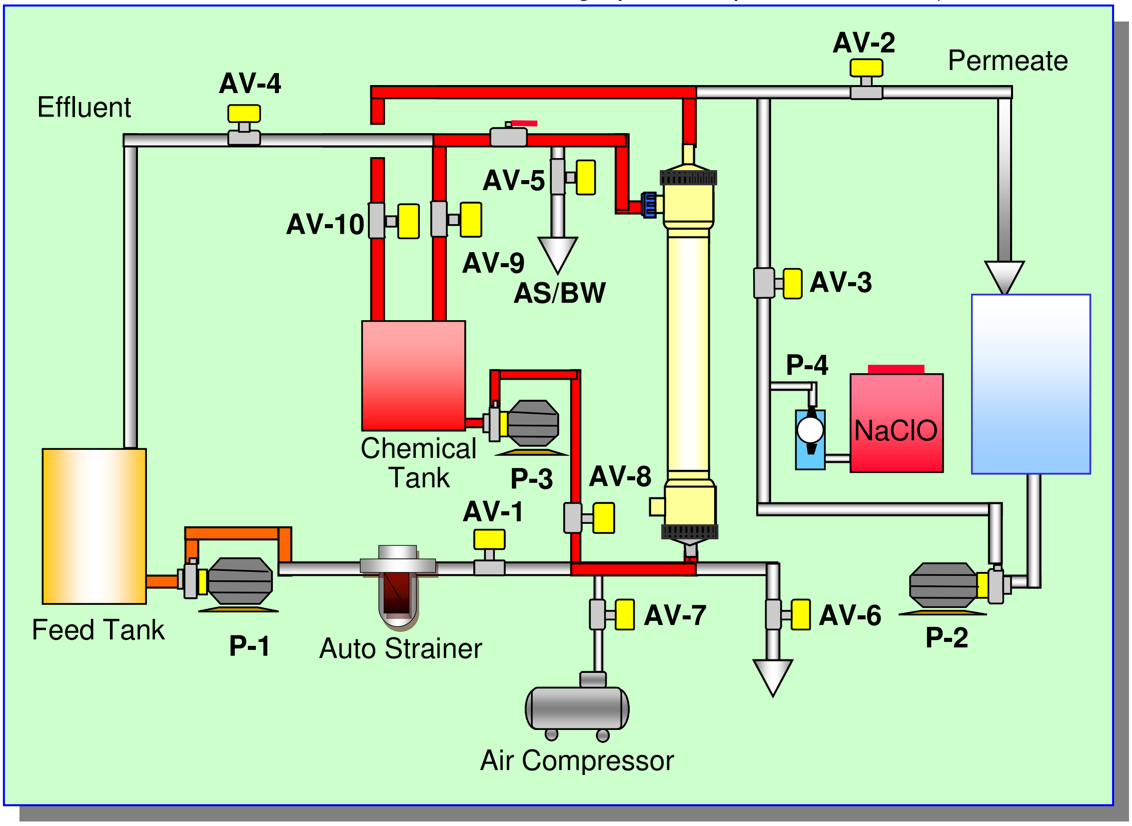


Figure 26 EFM Process Flow Diagram

Reference) EFM Timing Chart (* Valve open/close duration excluded)

EFM Process		60 min at a time						
Process		AS/BW	Drain	Chemical Supply	Drain	Rinse (BW/FL)	AS/BW	FL
Duration (min)		1	2	47	2	6	1	1
AV-1	Raw water feed valve							
AV-2	Filtrate valve							
AV-3	Backwash valve							
AV-4	Return valve							
AV-5	AS/BW drain valve							
AV-6	Drain valve							
AV-7	Air supply valve							
AV-8	Chemical supply valve							
AV-9	Return valve on chemical drain side							
AV-10	Return valve for chemical drain on permeate side							
P-1	Filtration pump							
P-2	Backwash Pump							
P-3	Chemical pump							
P-4	Sodium hypochlorite injection pump							
Air compressor		Turns on and off in accordance with pressure settings						

* The processes and durations shown here are typical examples. What processes and durations to employ depends on the system. Be sure to employ appropriate processes and durations for your system.

	ON or Valve opens
	OFF or Valve closes

Reference) CIP (EFM method) Timing Chart (* Valve open/close duration excluded)

EFM Process		480 min (8 hrs) at a time												
Process		AS/BW	Drain	Chemical Supply	Drain	Rinse (BW/FL)	AS/BW	FL	Drain	Chemical Supply	Drain	Rinse (BW/FL)	AS/BW	FL
Duration (min)		1	2	360	2	5	1	1	2	97	2	5	1	1
AV-1	Raw water feed valve					■		■				■		■
AV-2	Filtrate valve													
AV-3	Backwash valve	■				■	■					■	■	
AV-4	Return valve													
AV-5	AS/BW drain valve	■	■		■	■	■	■	■		■	■	■	■
AV-6	Drain valve		■		■				■		■			
AV-7	Air supply valve	■					■						■	
AV-8	Chemical supply valve			■						■				
AV-9	Return valve on chemical drain side			■						■				
AV-10	Return valve for chemical drain on permeate side			■						■				
P-1	Filtration pump					■		■				■		■
P-2	Backwash Pump	■				■	■					■	■	
P-3	Chemical pump			■						■				
P-4	Sodium hypochlorite injection pump	■												
Air compressor		Turns on and off in accordance with pressure settings												

* The processes and durations shown here are typical examples. What processes and durations to employ depends on the system. Be sure to employ appropriate processes and durations for your system.

■ ON or Valve opens

□ OFF or Valve closes

◆ Precautions

Measure permeate flux before and after each EFM, CEB, alkali CIP, and acid CIP to allow for a check of flux recoverability (effect of cleaning). Ensure sufficient rinsing between chemical cleaning steps when employing more than one chemical. Mixing sodium hypochlorite and acid generates chlorine gas.

Cleaning Protocol

Preliminary cleaning

Item	Parameter
Air Flow Rate	5 Nm^3/hr/module
Duration	1 min
Procedure	Simultaneous Air scrubbing/Backwash (AS/BW) × 1 min Perform under normal operating conditions. Repeat several times if the membrane is heavily contaminated.

Dilution water, rinse water

	Dilution Water		Rinse Water	
	UNA-treated Water	Tap Water, RO-treated Water	UNA-treated Water	Tap Water, RO-treated Water
River Water	○	○	○	○
Sewage Secondary Effluent	△	○	○	○
Seawater	×	○	△	○

△: Contact Asahi Kasei.

Chemical cleaning protocol

<table>
<tr><th>Item</th><th>Protocol</th></tr>
<tr><td>Chemical Solution Volume</td><td>The following are examples of chemical solution volumes required, based on the total volumes of module holdup volumes + piping volumes:
<table>
<tr><th>Item</th><th>UNA-600A</th><th>UNA-660A</th><th>UNA-620A</th></tr>
<tr><td>Module Holdup Volume</td><td>23</td><td>30</td><td>45</td></tr>
<tr><td>Reference Chemical Solution Volume</td><td>40 - 50</td><td>60 - 70</td><td>75</td></tr>
</table>
Unit: L/module</td></tr>
<tr><td>EFM•CEB Protocol (light cleaning)</td><td>Standard protocol
NaClO EFM
<table>
<tr><th>Step</th><th>Cleaning Type</th><th>Chemical Used</th><th>Concentration (%)</th><th>Cleaning Duration (hr)</th></tr>
<tr><td>Single</td><td>Alkali</td><td>NaClO</td><td>0.05</td><td>1</td></tr>
</table>
Acid EFM
<table>
<tr><th>Step</th><th>Cleaning Type</th><th>Chemical Used</th><th>Concentration (%)</th><th>Cleaning Duration (hr)</th></tr>
<tr><td>Single</td><td>Acid</td><td>Acid</td><td>1.0%</td><td>1</td></tr>
</table>
Acid cleaning: Acids such as oxalic acid, citric acid, and nitric acid can be used.
These are standard protocols and depend on permeate flux recovery rates achieved.</td></tr>
</table>

<table>
<tr><td>CIP Protocol
(heavy cleaning)</td><td>Standard protocol
<table>
<tr><th>Step</th><th>Cleaning Type</th><th>Chemical Used</th><th>Concentration (%)</th><th>Cleaning Duration (hr)</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Alkali</td><td>NaClO</td><td>0.25%</td><td rowspan="2">6</td></tr>
<tr><td>NaOH</td><td>1.00%</td></tr>
<tr><td>2</td><td>Acid</td><td>Citric Acid</td><td>1.00%</td><td>1</td></tr>
</table>
Acid cleaning: Acids such as oxalic acid, citric acid, and nitric acid can be used.
These are standard protocols and depend on permeate flux recovery rates achieved.</td></tr>
<tr><td>Discharge Flow Rate</td><td>1 - 2m³/hr/module</td></tr>
<tr><td>Duration</td><td>EFM, CEB：30 – 60 min
CIP: 6 - 8 hr for Alkali, 1 - 2 hr for acid</td></tr>
<tr><td>Temperature</td><td>< 40°C</td></tr>
</table>

◆ Precaution

Do not raise the temperature of chemical solution rapidly while the solution is circulating through modules as it may give a thermal shock to the modules. If the solution temperature is to be raised by 20°C or more, raise it at a rate of 10°C or less per minute.

Water Rinsing

Rinse the chemical solution in modules by backwash or by flushing with rinsing water.

Item	Protocol
Rinse Water Flow Rate	3 - 6m^3/hr/module
Rinsing Volume	CEB, EFM: 200 - 300L/module + Piping volume CIP: 400 - 500L/module + Piping volume
Rinse Duration	CEB, EFM: 3 - 8 min + Duration for piping CIP: 4 - 10 min + Duration for piping
Rinse Completion	· Completion of rinse is determined via concentration measurement of residual sodium hypochlorite, pH (or other) in rinse water discharge. · Implementing acid cleaning with sodium hypochlorite remaining in modules or piping may generate chlorine gas. · Before performing acid cleaning, be sure to measure the residual chlorine concentration and confirm that the measured concentration is below the level of detectability. · When the pH of rinsing water has reached 6 to 8, the completion of rinse can be assumed.

When only sterilizing, use a sodium hypochlorite solution with an effective chloride concentration of ≤ 100 mg/l. Thoroughly rinse the modules using clean water after sanitization.
Thoroughly wash off any chemical solution adhering to the outer surfaces of module housings.

Warning	
	When handling hazardous chemicals, always wear protectors such as safety goggles and rubber gloves. The chemicals include, but are not limited to, sodium hypochlorite and sodium hydroxide. If the solution comes in contact with eyes or skin, immediately rinse thoroughly with water. Then seek professional medical attention as soon as possible as there may be serious injury to eyes and skin.

Warning	
	Do not mix sodium hypochlorite and acids when both are used in a cleaning protocol. Mixing of these chemicals may generate lethal chlorine gas.

Assessing Post Cleaning Permeate Flux Recovery

After cleaning, use the below protocol to check permeate flux recovery. Consult Asahi Kasei when recovery is inadequate.

Procedure

(1) Initial permeate flux check

In order to judge flux recovery, first measure and record the following parameters prior to start of operation and after module replacement.

- Preliminary flux of clean water and/or feed water
- Pressure
- Water Temperature

(2) Measuring Methods

There are two approaches to measure recovery; i.e., 1- by using clean water, and 2- by using the actual raw process water.

When using raw process water, avoid extended operation as it may be difficult to establish actual flux.

Calculation

Using the measured values, calculate permeate flux at 100 kPa and 25°C at the start of operation and before and after cleaning.

Permeate flux at 100 kPa and 25°C = Permeate flux × 100 / TMP × Temperature conversion factor

* Average filtration pressure (TMP) = (Mod. inlet press. + Mod. outlet press.) / 2 - Filtrate pressure
* For temperature conversion factors, see the temperature conversion table on the next page.
  (e.g., Tc @ 15.2°C is 1.272 which is at the intersection of 15°C on left vertical scale and 0.2°C on the upper horizontal scale)
*

$$\text{Recovery rate of permeate flux (\%)} = \left(\frac{\text{Permeate flux at 100 kPa and 25°C after chemical cleaning}}{\text{Permeate flux at 100 kPa and 25°C at operation start}} \right) \times 100$$

* When measuring permeate flux, set the discharge effluent flow rate to 1m^3/hr or less per module.
  If not, the flux will not be measured correctly due to the variant pressure drop in the module. (The apparent flux will be higher than the actual permeate flux.)

Temperature conversion coefficient table

℃	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	2.013	2.006	1.999	1.992	1.985	1.978	1.972	1.965	1.958	1.951
1	1.945	1.938	1.932	1.925	1.919	1.912	1.906	1.899	1.893	1.887
2	1.881	1.874	1.868	1.862	1.856	1.850	1.844	1.837	1.831	1.825
3	1.820	1.814	1.808	1.802	1.796	1.790	1.784	1.779	1.773	1.767
4	1.762	1.756	1.750	1.745	1.739	1.734	1.728	1.723	1.717	1.712
5	1.706	1.701	1.696	1.690	1.685	1.680	1.675	1.670	1.664	1.659
6	1.654	1.649	1.644	1.639	1.634	1.629	1.624	1.619	1.614	1.609
7	1.604	1.599	1.595	1.590	1.585	1.580	1.575	1.571	1.566	1.561
8	1.557	1.552	1.547	1.543	1.538	1.534	1.529	1.525	1.520	1.516
9	1.511	1.507	1.502	1.498	1.494	1.489	1.485	1.481	1.477	1.472
10	1.468	1.464	1.460	1.455	1.451	1.447	1.443	1.439	1.435	1.431
11	1.427	1.423	1.419	1.415	1.411	1.407	1.403	1.399	1.395	1.391
12	1.387	1.383	1.380	1.376	1.372	1.368	1.364	1.361	1.357	1.353
13	1.349	1.346	1.342	1.338	1.335	1.331	1.328	1.324	1.320	1.317
14	1.313	1.310	1.306	1.303	1.299	1.296	1.292	1.289	1.285	1.282
15	1.279	1.275	1.272	1.269	1.265	1.262	1.259	1.255	1.252	1.249
16	1.245	1.242	1.239	1.236	1.233	1.229	1.226	1.223	1.220	1.217
17	1.214	1.210	1.207	1.204	1.201	1.198	1.195	1.192	1.189	1.186
18	1.183	1.180	1.177	1.174	1.171	1.168	1.165	1.162	1.160	1.157
19	1.154	1.151	1.148	1.145	1.142	1.140	1.137	1.134	1.131	1.128
20	1.126	1.123	1.120	1.117	1.115	1.112	1.109	1.106	1.104	1.101
21	1.098	1.096	1.093	1.091	1.088	1.085	1.083	1.080	1.078	1.075
22	1.072	1.070	1.067	1.065	1.062	1.060	1.057	1.055	1.052	1.050
23	1.047	1.045	1.042	1.040	1.038	1.035	1.033	1.030	1.028	1.026
24	1.023	1.021	1.019	1.016	1.014	1.012	1.009	1.007	1.005	1.002
25	1.000	0.998	0.995	0.993	0.991	0.989	0.986	0.984	0.982	0.980
26	0.978	0.975	0.973	0.971	0.969	0.967	0.965	0.962	0.960	0.958
27	0.956	0.954	0.952	0.950	0.948	0.945	0.943	0.941	0.939	0.937
28	0.935	0.933	0.931	0.929	0.927	0.925	0.923	0.921	0.919	0.917
29	0.915	0.913	0.911	0.909	0.907	0.905	0.903	0.901	0.899	0.898
30	0.896	0.894	0.892	0.890	0.888	0.886	0.884	0.882	0.881	0.879
31	0.877	0.875	0.873	0.871	0.870	0.868	0.866	0.864	0.862	0.861
32	0.859	0.857	0.855	0.853	0.852	0.850	0.848	0.846	0.845	0.843
33	0.841	0.840	0.838	0.836	0.834	0.833	0.831	0.829	0.828	0.826
34	0.824	0.823	0.821	0.819	0.818	0.816	0.814	0.813	0.811	0.810
35	0.808	0.806	0.805	0.803	0.802	0.800	0.798	0.797	0.795	0.794
36	0.792	0.791	0.789	0.787	0.786	0.784	0.783	0.781	0.780	0.778
37	0.777	0.775	0.774	0.772	0.771	0.769	0.768	0.766	0.765	0.763
38	0.762	0.760	0.759	0.757	0.756	0.755	0.753	0.752	0.750	0.749
39	0.747	0.746	0.745	0.743	0.742	0.740	0.739	0.738	0.736	0.735
40	0.733	-	-	-	-	-	-	-	-	-