Toray UF

Instruction Manual

“HFUG Series”
[HFUG-B2315AN (type AN)]

TORAY
Innovation by Chemistry

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Notice

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TABLE OF CONTENTS

I. Introduction

Toray PVDF Hollow Fiber Membrane Module "HFUG series" is a pressurized hollow fiber UF (Ultra Filtration) membrane module developed with polymer science and membrane fabrication technologies accumulated over decades of successful membrane manufacturing at Toray Industries, Inc.

The membrane material is Polyvinylidene fluoride (PVDF). The nominal pore size of the membrane is 0.01 micrometers.

The module, which is permanently potted in its casing, is pressure-driven which provides filtrate quality equal to submerged modules, while offering greater TMP range for more flexible plant operation. Maximum operating pressure is 300 kPa (43.5 psi). The flow direction is outside-in, which is more suitable for higher turbidity water treatment because of the air-scrubbing effectiveness. Additionally, outside-in modules can remove suspended solids more effectively at higher recovery rates compared to inside-out fibers.

1. Characteristics of Toray "HFUG series" Membrane Module

(1) High Filtration Flux

HFUG series provides high filtration flux and stable operation for the filtration of various raw water sources. The membrane is made with a special spinning method, which enables high permeability and high fouling resistance.

(2) Excellent Water Quality

HFUG series provides very good water quality for the filtrate, extremely low turbidity since the membrane has 0.01 micrometers nominal pore size. HFUG series is recommended to be applied to the tertiary treatment of sewage and RO pretreatment in desalination.

(3) High Mechanical Strength

The membrane of HFUG series has very high mechanical strength because it is made of PVDF with the special spinning method developed by Toray. HFUG series provides high integrity and durability under recommended operating conditions.

(4) High Chemical Durability

The membrane material of HFUG series is PVDF, which allows to clean the membrane with high concentrations of chlorine and with high concentrations of acid resulting in better cleaning and longer sustainable membrane flux rates.

2. Applications of Toray "HFUG series" Membrane Module

- Drinking Water Production
- Tertiary Treatment
- RO Pretreatment
- Industrial Water Production
- Reuse of Industrial Wastewater

II. For Your Safety

- Please be sure to read and follow the instructions below before using HFUG series. This manual should be retained for future reference.
- Follow the safety precautions as they are intended to protect operators and equipment from various risks such as physical harm and/or property damage. The following table shows a level of potential risk for each indicated symbol.

DANGER	This symbol indicates an imminent hazardous situation which will result in serious injury or death when the instruction is not observed.
WARNING	This symbol indicates a potentially hazardous situation which will result in serious injury or death when the instruction is not observed.
CAUTION	This symbol indicates a potentially hazardous situation which might result in injury or property damage when the instruction is not observed.

- The following table explains the information to be noted.

 Prohibited	“Prohibited” This symbol indicates a prohibited action or procedure.
 Instruction	“Instruction” This symbol indicates an important action or procedure which has to be taken without fail.

1. Safety Instruction for Unpacking and Installation

DANGER


Instruction

Be sure to wear safety gears such as rubber gloves and safety glasses for unpacking. The membrane is packaged in sodium hypochlorite solution (Max. 200 mg/L as Cl_2). If the solution happens to splash onto the skin, wash the affected part with running water. If the solution happens to get in the eyes or mouth, wash the affected part with sufficient amounts of clean running water for more than 15 minutes and see the doctor immediately.

WARNING


Instruction

Be sure to wear safety gears such as a helmet and safety shoes to avoid injury due to falling of related parts or equipment, such as module, etc.

CAUTION


Prohibited

The preservative solution should be drained out before using the modules. After that, fill tap water or equivalent quality water into the modules to prevent the hollow fiber membrane from drying out. Do not allow the modules to dry even for a few hours.


Prohibited

The membrane modules should not be frozen.


Prohibited

Be careful not to damage or dent the modules during handling.


Instruction

Be sure to wear protective gloves to avoid injury of hands by packing box of the modules.


Instruction

Housing type joints and screw are applied to connect the modules to the piping. Follow the instruction of the connection provided by the supplier at the connection point. Wrong connections may damage the modules.


Instruction

When connecting and unconnecting the modules to the piping, be sure to secure a sufficient working space, and take care not to catch and hurt fingers.


Prohibited

Keep the connection surface free of any dirt or oil.


Instruction

Be sure to install the modules vertically for effective air-scrubbing.

2. Safety Instruction for Filtration Operation

DANGER


Instruction

Flush all the piping out with clean water and make sure no debris is remaining in the piping prior to connecting the modules.


Instruction

Confirm that the preservative chemical in the modules is completely drained out before starting the filtration operation. The preservative chemical is harmful to humans.


Instruction

Flush the modules at low pressure, filling from the bottom, and vent to remove any air from the modules. Air left in the modules may cause water hammer and may result in damage to the membrane.


Instruction

Prior to use, make certain modules are flushed. Filtrate should be drained unless it meets the required quality.

WARNING


Instruction

Protect modules from direct sunlight and ultraviolet light. Ultraviolet light can degrade module housings and membranes.


Instruction

Constantly monitor filtrate quality such as turbidity and/or the number of particles during filtration, and stop the operation if abnormal water quality is detected.


Prohibited

Do not exceed the maximum applicable pressure of 300 kPa (43.5 psi). Higher pressures can damage the modules. Do not exceed the maximum temperature of 40 deg C (104 deg F). The higher temperature damages the modules.


Prohibited

Do not freeze the membrane modules.


Instruction

The operating conditions, including the filtration flux and the periodical physical cleaning, must be properly set up otherwise the trans-membrane pressure may rise too quickly. The operation range is described in the latter section of this manual.


Instruction

Make sure air tubes or connected pipes are properly fixed. Otherwise, the tubes or connected pipes may be blown away or behave violently during air-scrubbing.


Instruction

Do not overfeed air to the modules. Excessive scrubbing air damages the membranes and/or shortens the membrane life.
The air flow rate should be within the range below for each module type.

Air flow rate: 3.6 – 6.7 Nm^3/h (2.1 – 3.9 scfm)

The maximum required air pressure during the air-scrubbing for the inside of the module will be 40 kPa (6 psi).


Instruction

At the integrity tests, such as Pressure Decay Test (PDT) or Diffusive Air Flow (DAF) Test, keep the air pressure below 130 kPa (18.9 psi). Also, keep the source air pressure lower than 200 kPa (29 psi), to prevent excess air inflow. All the air used for air-scrubbing and integrity testing must be dry oil-free air.

3. Safety Instruction for Chemical Cleaning

DANGER


Instruction

Take special precautions when handling chemicals during chemical cleaning. Wear the safety gears such as safety glasses and protective gloves. If chemicals come in direct contact with your skin or clothes, treat the contacted part appropriately based on the SDS.


Prohibited

Do not mix sodium hypochlorite with acid. Such mixture generates toxic chlorine gas.


Instruction

Stop operation whenever any anomaly occurs with the equipment or any signs of an anomaly are observed.

CAUTION


Instruction

In the chemical cleaning, strictly follow the procedure described in the latter section of this manual. Otherwise, it may damage the modules or negatively affect the membrane performance.

4. Safety Instruction for Disposal

WARNING

Instruction

Apply a service of a qualified waste disposing company when disposing of the modules. Use the appropriate facilities in which hydrogen fluoride (HF) gas can be neutralized when the module is to be incinerated. HF gas is generated with the incineration of membrane.

5. Warranty Claims

UF modules that are damaged due to improper loading, shipping, handling, or storing shall not be covered by Toray Industries, Inc.'s warranty. Therefore, it is very important that the customer firmly follows instructions of loading, shipping, handling, and storing of the UF modules mentioned in this Instruction Manual.

UF modules which are in their original sealed package can be stored for 12 months from the date they were shipped from the factory or warehouse. If they are stored for longer than 12 months, the warranty will become void unless otherwise Toray Industries, Inc. agrees.

6. Warranty Policy

Full and proper compliance with this Instruction Manual is a mandatory required thing for the claims under the warranty. In case of making a warranty claim, the customer automatically agrees to provide Toray Industries, Inc. with the information about operation mode, recording performance data of UF systems.

Kindly please contact Toray Industries, Inc. if the customer wishes to deviate from any of the procedures or specifications mentioned in this Instruction Manual and request written approval in advance. Otherwise, the customer has a risk of invalidation for any warranty claims that they may make in the future.

III. Specifications of Toray “HFUG Series” Membrane Module

Table 1. Specifications of membrane *1)

Membrane Material		PVDF (Polyvinylidene fluoride)
Nominal Pore Size *2)		0.01 micrometers
Trans-Membrane Pressure	Maximum *3)	300 kPa (43.5 psi)
	Normal Operation	Lower than 200 kPa (29.0 psi)
Storage and Operating Temperature Range		1 – 40 deg C (34 – 104 deg F)
Operating pH Range		1 – 10

*1): Note that the specifications are subject to change without notice.

*2): Estimation from removing model particles.

*3): TMP (Trans-Membrane Pressure) should be below 300 kPa (43.5 psi) at any time even during the filtration.

Table 2. Feed water limits *1), *4)

Turbidity	Intermittent Peak *5)	200 NTU
	Continuous Maximum	50 NTU
TSS	Intermittent Peak *5)	200 mg/L
	Continuous Maximum	50 mg/L
Ozone		Not detected
Pretreatment Filter Mesh Size		Smaller than 200 micrometers
Temperature Range		1 – 40 deg C (34 – 104 deg F)
pH Range		1 – 10
Max. Feed Pressure		300 kPa (43.5 psi)

*1): Note that the specifications are subject to change without notice.

*4): For design, please contact us.

*5): The duration time should be less than 48 hours and the occurrence frequency should not exceed more than once a month.

Table 3. Cleaning limits *1)

Cleaning pH Range	0 – 12
Cleaning Temperature Range	1– 40 deg C (34 – 104 deg F)
Maximum Concentration of NaClO as Cl_2	3,000 mg/L ($10 \leq pH \leq 12$)
Maximum NaClO Exposure (Lifetime contact time) as Cl_2	1,000,000 mg/L hours
Maximum Acid Contact Time	1,000 hours ($pH \geq 0$)

*1): Note that the specifications are subject to change without notice.

Table 4. Specifications of modules *1)

Module Type		HFUG-B2315AN
Membrane Surface Area (Outer Surface)		75 m^2 (807 ft^2)
Dimensions	Diameter	178 mm (7.01 inches)
	Length *6)	2,332 mm (7.651 ft)
Weight	Full of Water	65 kg (143 lbs)
	Drained	35 kg (77 lbs)
Materials	Housing	PVC and/or equivalent
	Potting	Epoxy and/or equivalent
Connections	Top	Housing type joint, 2 inches (U.S.)
	Bottom	Housing type joint, 2 inches (U.S.)
	Side	Screw, 2.3 inches (original)
Operating Conditions	Max. Feed Water Flow (Feed Water only)	12.5 m^3/h (55 gpm)
	Max. Backwash Flow (Backwash only)	13.8 m^3/h (61 gpm)
	Max. Air Flow (Air only)	6.7 Nm^3/h (3.9 scfm)
	Filtration Method	Outside to inside, dead end
	Max. Inlet Pressure	300 kPa (43.5 psi)
	Max. Temperature	40 deg C (104 deg F)

*1): Note that the specifications are subject to change without notice.

*6): The length above is for TYPE A. In case of TYPE B, 2,372mm (7.782ft), In case of TYPE C, 2,336mm (7.677ft).

CAUTION

- Handle and operate the modules within the ranges and the limits indicated in Table 1 to 4. Operation out of these ranges or limits may damage the modules and affect filtration performance.

IV. Configuration of Toray “HFUG Series” Membrane Module

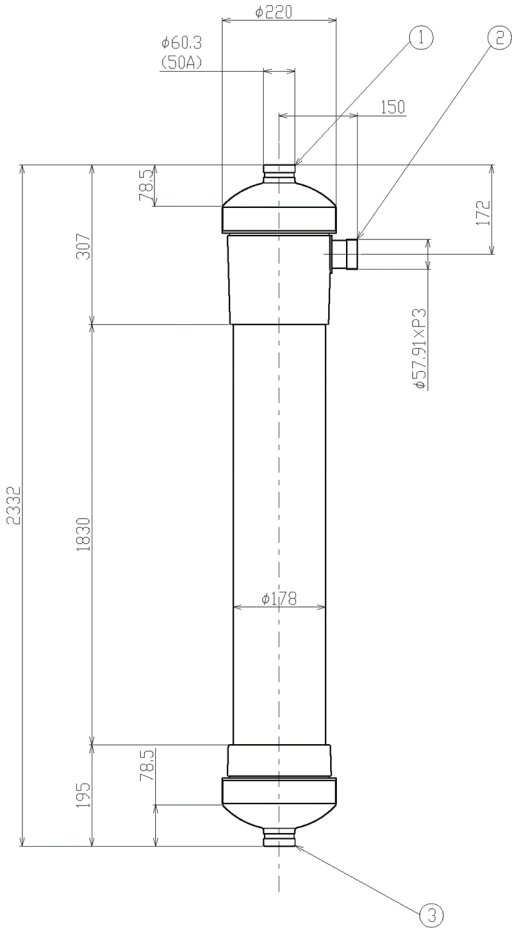


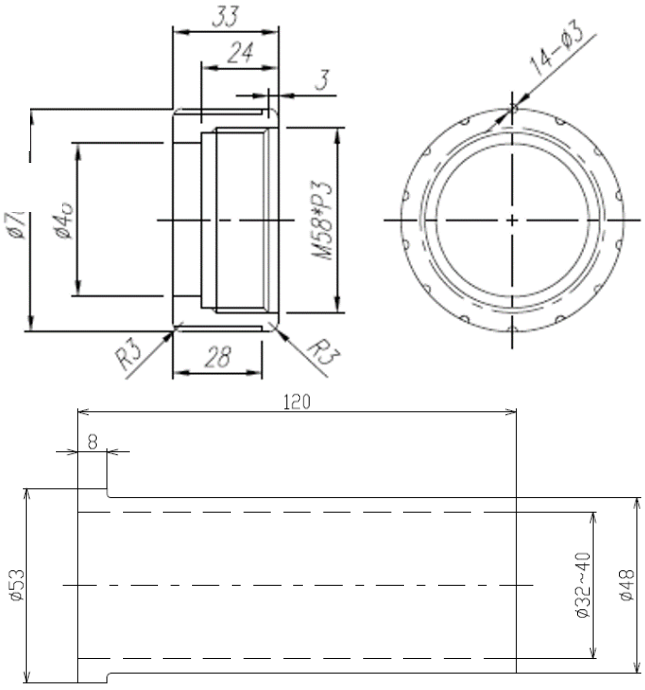
Fig. 1. HFUG-B2315AN (TYPE A)

(1): Filtrate Outlet / Inlet of Backwash Water
(2): Air Outlet / Backwash Water Outlet
(3): Feed Water Inlet / Air Inlet / Drain Outlet

Connections

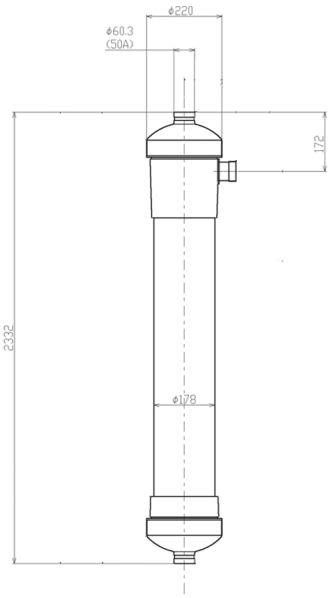
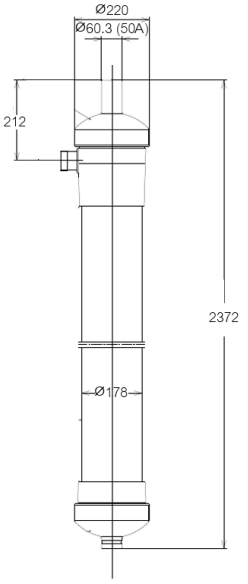
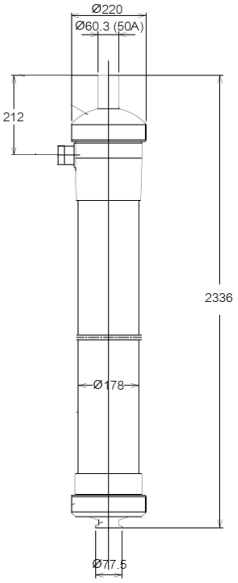
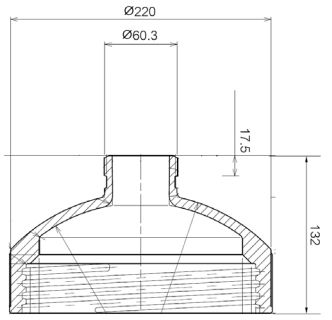
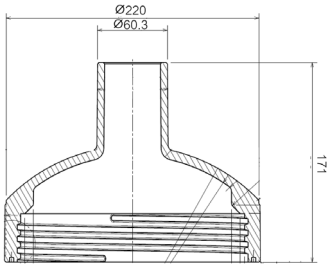
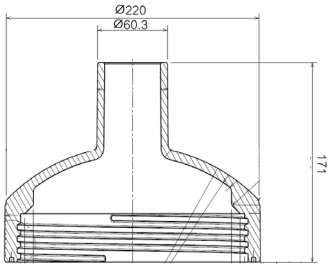
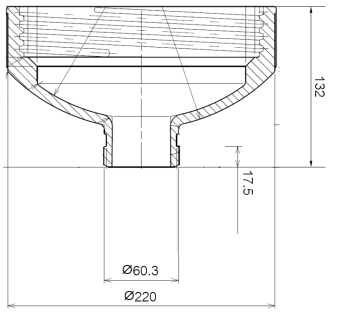
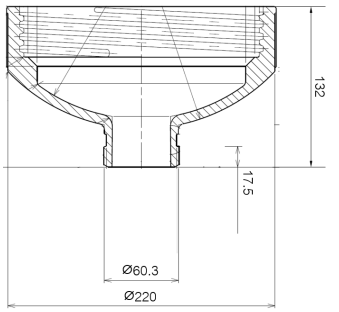
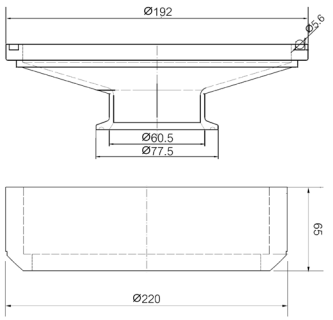
	Pipe fitting outer diameter mm (in)	Connectors
(1)	60.3 (2”)	Housing type joint 2 inches (U.S.)
(2)	57.9 (2.3”)	Original *) + AS568-325 (Gasket)
(3)	60.3 (2”)	Housing type joint 2 inches (U.S.)

*) Referential Drawings:



Depending on customer demands, HFUG Series provides several connection options. TYPE B or C can be used depending on how the top or bottom is connected. Please contact Toray for more information.

Table 5. Referential drawings for HFUG-B2315AN (TYPE A, B and C)

	HFUG-B2315AN (TYPE A)	HFUG-B2315AN (TYPE B)	HFUG-B2315AN (TYPE C)
Figure			
Top Cap			
Bottom Cap			

V. Installation

The standard procedure to install membrane modules is described below.

1. Unpack membrane module(s) from a wooden box or corrugated box.

CAUTION	● Be sure to wear protective gloves to avoid injury of hands by packing box of the modules.

2. Remove a plugging plate from each nozzle of the module.

3. Drain out the preservative solution from the module.

DANGER	● Wear rubber gloves and safety glasses when draining the preservative chemical. Note that the preserving chemical is sodium hypochlorite solution (Max. 200 mg/L as Cl_2). If this solution splashes onto your skin, wash the affected part with running water. If the solution gets in your eyes or mouth, wash the affected part with enough amounts of running water for over 15 minutes and see the doctor immediately.

4. Put the module vertically on a piping or a pedestal in the module rack. Fix the module upright with the connections and/or a support belt (see Fig. 2). When installing a pedestal, decide its size and location considering the shapes and overall lengths of Type A, B and C.

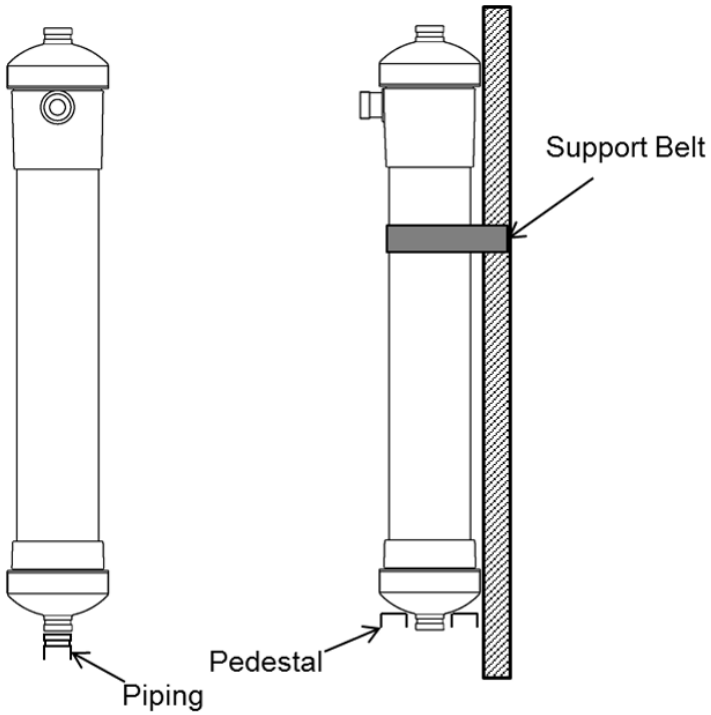


Fig. 2. Typical example of the membrane module installation

WARNING	● Do not drop the module. ● Use equipment such as chain blocks, a crane, or a forklift truck when handling the module. The module is too heavy to handle by hand.
CAUTION	● Take care not to catch and hurt fingers. ● Be careful not to install the module upside down. Confirm the module is installed in the right direction. ● Do not overtighten the module with the connections and/or a support belt, or you may damage the module. ● Do not allow the hollow fiber membranes and modules to dry even for a few hours, especially in summer. ● Do not freeze the module.

5. Connect the piping to each connection point of the module with Housing type joints and screw (see Fig. 4). For the screw, use plastic connection and tighten by hand. When tightening or loosening the Housing type joints, make certain to maintain sufficient space prior to the work and be careful not to injure one's fingers or other body parts.

CAUTION

- Keep the connection surface free of any dirt or oils.
- Follow the instruction below when storing the modules. A wrong use may cause the damage to the module.

6. Air inject should be located just beneath the bottom nozzle of the module to inlet air completely to the module. Also, a check valve is necessary to the air piping to avoid water reverse flow (see Fig. 3).

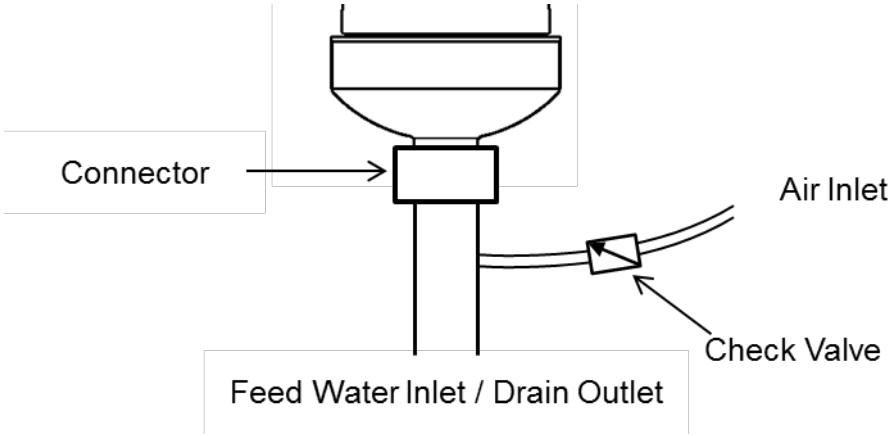


Fig. 3. Typical example of the air pipe installation

WARNING

- Make sure air tubes or connected pipes are properly fixed. Otherwise, the tubes or connected pipes may be blown away or behave violently during air-scrubbing.

7. Make sure that the module is installed vertically.

CAUTION

- If the module is not installed vertically, the effect of the air-scrubbing would be reduced, and an effective filtration will be impaired.

VI. Operation

1. Filtration

(1) Check that all pipes are connected appropriately and flushed out prior to the operation. Fig. 4 shows a typical example of membrane pipe connection.

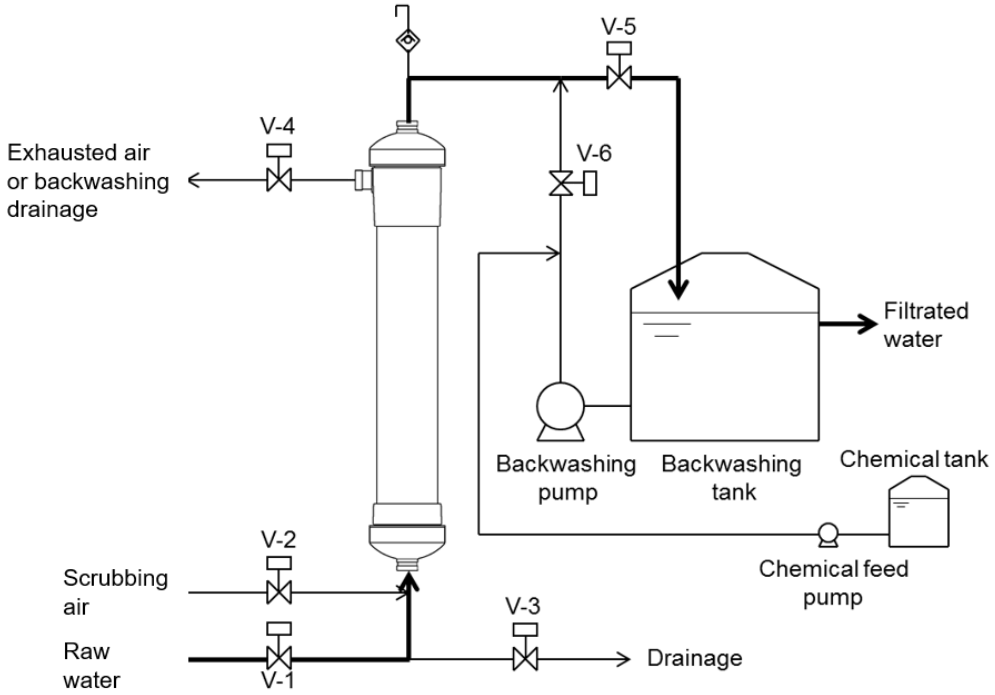


Fig. 4. Typical example of membrane pipe connection

(2) Make sure the feed water valve (V-1), the drainage valve (V-3), and the valve for the air-scrubbing air (V-2) are “closed”.

(3) Make sure the filtrate line is open. Open the air exhaust valve (V-4).

(4) Gradually open the feed water valve (V-1) and fill the feed water to the module to purge any air out.

CAUTION

- Do not open the feed water valve (V-1) quickly, or water-hammer may occur, and the module could be damaged.

(5) Confirm that the air is out of the module, and then close the air exhaust valve (V-4).

(6) Set appropriate volume of filtrate flow.

 CAUTION	● Do not exceed 300 kPa (43.5 psi) to avoid damage to the module. ● Operating conditions including the filtration flux and the physical cleaning should be properly set up to observe the rise of trans-membrane pressure (Details are described in the next session). Please contact us for any technical support if necessary.

(7) When stopping the operation, gradually close the feed water valve (V-1).

2. Backwash and Air-scrubbing

The physical cleaning with backwash followed by air-scrubbing should be carried out periodically and automatically for the continuous filtration. The frequency of the physical cleaning mainly depends on the raw water quality (Typical frequency is once every 30 minutes for the surface water filtration. Please contact us for any technical support if necessary). Fig. 5 shows a typical example of the flow diagram for backwash and air-scrubbing.

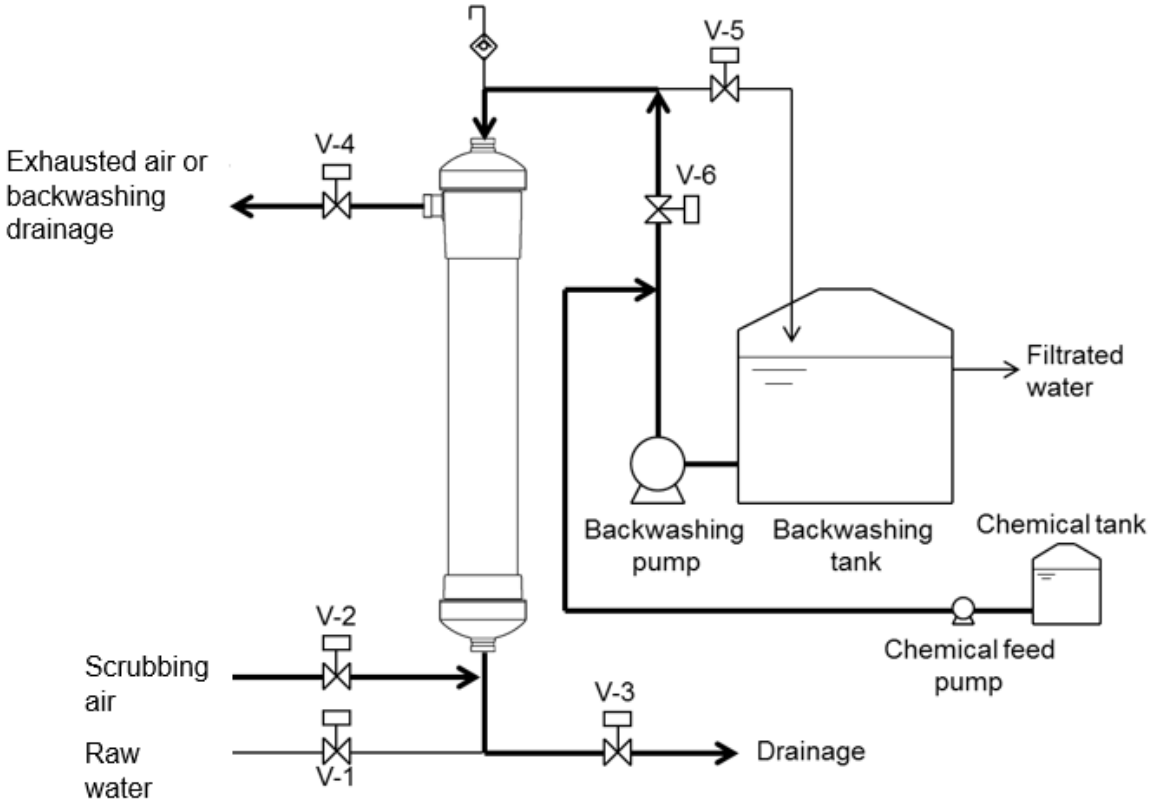


Fig. 5. Flow diagram for backwash and air-scrubbing

(1) Close the feed water valve (V-1) and stop the feed water pump.

(2) Open the air exhaust valve (V-4).

(3) Close the filtrate valve (V-5) and open the backwashing valve (V-6) to feed back the filtrate from the backwashing tank to the membrane module. During the backwash, the chemical feed pump can be operated to dose chemical to the backwash water. The chemical is

usually sodium hypochlorite, and the dosing ratio should be up to 50 mg/L as Cl_2.
The flow rate of backwash water is set up in advance for 1.0 to 1.5 times the filtrate flow rate. Do not exceed Max. Backwash Flow described in Table 4.

(4) After backwashing for a fixed time (normally 30 seconds, up to 60 seconds), close the backwashing valve (V-6) and stop the backwashing pump.

(5) Open the air exhaust valve (V-4) and the air-scrubbing valve (V-2) for air-scrubbing for a fixed time (normally 30 seconds, up to 60 seconds).

CAUTION

- The air flow rate for air-scrubbing should be within the range below. Excessive air flow rate may damage the hollow fiber membrane.

  Air flow rate: 3.6 – 6.7 Nm^3/h, normally 4.5 Nm^3/h
  (2.1 – 3.9 scfm, normally 2.6 scfm)

  The maximum required air pressure during the air-scrubbing for the inside of the module will be 40 kPa (6 psi).

(6) Close the air-scrubbing valve (V-2) and open the drainage valve (V-3).

(7) Close the drainage valve (V-3) after the water is all drained out.

(8) Run the feed water pump and open the feed water valve (V-1).

(9) Close the air exhaust valve (V-4) after the air is purged from the module.

CAUTION

- Constantly monitor filtrate quality during filtration and stop the operation if abnormal water quality is detected. In that case, check the integrity of the element with PDT (Pressure Decay Test) or DAF (Diffusive Air Flow) Test. The test procedure is provided as the technical information by Toray.

3. Toray Maintenance Cleaning

Instead of chemical dosing for every backwash, soaking the membrane in a chemical solution several tens of minutes a day is also effective for membrane performance retention. This process is called Toray Maintenance Cleaning (TMC). The TMC is usually held following the backwash and air-scrubbing which does not contain the chemical dosing. The frequency and soaking time of the TMC mainly depends on the raw water quality (Normally once a day for 20 minutes. Please contact us for any technical support if necessary). Fig. 6 shows a typical example of flow diagram for the TMC.

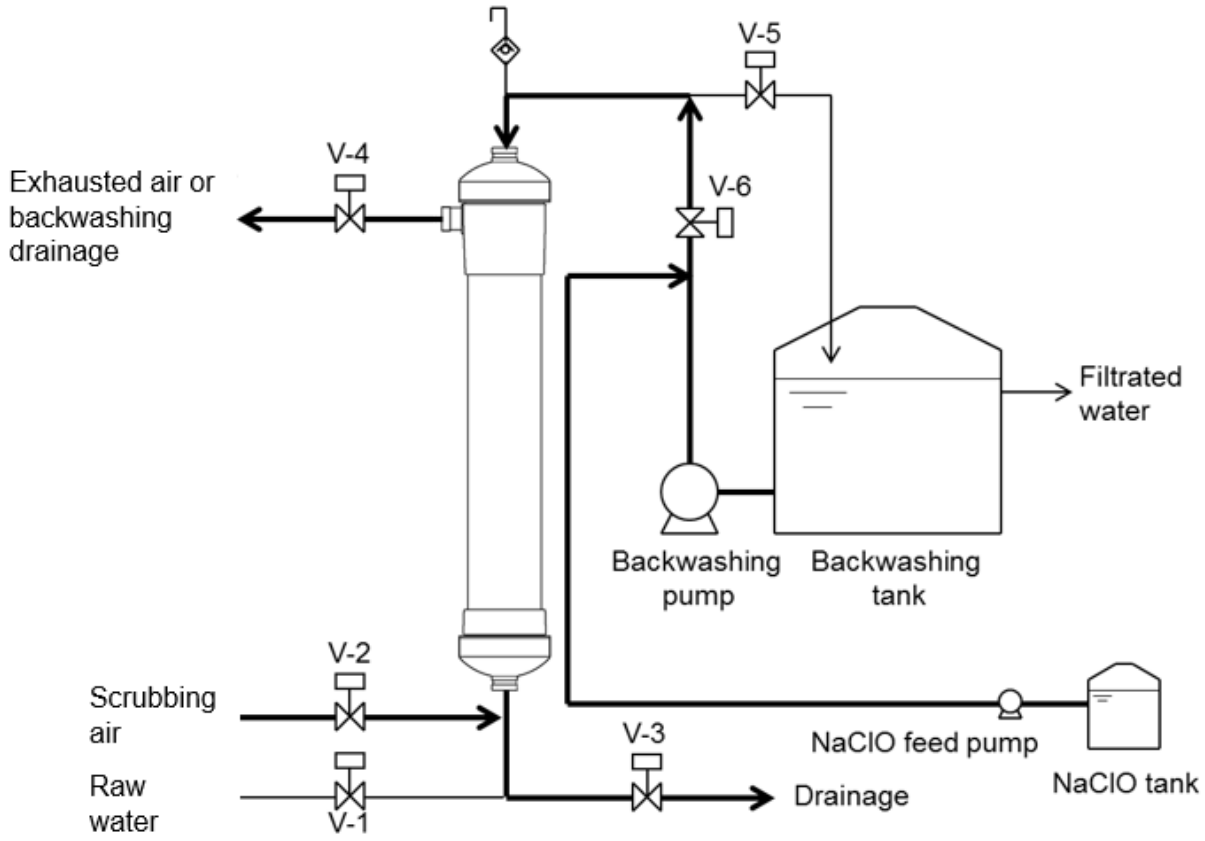


Fig. 6. Flow diagram for the TMC

(1) Open the air exhaust valve (V-4) and the drainage valve (V-3).

(2) Open the backwashing valve (V-6), run the NaClO feed pump and the backwashing pump to feed the chemical enhanced backwash water to the membrane module. The chemical is usually sodium hypochlorite, and the dosing ratio should be up to 300 mg/L as Cl_2 for

TMC.
The flow rate of backwash water is set up in advance for 1.0 to 1.5 times the filtrate flow rate. Do not exceed Max. Backwash Flow described in Table 4.

(3) As soon as the NaClO is detected in the drainage water, close the drainage valve (V-3).

(4) After making sure water comes out from the upper part of the side nozzle of the membrane module, stop the NaClO feed pump, close the backwashing valve (V-6), and stop the backwashing pump.

(5) Soak the membrane in the chemical for a fixed time (normally 20 minutes). And then, open the air-scrubbing valve (V-2) for a fixed time (normally 60 seconds).

- The air flow rate for air-scrubbing should be within the range below. Excessive air flow rate may damage the hollow fiber membrane.

  Air flow rate: 3.6 – 6.7 Nm^3/h, normally 4.5 Nm^3/h
  (2.1 – 3.9 scfm, normally 2.6 scfm)

  The maximum required air pressure during the air-scrubbing for inside of the module will be 40 kPa (6 psi).

(6) Close the air-scrubbing valve (V-2), open the drainage valve (V-3) to drain the chemical from the membrane module.

(7) Close the drainage valve (V-3), open the backwashing valve (V-6), and run the backwashing pump (normally 30 seconds). Stop the backwashing pump, close the backwashing valve (V-6), and then open the air-scrubbing valve (V-2) (normally 30 seconds). Repeat this procedure until the overflow water meets the required water quality.

(8) Repeat the process of (7) until the overflow water meets the required water quality.

(9) Make sure the air-scrubbing valve (V-2) and the backwashing valve (V-6) are “closed” and the backwashing pump is “stopped”.

 **CAUTION**	● Constantly monitor filtrate quality during filtration and stop the operation if abnormal water quality is detected. In that case, check the integrity of the element with PDT (Pressure Decay Test) or DAF (Diffusive Air Flow) Test. The test procedure is provided as the technical information by Toray.

4. Basic Trans-Membrane Pressure Calculation

To calculate accurate Trans-Membrane Pressure (TMP), it is necessary to involve the height difference of inlet and outlet pressure gauges (see Fig. 7).

Example calculation of TMP

TMP $= (P_{in} - H_{in}) - (P_{out} - H_{out})$

$= (70 - 10) - (20 - (- 25))$

$= 60 - 45$

$= 15$ kPa

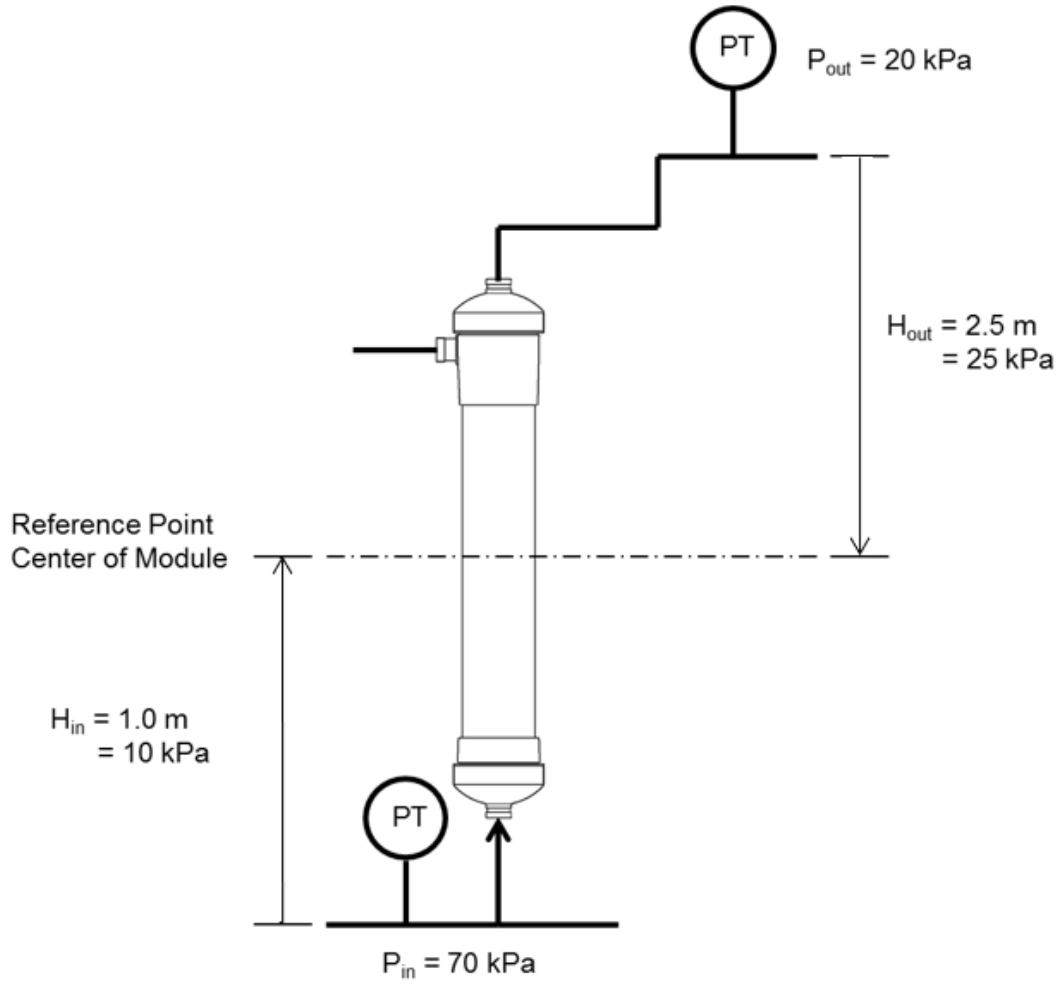


Fig. 7. Basic TMP calculation

Note, the following formula may also be used:

TMP $= P_{in} - P_{out}$ - total delta H

$= 70 - 20 - (10 - (- 25)) = 15$ kPa

5. Temperature Correction Factor

The permeability of the membrane is influenced by temperature mainly because the water viscosity changes with temperature. It is necessary to eliminate the temperature effect with the temperature correction factor (TCF) shown in Fig. 8 to evaluate the permeability correctly.

A Trans-Membrane Pressure (TMP) measured at some real temperature can be converted to 25 deg C corrected TMP with multiplying by TCF at real temperature.

A filtrate flow rate measured at some real temperature can be converted to 25 deg C corrected filtrate flow rate with divided by TCF at real temperature.

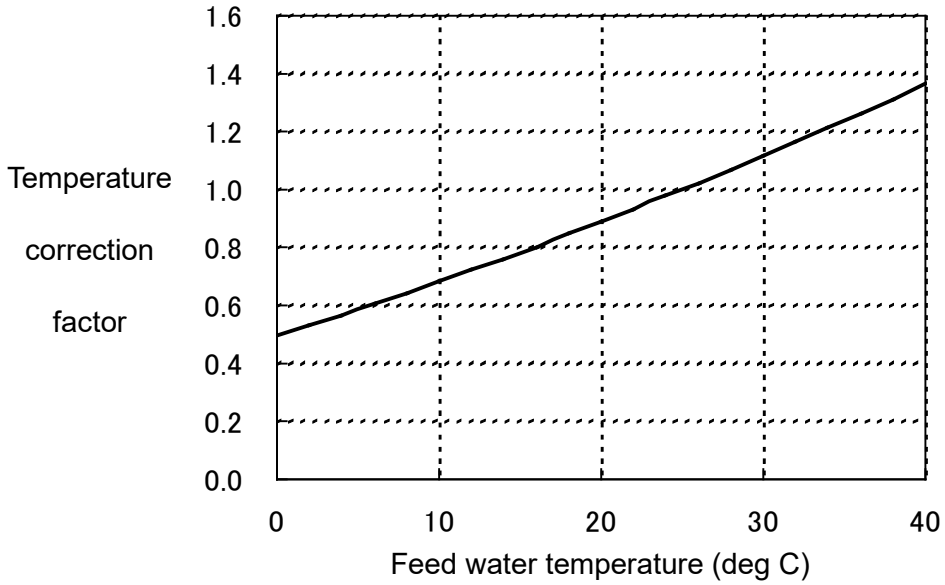


Fig. 8. Temperature correction factor (TCF)

The equation for calculating TCF at a temperature (T deg C) is as follows.

TCF = 0.0008902 / (0.01257187 x EXP((1－0.005806436 x (273.15 + T)) /
(0.001130911 x (273.15 + T) - 0.000005723952 x (273.15 + T) x (273.15 + T))) / 1000)

6. Performance Recording

To effectively evaluate the current UF system performance, including quick recognition of undesirable trends in operation and appropriate countermeasures, it is necessary to compare current operating performance data with a performance data which were recorded at the first placed in service. Log the data which is concerned about the UF operation and must include regular information on: flow, trans-membrane pressure, contractually specified feed water quality parameters and temperature, and elapsed time since start-up (days). The data might be captured and logged automatically every 2 seconds to help optimize the UF operation system.

VII. Chemical Cleaning

The chemical cleaning should be carried out to remove foulants accumulated in the membrane pores or sticking to the membrane surface.

CAUTION	• Carry out the chemical cleaning before the trans-membrane pressure rises to 200 kPa (29.0 psi), or the module filtration performance could be reduced significantly. • Follow the instruction described in this manual when you carry out the chemical cleaning. If you use the unacceptable chemicals or perform the cleaning altered from the recommended procedure, the membrane could be seriously damaged.

DANGER	• Pay full attention when handling chemicals and be sure to wear the safety gears such as glasses and gloves. The chemicals used for the chemical cleaning are harmful to people. If chemicals directly contact your skin, your eyes, or other body parts, take the appropriate treatment as stated in its SDS. • Do not mix sodium hypochlorite with acid. Such mixture generates toxic chlorine gas. • Stop operations when any instrumental anomalies occur, or any sign of anomalies are observed.

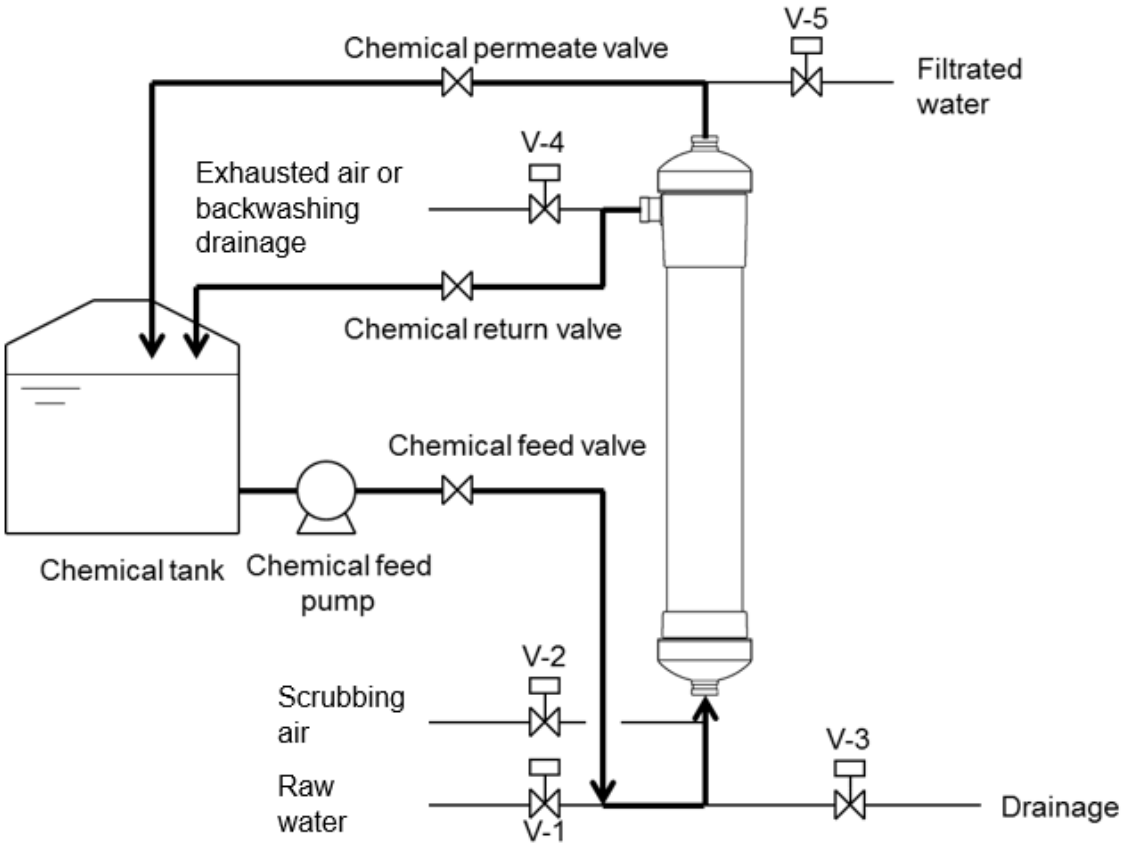


Fig. 9. Flow diagram for chemical cleaning

(1) The flow diagram for cleaning simultaneously both outer surface and inside of hollow fiber membranes is shown in Fig. 9. The flow diagram can be changed case by case. Please contact us for further information if necessary.

(2) Open the chemical return valve and then open the chemical feed valve.

(3) Run the chemical feed pump to start for chemical circulation. Then, open the chemical permeate valve to let the chemical pass through the membrane.

(4) Circulate the chemical for a fixed time.

(5) Stop the chemical feed pump.

(6) Drain the chemical and rinse the cleaning line and the module thoroughly with product water.

CAUTION	● Take appropriate measures to prevent the mis-operation or accidents that could cause the chemicals to get into the product water. Check the piping and correctly position of each valve before starting the chemical cleaning.

(7) The standard conditions for chemical cleaning are shown in Table 6.

- The concentration and the circulation time shown in Table 6 should be observed. Otherwise, the membrane module may get damaged and/or the life of membrane may be shortened.

- The cleaning temperature should be 20 to 40 deg C.

- The circulation flow rate for each type of the module is as follows.

  Flow rate for chemical cleaning: 52.5 L/min (13.8 gpm)

Table 6. Standard conditions for chemical cleaning

Pollutants	Chemicals	Maximum Concentration	Circulation Time (hr)
Inorganic substances	Citric acid *7)	3.0 wt%	1 - 3
Organic substances	Sodium hypochlorite	3,000 mg/L as Cl_2 ($10 \leq pH \leq 12$)	1 - 3

*7): Besides citric acid, hydrochloric acid (with the maximum concentration of 1.0 mol/L), oxalic acid (with the maximum concentration of 1.0 wt%), sulfuric acid (with the maximum concentration of 0.05 mol/L), and nitric acid (with the maximum concentration of 0.1 mol/L) are acceptable.

CAUTION

- In the case of cleaning with acid and with sodium hypochlorite alternately, rinse the cleaning line and the module with clean water thoroughly after each cleaning. Use product water for rinsing and make sure that pH of the water in the module is in the range between pH 6.5 and 7.5 after rinsing.

DANGER

- Do not use any other chemicals than those indicated above.
- Do not mix sodium hypochlorite with acid. Such mixture generates toxic chlorine gas.

Instruction

The chemical cleaning should be done at least once a year. Otherwise, the module filtration performance could be reduced.

VIII. Storage of Membrane Module

Follow the instruction below when you store the modules.

- Be careful not to freeze the modules.

1. Storage of New Membrane Module

Keep the modules in the original packing in a dark and cool place (1 to 40 deg C). Avoid direct sunlight and moisture.

2. Storage of Membrane Module after Use

(1) Short-term, or temporary shutdown or storage

In the case of the suspension of operation for less than four days, stop the feed water and keep modules full of water. Keep the modules at 1 to 40 deg C.

If suspended from four days to less than eight days, fill the module with the chemical described in Table 7. Use filtrate quality water. Keep the modules at 1 to 40 deg C.

Table 7. Conditions for storing membrane modules for less than eight days

Maximum Storage Period	Chemical	Concentration of the Chemical
7 days	Sodium hypochlorite	20 mg/L as Cl_2

(2) Long-term storage

First, carry out a chemical cleaning with sodium hypochlorite. Fill the module with the chemical described in Table 8. Use filtrate quality water. Follow the instructions shown in Table 8.

Keep the modules sealed with the aqueous chemical solution shown in Table 7 or Table 8. If removing modules from the system, seal them and store them out of direct sunlight. Keep the modules at 1 to 40 deg C.

Table 8. Conditions for storing membrane modules for more than seven days

Storage Period	Preservative Chemical *8)	Concentration of the Chemical
More than 7 days	Sodium hypochlorite	10 mg/L as Cl_2 *9)
	Sodium bisulfite	1,000 mg/L

*8): Select either sodium hypochlorite or sodium bisulfite chemical solution.

*9): Be careful not to exceed the sodium hypochlorite contact upper limit shown in Table 3.

- Rinse the module thoroughly with clean water after the chemical cleaning with sodium hypochlorite and fill the module with sodium bisulfite solution. Toxic chlorine gas is generated when mixing sodium hypochlorite with sodium bisulfite without first flushing with water.

3. Replace Preservative Chemical

Check the pH value of sodium bisulfite solution as the preservative and replace the chemical if the pH is below three (3.0). Sodium bisulfite solution with a pH of 3 to 6 is active for the preservation. Sodium bisulfite reacts with oxygen and forms sulfuric acid which results in a lower pH.

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