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Submerged Membrane Module for MBR TORAY “MEMBRAY”

"TMR090 Series"
Instruction Manual

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Content

Symbols used in this manual

DANGER	This symbol is used to indicate an imminent hazardous situation which, if not avoided, will result in serious injury or death.
WARNING	This symbol is used to indicate a potentially hazardous situation which, if not avoided, can result in serious injury or death.
CAUTION	This symbol is used to indicate a potentially hazardous situation which, if not avoided, may result in injury or property damage.

I. INTRODUCTION

“MEMBRAY” is a submerged membrane module suitable for the membrane bioreactor system (MBR) that has been developed in Toray Industries, Inc based on the years of experience of polymer science and the membrane technologies.

"TMR090 Series" is a lineup of "MEMBRAY", which is more compact compared to the other "TMR140 Series", thus, suitable for the application where only a limited space is available, such as for containerized package plants, domestic wastewater treatment, reclamation in buildings or on marine boats application.

"TMR090 Series" is equipped with fine-bubble air diffusers, which significantly reduces the daily cleaning operation of air diffusers and increases the oxygen dissolution efficiency.

This manual describes the specifications of "TMR090 Series", necessary peripheral equipments and the safe and proper handling method of the module during installation, operation and maintenance works.

Designer and operators should thoroughly read this manual to ensure stable operation.

1. Features of MBR

The process flow of the conventional activated sludge system (CAS) and MBR are shown in Fig.I-1 and Fig.I-2, respectively.

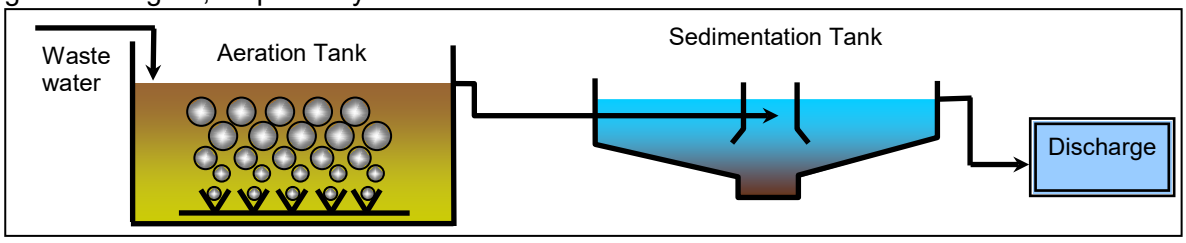


Fig. I-1 CAS Flow

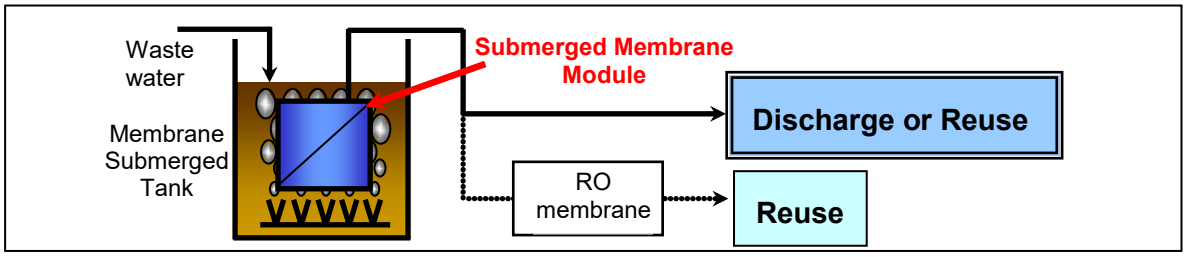


Fig. I-2 MBR Flow

MBR provides the following advantages:

(1) Small Footprint

Unlike CAS, MBR separates sludge within aeration tank using membranes, thus eliminate

the space for preparing sedimentation tank. Also with membrane, MBR can hold higher concentration of activated sludge in the aeration tank, so its volume can be reduced. As a result, MBR provides smaller footprint compared to CAS.

(2) High quality of treated water

MBR removes suspended solid (SS) from the sludge liquid with membrane much more certainly than conventional sedimentation process. MBR also rejects microorganisms such as Escherichia coli and Cryptosporidium efficiently.

2. Outline of "TMR090 Series"

"TMR090 Series" is the membrane module composed of the element block and the aeration block. The element block contains a number of membrane elements set at equal clearance, each of which has flat sheet membranes fixed on both sides of ABS panel. Each element is connected via polyurethane tube to the permeated water manifold. The aeration block consists of fine-bubble air diffusers to supply scouring air (see Fig.I-3). This module is used submerged in sludge liquid. The following shows the features of "TMR090 Series".

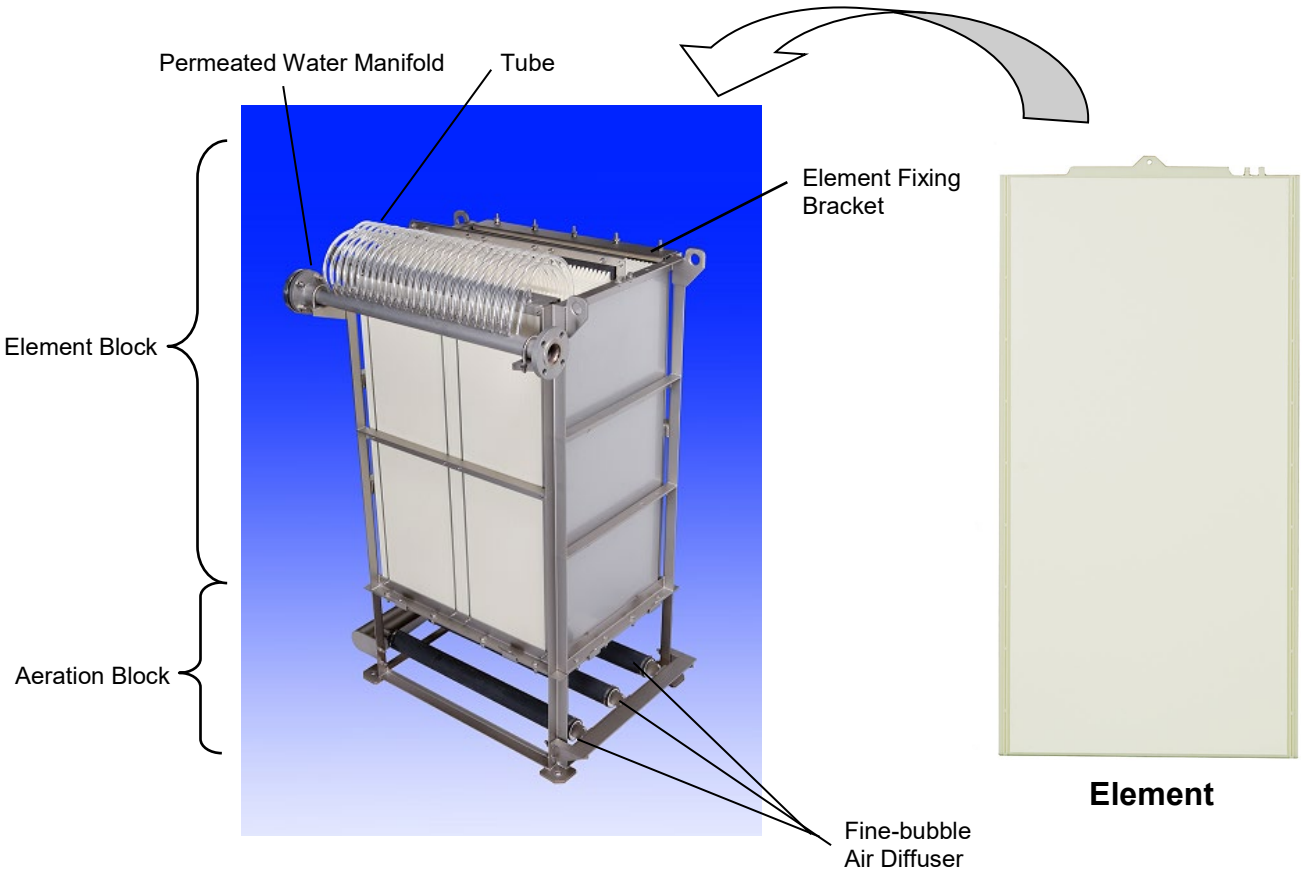


Fig. I-3 Appearance of "TMR090-050S"

(1) Shape of Element

The membrane element is a flat sheet type as shown in Fig.I-4. At the normal filtration operation, the sludge accumulated on the membrane surface is cleaned up effectively with upward water stream generated with the scouring air supplied from the air diffusers installed at the bottom side (Fig.I-5). This mechanism ensures stable filtration, since the membrane does not easily admit of sludge adherence to its surface. In addition, shorter element (1059 mm) compared to "TMR140 Series" allows the use in the space with height limitation.

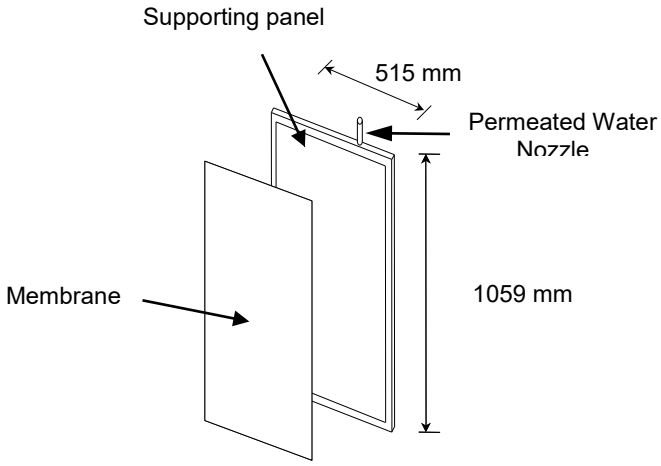


Fig. I-4 Structure of Element

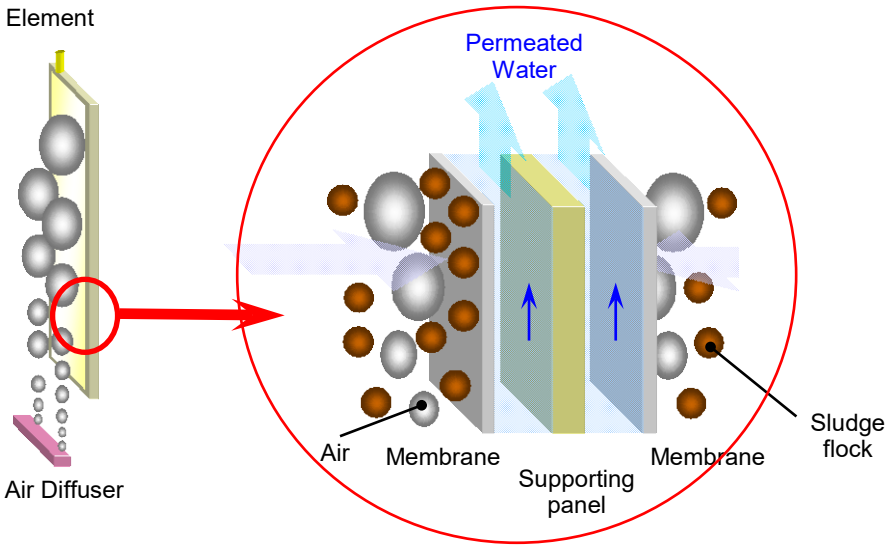


Fig. I-5 Filtration Principle of Activated Sludge

(2) Membrane Structure

The flat sheet membrane consists of PVDF (Polyvinylidene Fluoride) functional layer and the base layer of PET (polyester) non-woven fabric. This structure gives the membrane superior physical strength and high chemical resistance.

(3) Membrane Pore Size

Numerous small-size pores are distributed evenly over the membrane surface with a sharp pore-size distribution. This structure gives outstanding high treated water quality and excellent water permeability, making the membrane highly resistant to clogging (see Fig.I-6 and Fig.I-7) compared to other membranes. The average pore size is 0.08 micron meter.

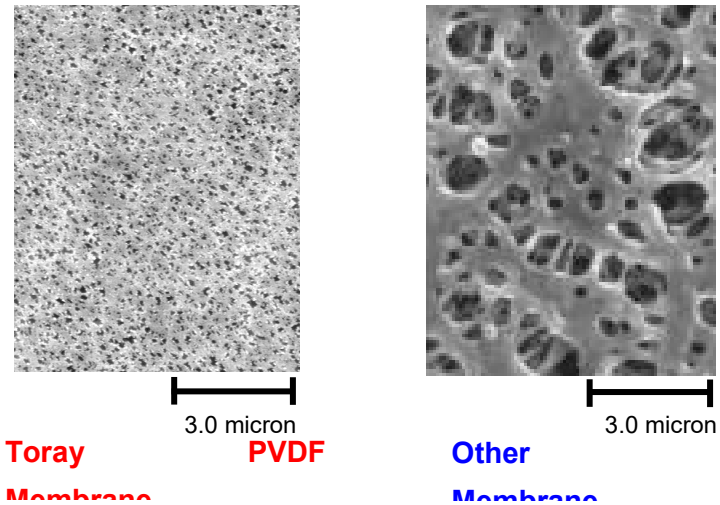


Fig. I-6 Membrane Surface (photo)

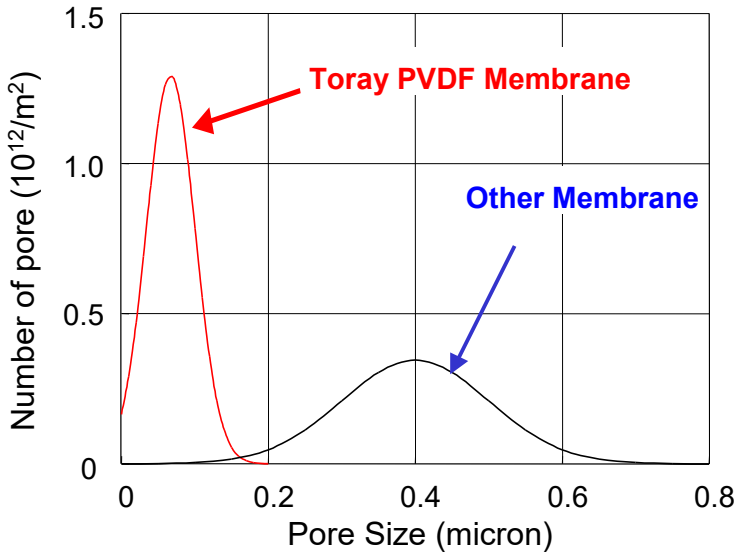


Fig. I-7 Pore Size Distribution

(4) Element replacement

Each element can be taken out from the modules separately for the inspection or the replacement. In the case of the membrane damage, the filtration operation can be recovered in a short time by replacing relevant elements one by one with spare ones.

(5) Fine-bubble Air Diffusers

"TMR090 Series" is equipped with fine-bubble air diffusers, which significantly reduces the daily cleaning operation of air diffusers and additionally increase the oxygen dissolution efficiency to 1.3-2.0 times as high as the coarse-bubble diffusers.

II. FOR SAFE OPERATION OF “TMR090 Series”

Before using “TMR090 Series”, please thoroughly read this Instruction Manual and follow the instructions described in this manual, especially the safety precautions shown below. The details of each precaution are described in the relevant chapter.

1. Unpacking and Installation

 **DANGER**	When lifting “TMR090 Series” or its part, please attach chains or slings to it and raise it straight upward calmly to prevent it from shaking. Please never allow any person under lifted article.
 **DANGER**	Please use chains or slings compatible with lifting weight when lifting "TMR090 Series" or its part.
 **DANGER**	When installing “TMR090 Series” module, please set up a foothold in advance. Please never climb the module. Please use protective equipment to ensure the safety of workers.
 **CAUTION**	At transportation, storage and installation, please take appropriate measures to protect "TMR090 Series" or its part from damage. Please don't put any heavy objects on the module. Please take care to protect the module from collision with other objects.
 **CAUTION**	Please do not leave "TMR090 Series" for hours in the place where the temperature is higher than 40 °C or in the place exposed to direct sunlight.
 **CAUTION**	Please take adequate measures to protect “TMR090 Series” from sparks caused by welding, fusion cutting or grinding throughout the entire process from installation work to operation startup.
 **CAUTION**	Please protect “TMR090 Series” from freezing at any time.
 **CAUTION**	Please don't pressurize the permeate side of "TMR090 Series".
 **CAUTION**	Please install the screen with openings of 3.0 mm or under before the membrane submerged tank. It is recommended to use the mesh type screen. Overflow or waste carryover must be avoided at any time.

2. Operation and Maintenance

WARNING	Don't use the treated water for drinking.
WARNING	Before discharging the treated water to the environment or reusing it, make sure to analyze its quality and confirm that the water quality meets the intended purpose.
WARNING	Don't burn the membranes without appropriate facilities since harmful Hydrogen fluoride (HF) gas is generated at burning. When dispose membranes, please apply a service of a qualified waste disposing company.
CAUTION	When the clean water operation, charging clean water to the membrane submerged basin with the air discharge valve open to release air from the elements. After charging water, close the air discharge valve.
CAUTION	Don’t use the ground water, which contains considerable amount of iron, manganese, calcium or silica, for the clean water operation as it may cause the clogging of the membrane.
CAUTION	Don't continue the clean water operation unnecessarily. A long-time filtration of clean water tends to cause the clogging.
CAUTION	Once the membrane gets wet, keep it wet. If the wet membrane is dried up again, the permeability of the membrane might be decreased seriously.
CAUTION	When feeding the seeding sludge, be sure to remove foreign substances from it with the screen with openings of 5mm or under.
CAUTION	Don't do the filtration operation without supplying the scouring air in a right way, or the membrane will be clogged severely.
CAUTION	Don't put in the activated sludge liquid chemicals, toxic agents, oils or other substances that may adversely affect activated sludge.

 **CAUTION**	Please avoid abrupt changes of operating conditions, especially pH, temperature and the suction pressure of the membrane even within the range of the standard operating conditions (Table VII-1).
 **CAUTION**	Please replace the renewal parts periodically or when the deterioration is detected at the inspection.
 **CAUTION**	Prevent “TMR090 Series” from freezing at any time.
 **CAUTION**	Please take care not to dry the membranes when taking "TMR090 Series" out of the liquid for the inspection or the maintenance. If the wet membrane is dried up again, the permeability of the membrane might be decreased seriously.
 **CAUTION**	Please stop the scouring air when the filtration operation stops except for the following conditions: 1) In case of applying intermittent filtration, do not stop the scouring air for each relaxation period. 2) In case that the plant operation stops for a while, aeration is applicable for mixing or aeration demand, however, the flow rate should be controlled minimal.
 **CAUTION**	Please don’t re-use the old permeate tubes once disconnected from the nozzles since the connection tightness of the tubes are reduced.

3. Chemical Cleaning of Element

 **WARNING**	The chemical agents used for the chemical cleaning are harmful to the health. When handling chemicals, please read their material safety data sheet (MSDS) in advance and make sure to wear necessary protectors such as protective goggles and protective gloves.
 **WARNING**	If the chemical agents stick to your skin or clothes, immediately wash it away with enough amount of running water.
 **WARNING**	If the chemical agents enter your eyes, immediately wash it away with enough amount of running water and see the doctor.

WARNING	If any abnormality is found in the equipment during chemical cleaning, immediately stop operation and check it.
WARNING	If chemical is injected forcibly directly with the chemical feed pump or by any other means, the internal pressure of the elements will increase and the elements will get damaged. Be sure to inject chemical with the pressure of lower than 10 kPa (100 mbar).
WARNING	When injecting the chemical agents at the chemical cleaning, please confirm beforehand that the modules are completely submerged in the liquid and the liquid level of the membrane submerged tank is higher by more than 300 mm than the top of the module.
WARNING	Please store the chemical agents in a dark cold place free from direct sunlight.
WARNING	Please use the appropriate tank or the container, for storing the chemical agent, made of the material having enough corrosion resistance to each chemical agent.
WARNING	Don't mix sodium hypochlorite with acids, including oxalic acid or citric acid; otherwise toxic chlorine gas is generated.
CAUTION	Don't mix sodium hypochlorite with heavy metals.
CAUTION	Please stop the scouring air during the chemical cleaning, or the membrane elements might be damaged.

III. SPECIFICATIONS AND PERFORMANCE OF "TMR090 Series"

1. Specifications of Element

TableIII-1 and Fig.III-1 shows the specifications and the appearance of the element for TMR090 Series, respectively.

Table III-1 Specifications of Element (TSP-50100)

Model name		TSP-50100
Membrane configuration		Flat sheet
Application		Filtration of activated sludge
Filtration method		Suction filtration
Nominal pore size (μm)		0.08
Effective membrane area (m^2)		0.9
Dimensions (mm)	Total width	515
	Total height	1059
	Thickness	13.5
Weight (kg)	Dry	3.0
	Wet (Reference)	5.0
Main material	Membrane	PVDF and PET non-woven fabric
	Supporting panel	ABS resin

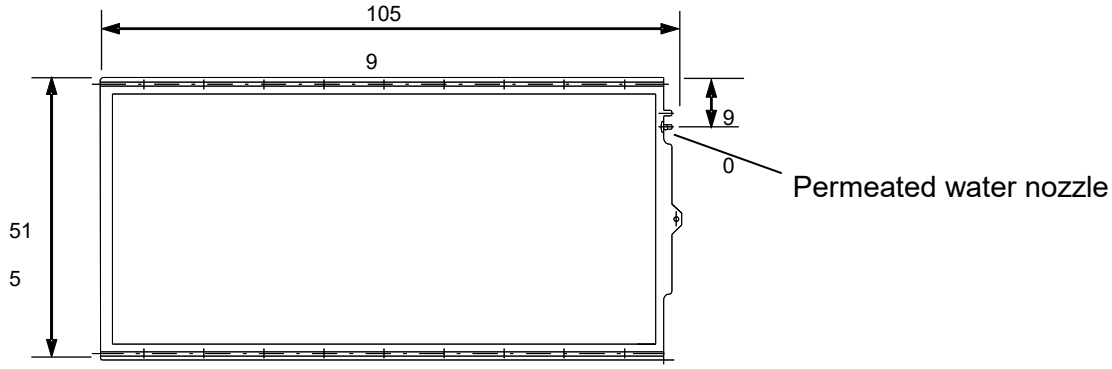


Fig.III-1 Appearance of Element (unit: mm)

2. Specifications of Polyurethane Permeate Tube

Table III-2 shows the specifications of polyurethane permeate tube.

Table III-2 Specifications of Polyurethane Permeate Tube

Material	Thermoplastic polyether-polyurethane TPU-ARET*1
Inside diameter / outside diameter / total length (mm)	8/11/380

*Allowable temperature limit: 60 degree C
*1 The material name due to the ISO-18064.

3. Specifications and Performance of "TMR090 Series" Module

Table III-3 shows the specifications of "TMR090 Series" modules.

EPDM is equipped as standard membrane material for the diffuser. EPDM has been used in a lot of application for sewage treatment and industrial wastewater treatment and wears well. However, EPDM is weak to oil and solvent. For wastewater containing high concentration of oil and solvent, polyurethane is the preferable choice. We have the line-up of polyurethane membrane diffuser-equipped TMR090 as an option. Please contact us if you have any difficulties in choosing the type of diffuser.

Table III-3 Specifications of "TMR090 Series" Modules

Model name		TMR090-050S	TMR090-100S
Number of membrane elements		50	100
Element block structure		1 deck 1 row	1 deck 1 row
Dimensions *1	Width (mm)	730	730
	Length (mm)	990	1720
	Height (mm)	1470	1470
Weight（kg）	Module (dry) (Aeration block + Element block)	265	460
	Module (wet) (Maximum weight in case of sludge clogging)*2	475	885
Material	Permeate water manifold	304 stainless steel (316LSS as option)	
	Housing	304SS/ABS resin (316LSS as option)	
	Diffuser	EPDM rubber/PVC/304SS (316LSS as option)	
	Element fixing gaskets	EPDM rubber	
Operating Range	Temperature (degree C)	not higher than 40	
	pH*4 of liquid	5-10	
	MLSS (mg/L)	not higher than 18,000	
	Trans-membrane pressure (kPa)	not higher than 20 (200 mbar)	
	Cleaning chemicals feed pressure (kPa)	not higher than 10 (100 mbar)	
	Scouring Air Flow rate (NL/min/Module)*6	500-650	1,000-1,300
Connections	Manifolds: Flanges*3	ANSI 1 1/2 inch	ANSI 2 inch
	Air diffusers : Screws	NTP 1 1/2 (one side)	NTP 1 1/2 (both sides)

*1 The total dimensions excluding the connection tube
*2 The weight assumed in the case of sludge clogging between elements.
*3 The flange dimensions are described in the drawings attached to this manual. UNI (ISO) flange is also available as option.

*4 Except when the chemical cleaning with the designated chemical agents.
*5 The connecting socket has an internal thread. The use of tapered screw is recommended for screw connections.
*6 “NL” means air volume as being 0 degree C and 101.325 kPa (1 atm).

Table III-4 and III-5 show the performance of "TMR090 Series" modules.

Table III-4 Permeate water quality

Model name		TMR090-050S	TMR090-100S
Permeate water quality*1	TSS (mg/L) *2	Not higher than 3.0	
	Turbidity (NTU) *3	Not higher than 1.0	

*1 This value is a guarantee value of Toray that can be attained when the modules are installed and operated appropriate under the standard conditions as specified in this Instruction Manual and Operation and Maintenance Guideline during a period specified separately by Toray.
*2 Measuring method of TSS is complied with Standard Method of Examination of Water and Wastewater 20th Edition (1998), Section 2540D, Total Suspended Solids Dried at 103-105 degree C or ISO 11923.
*3 Measuring method of NTU is complied with Standard Method of Examination of Water and Wastewater 20th Edition (1998), Section 2130, Turbidity or ISO 7027.

Table III-5 Flow capacity (Reference value)

Model name		TMR090-050S	TMR090-100S
Continuous Filtration Flow (m^3/d)	Sewage	5 - 35	10 - 70
	Industrial wastewater	5 - 23	10 - 46

*4 This value is just a reference value and is not a guarantee value of Toray. Sustainable operating filtration flow capacity varies among the plant depending on the type of wastewater, total process design and operating condition. In case of industrial wastewater application, it is strongly recommended to conduct a pilot test before membrane tank designing.

IV. MEMBRANE FILTRATION PROCESS DESIGN FOR “TMR090 SERIES”

The standard filtration pattern time chart, the schematic flow diagram of the membrane filtration, the layout of “TMR090 Series” modules in the membrane submerged tank, and the piping procedures are described in this section. These would help you design the membrane filtration process with “TMR090 Series”.

1. Standard Filtration Pattern

Two kinds of the filtration patterns are available with "TMR090 Series". Usually intermittent filtration (filtration with relaxation) is adopted and details are shown below, whereas sometimes simple continuous filtration can also be applied. In both cases aeration shall be done continuously while filtrating.

In the case of the intermittent filtration, the filtration is suspended (“relaxed”) for a short period at certain intervals while the scouring air continues, as shown in Fig. IV-1. While the filtration is suspended, the membrane surface is cleaned up more effectively with the scouring air due to the absence of suction. Although the automatic system control for periodical start and stop of the filtration is required, the intermittent filtration is recommended for stable and efficient membrane filtration. The recommended time cycle for the intermittent filtration is 9-minute filtration and 1-minute relaxation.

Please stop the scouring air when the filtration operation stops except for the following conditions:

1) Each relaxation period in case of applying intermittent filtration.

2) In case that the plant operation stops for a while, aeration is applicable for mixing or aeration demand, however, the flow rate should be controlled minimal.

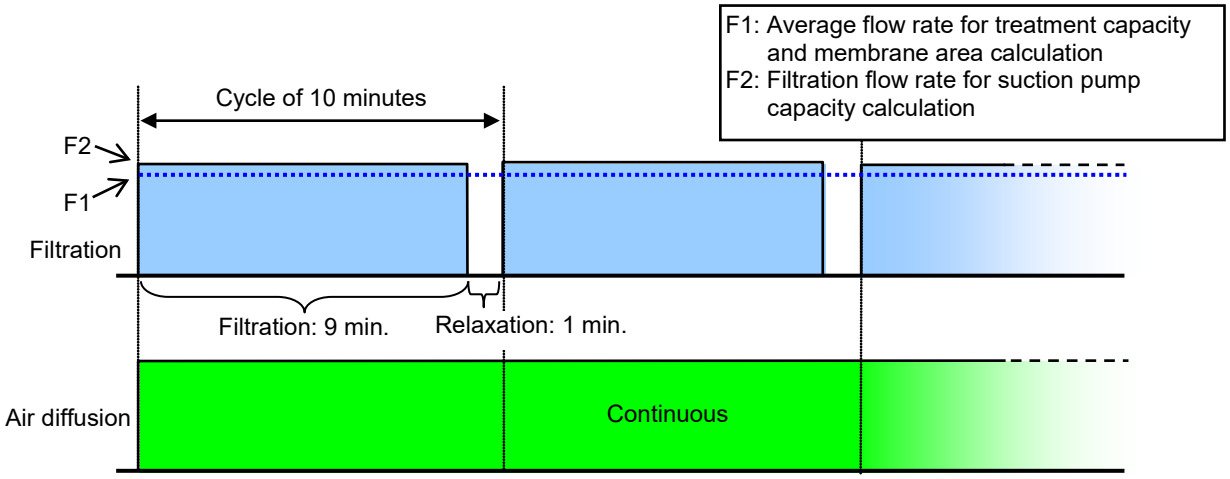


Fig.IV-1 Recommended Time Cycle for Intermittent Filtration

2. Flow Diagram of Membrane Filtration Process

Two schematic flow diagrams of the membrane filtration process are shown below. One is for the gravity filtration with water head difference and the other is with suction pump. Major necessary peripheral devices for membrane filtration process are described in the latter part of this section.

In any cases, the fine screen with openings of 3.0 mm or under should be installed before the membrane submerged tank, or the modules might be polluted and clogged severely with trashes brought with the raw water.

It is also recommended to prepare enough capacity of the buffer tank (flow equalization tank) prior to the MBR process to equalize BOD load and filtration flow capacity so as to enable stable operation of the biological treatment and membrane filtration process.

(1) Gravity filtration configuration

The filtration can be performed with using a natural water head differential pressure generated from a vertical distance between the liquid level of the membrane submerged tank and the level of the permeate water outlet (see Fig. IV-2).

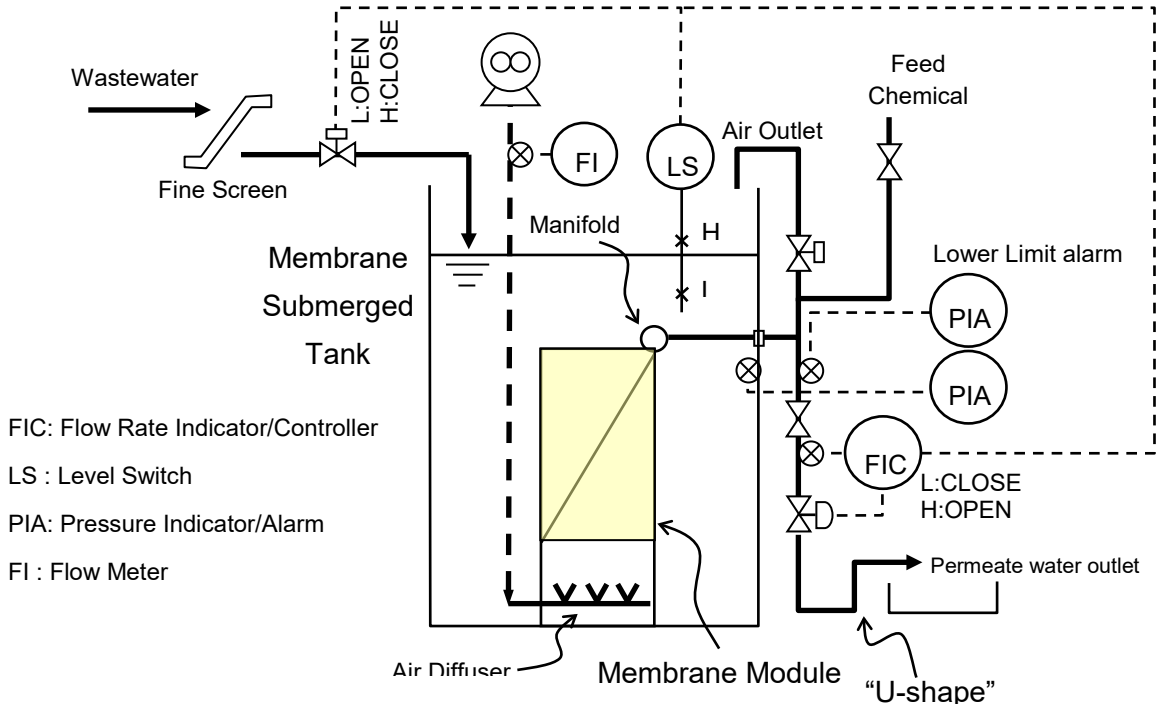


Fig. IV-2 Schematic Flow Diagram for Gravity Filtration

In order to obtain enough suction pressure for the filtration considering the friction loss of pipe and valves, the permeate water outlet should be located sufficiently below the liquid level of the membrane submerged tank (normally 3 m below water level or lower).
It is recommended that the piping from the permeate water manifold to the permeate water outlet should directly penetrate the tank wall, as shown in Fig.IV-2. Also if the permeate water outlet is located in the open air, it is also recommended to make the pipe just before the permeate water outlet U-shape to seal the piping with water.

The permeate water flow is controlled with the automatic control valve (the permeate control valve). When the liquid level of the membrane submerged tank gets to the lower limit, this control valve fully closes the permeate water line to stop the filtration. When the liquid level gets to the higher limit, the automatic shutter valve on the raw water feed line closes its line to stop raw water coming.
In this gravity filtration, the air accumulated in the permeate water line should be discharged once a day at least; otherwise the effective water head is reduced seriously. The air purge nozzle should be installed at the highest position of the permeate water line and the automatic shutter valve (the air purge valve) is recommended to be installed on the line just before the nozzle. (As shown in Fig.IV-2) Stopping the filtration (fully closing the permeate control valve) and opening the air purge valve for a few minutes, the air is easily purged.

(2) Pump suction configuration

Figure Fig. IV-3 illustrates the general configuration for pump suction filtration.

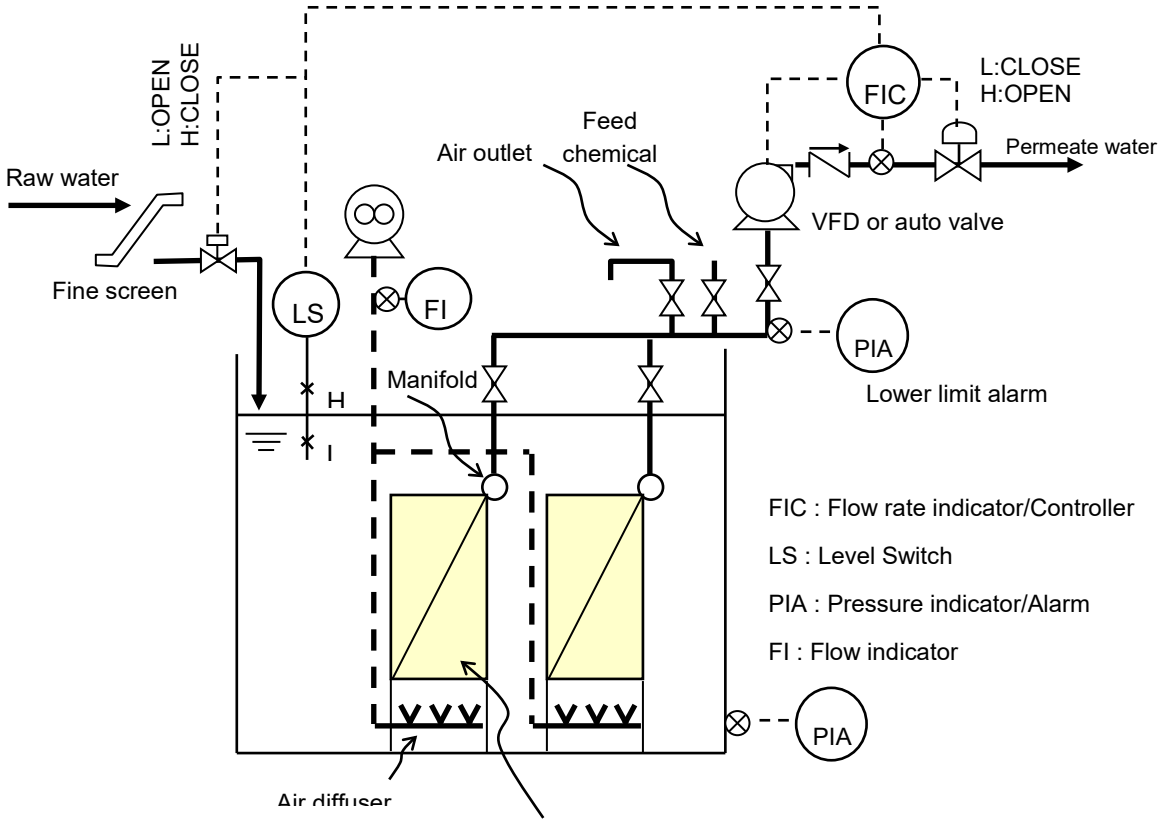


Fig.IV-3 Schematic Flow Diagram for Pump Suction Operation

The permeate water flow is controlled by a flow meter and a suction pump with an automatic control valve or by a flow meter and a suction pump with VFD control. In case water level in the membrane submerged basin gets to the lower limit, filtration has to be stopped. If the water level reaches the upper limit, the level controller will stop raw water inflow.

In some cases with this pump suction configuration, an equipment may be needed to discharge the air accumulated in the permeate water line. A range of methods can be applied for this air removal such as vacuum pump, ejector or manual water injection. Please contact TORAY or refer to the engineering manual for the details.

(3) Necessary devices for membrane filtration process

Major necessary peripheral devices to operate membrane filtration process are explained below. Some other devices than mentioned below might be required case by case.

a. Fine screen

The wastewater should be treated by screen with openings of 3.0 mm or under before flowing into the membrane submerged tank, otherwise the modules are polluted and clogged with foreign substances seriously. It is recommended to use the mesh type screen. Overflow or waste carryover must be avoided at any time.

b. Flow control device

A flow rate controller, a flow meter combined with an automatic control valve, or a flow meter combined with VFD controlled suction pump should be installed on the permeate water line to control the flow rate of permeate water. In the case of operating a number of “TMR090 Series” modules simultaneously in one train, it is advised to install one flow rate controller for one train of the modules.

c. Differential pressure measuring instrument

For trans-membrane pressure (TMP) determination the differential pressure (in the permeate line and water level) has to be measured and calculated, either by installing two pressure sensors and calculating the readings in the PLC or by using a differential pressure device.

In the former case, one pressure gauge should be installed on the permeate water line and the other one in the membrane submerged tank, to monitor the trans-membrane pressure. In case of operating a number of “TMR090 Series” modules simultaneously in one train, it is advised to install one differential pressure measuring instrument for one train of the modules.

[Example]

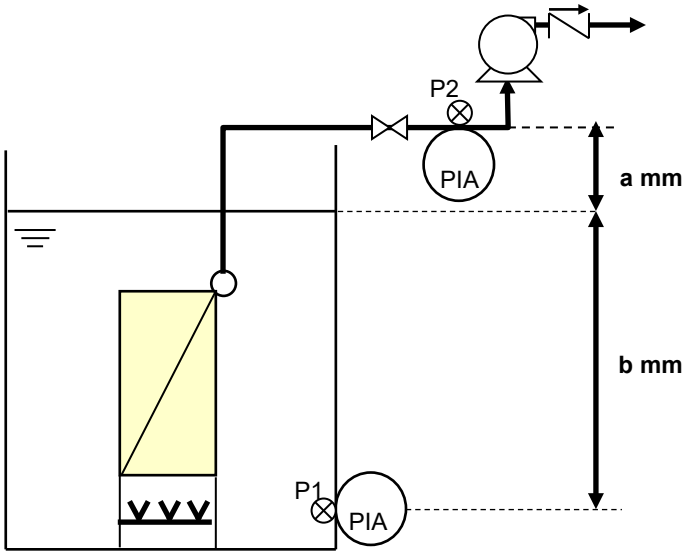


Fig.IV-4 Differential Pressure Measurement & Calculation

- a = 1,000 mm (= 10 kPa, 100 mbar), b = 3,000 mm (= 30 kPa, 300 mbar)
- PIA readings;

	Filtration (pump ON)	Relaxation (pump OFF)
P1 (kPa)	29	30
P2 (kPa)	-15	-10

In this case, differential pressure (dP) is calculated as follows;

$dP = (P1_{Filtration} - P1_{Relaxation}) - (P2_{Filtration} - P2_{Relaxation}) = (29) - (30) - [(-15)-(-10)] = 4$ kPa

d. Air supply unit (such as a blower)

This unit supplies air to the air diffusers of "TMR090 Series" module. The air flow rate supplied to the module should be always within the range of "Scouring Air Flow Rate" indicated in Table III-3.

e. Air flow meter.

An air flow meter is recommended to be installed to check the flow rate of the scouring air supplied to the module. In case of operating a number of “TMR090 Series” modules simultaneously in a train, it is advised to install at least one air flow meter for each train.

f. Suction pump

A suction pump is required in the case of pump suction configuration. Accurate flow rate control is needed for the suction pump with VFD control. The use of a volute pump (centrifugal pump) or volumetric pump (screw pump) with self-priming function is recommended.

g. Level sensor

Level sensor is necessary to be installed in the membrane submerged tank to monitor and control the liquid level of the membrane tank and to calculate the TMP in PLC.

h. Siphon breaking piping

In case of pump suction, filtration flow may not be stopped by stopping suction pump if the discharge point of the permeate water is lower than water level of the membrane submerged basin. This siphon flow has to be avoided and permeate flow has to be stopped whenever pump stops.

CAUTION

Please install the screen with openings of 3.0 mm or under before the membrane submerged tank. It is recommended to use the mesh type screen. Overflow or waste carryover must be avoided at any time.

3. Layout of "TMR090 Series" Modules in Membrane Submerged Tank

(1) Layout of Modules in Membrane Submerged Tank

Fig.IV-5a shows how the liquid circulates in the membrane submerged tank. An upward flow is generated by supplying the air from the fine bubble air diffuser located at the lower side of the membrane modules. The flow then goes downward along both sides of the element block. This circulation flow cleans the membrane surfaces and at the same time mixes sludge liquid. It is very important to arrange the membrane modules with appropriate distances in order to obtain an effective circulation flow.

Fig.IV-5a and Fig.IV-5b present a top view and a side view of the tank containing three membrane modules. It is required to keep the dimensions of W1, W2, W3 and L1 as mentioned below.

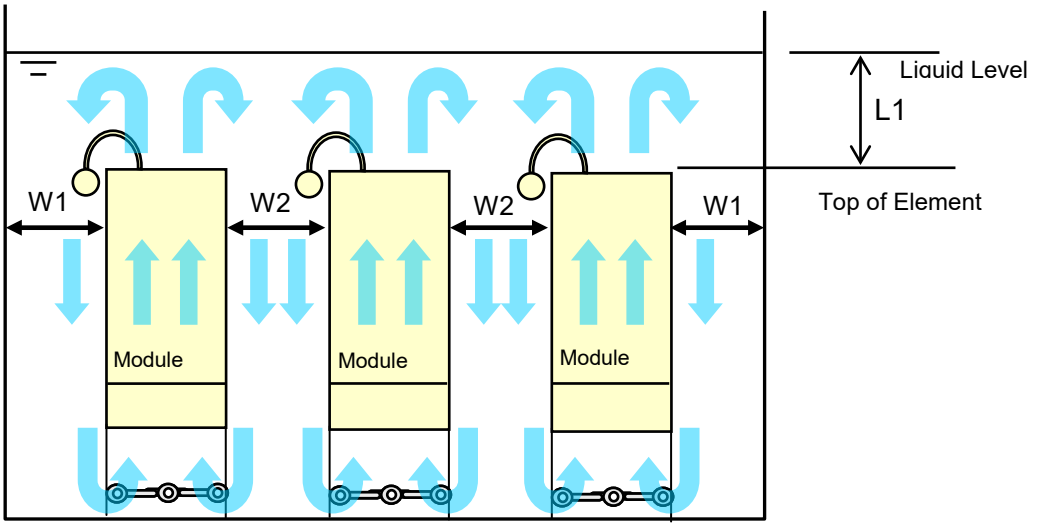


Fig.IV-5a Membrane Module Layout in Membrane Submerged Tank (side view)

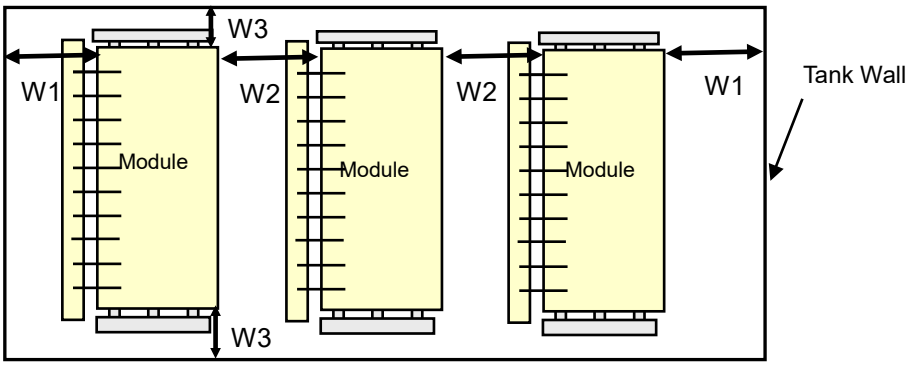


Fig.IV-5b Membrane Module Layout in Membrane Submerged Tank (top view)

(i) W1 : 380 to 680 mm

(ii) W2 : 430 to 730 mm

(iii) W3 : W3 should be as short as possible (normally about 400 mm) within the range allowing piping and maintenance work.

(iv) L1 : L1, the distance between the top of the element and the liquid level of the tank, should be 300 mm or over at any time of the operation.

* Please contact us in the case of facing difficulties with a layout design, including installation of the membrane modules in the existing aeration tank. It is recommended to install the modules with adjustable stands as shown in Fig.IV-6 so as to set modules horizontally when installing on an unlevel tank floor.

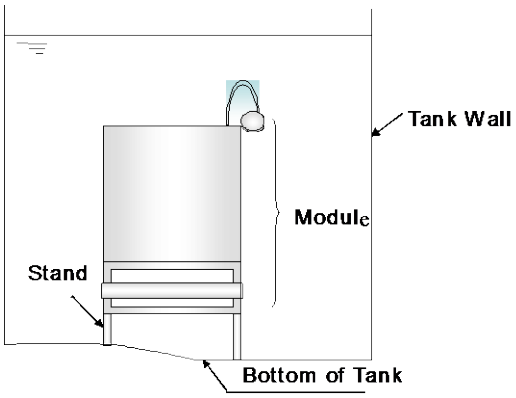


Fig.IV-6 Installation with Stands (side view)

(2) Layout of Modules installed with Other Aeration Equipment

In the case that the membrane modules are installed in the tank with other oxygen-supplying aeration equipment or in the existing tank where there is already other oxygen-supplying aeration equipment, please take the following precautions in addition to what is mentioned in the above section.

・ Please keep twice of W3 of the distance between the modules and other oxygen-supplying equipment in the case shown in Fig.IV-7,

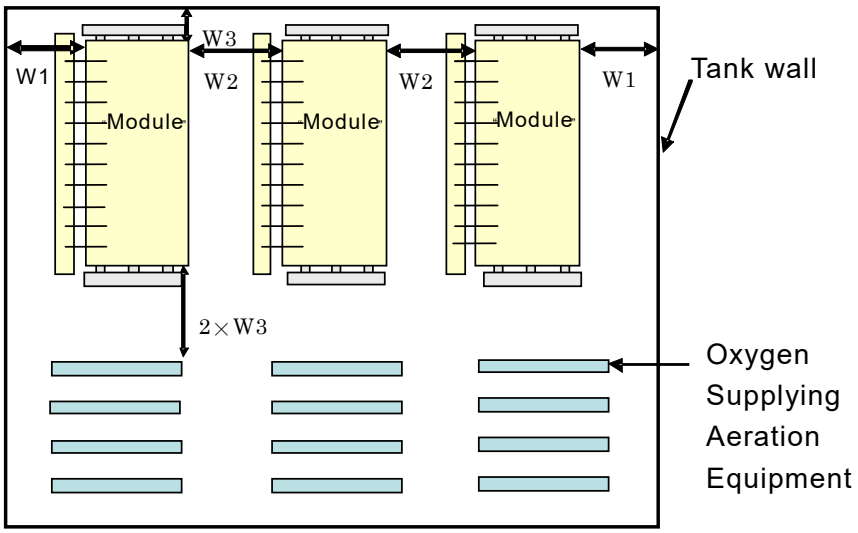


Fig.IV-7 Membrane Module Layout in Membrane Submerged Tank with other aeration equipment (top view)

Please keep twice of W1 of the distance between the modules and other aeration equipment in the case shown in Fig.IV-8,

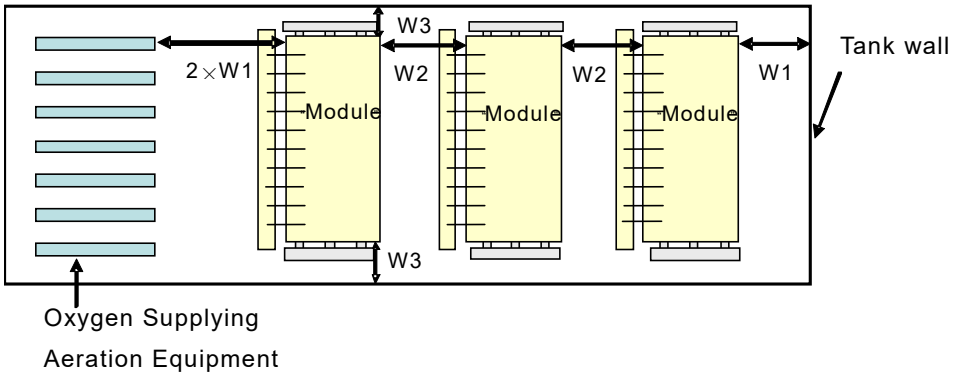


Fig.IV-8 Membrane Module Layout in Membrane Submerged Tank with other aeration equipment (top view)

4. Piping

The procedures of the pipe arrangement for the air diffusers and the permeate water manifold are described in this section. The connections of the air diffuser and the permeate water manifold are shown in the module drawings attached to this manual.

(1) Pipe Arrangement for the air diffusers

The pipe from the air supply device (the blower) is connected to the air diffusers with the screws (A) as shown in Fig.IV-9-11. It is recommended to install the flange connection (B) above the liquid surface on this line in order to disjoint the piping in the case of lifting the modules.

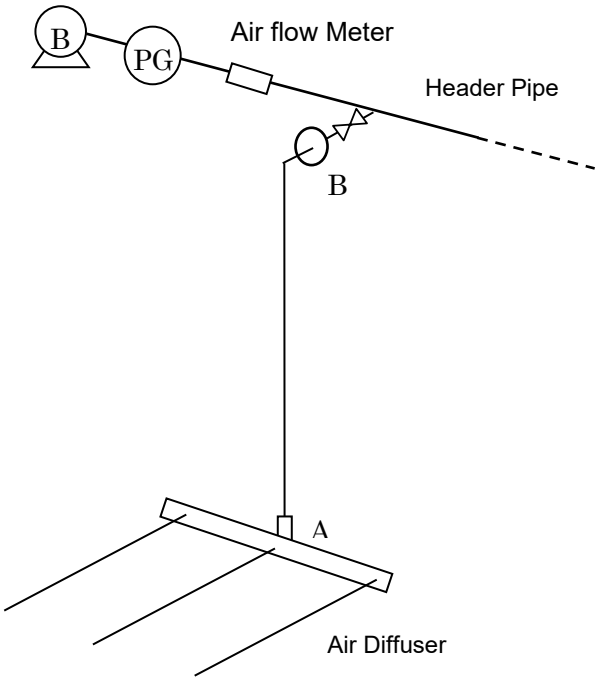


Fig.IV-9 Example of Piping to Air diffusers for TMR090-050S

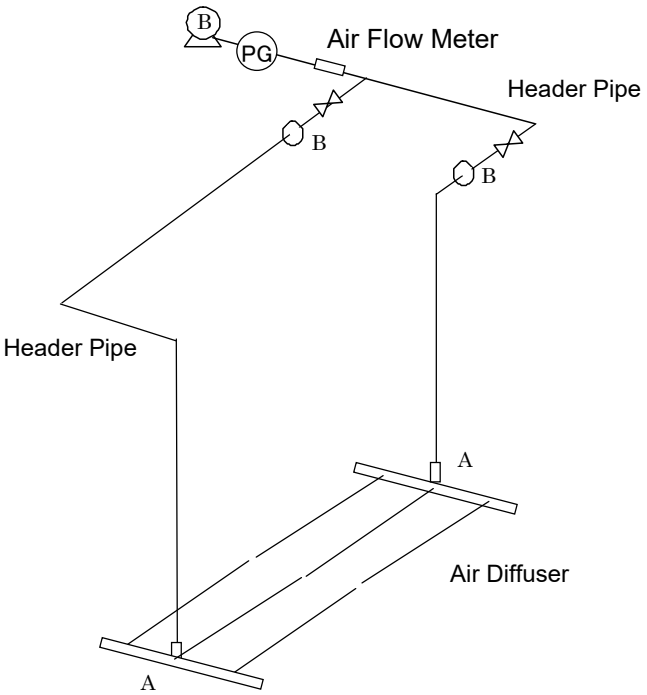


Fig.IV-10 Example of Piping to Air diffusers for TMR090-100S (Installation of One Unit)

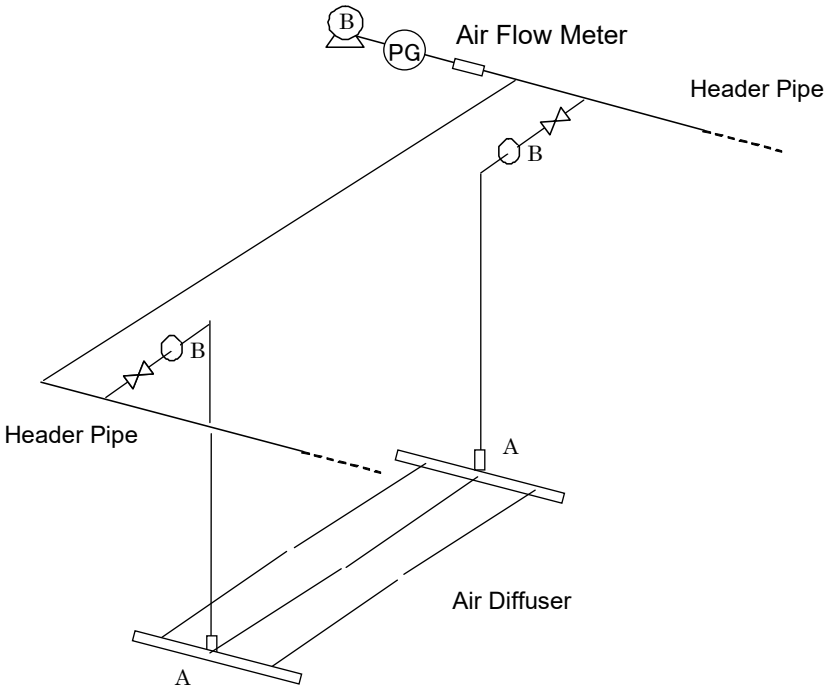


Fig.IV-11 Example of Piping to Air Diffusers for TMR090-100S (Installation of Multiple Units)

Blower(s) and air piping for membrane scouring should be completely separated from the biological aeration system so that the membrane scouring air flow rate would not be affected by DO control in oxidation process. Membrane scouring blower(s) must have enough capacity to satisfy the scouring air flow rate requirements for all modules. About 10 kPa or 100mbar of the pressure loss with the fine-bubble air diffusers should be considered when choosing blowers.

Rotary, turbo or centrifugal blowers can be used for membrane scouring. Oil-free blowers are recommended in order to avoid the accidental contamination of the scouring air with oil, which could result in damage of membrane diffuser. Depending on the atmosphere, the use of a suction filter to protect the diffuser from dust or sand is recommended. An air filter that removes more than 99.5% of 2-micron dust is a suitable example.

It is necessary to install an air flow meter and valve and recommended to install a pressure gauge in the air supply to check the air flow situation and to adjust the air flow rate just in case.

(2) Piping to Manifold

Fig.IV-12 and Fig.IV-13 give two examples of leading permeated water from the Membrane Submerged Tank. Fig.IV-12 shows downward piping and Fig.IV-13 shows upward piping.

The downward piping is for the gravity filtration. The upward piping is for the operation with suction pump located above the Membrane Submerged Tank.

In both upward and downward piping cases, the chemical injection valve and the air discharge valve should be installed on a branch pipe of the line from the permeate water manifold to the permeate water valve. The devices necessary for chemical cleaning are described in VIII-3 to VIII-6.

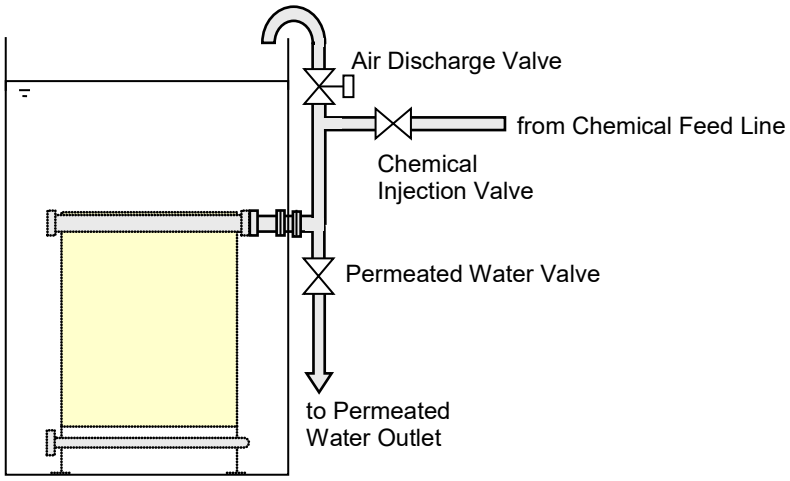


Fig.IV-12 Downward Piping from Membrane Submerged Tank

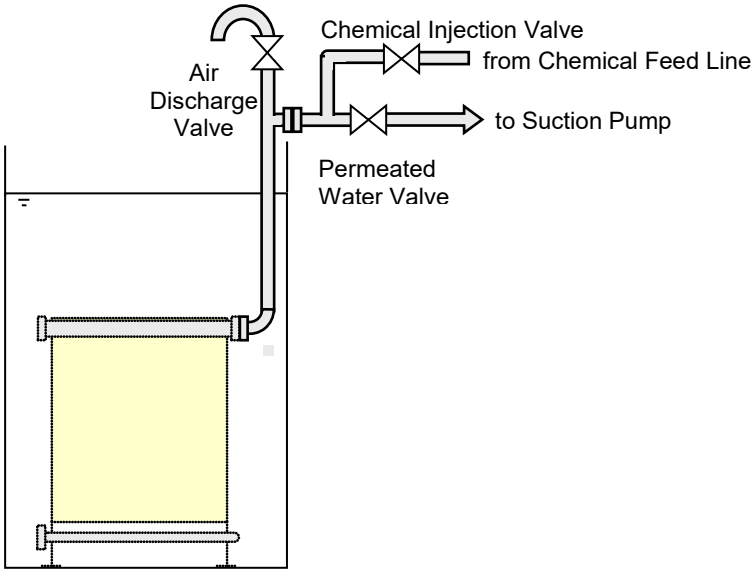


Fig.IV-13 Upward Piping from Membrane Submerged Tank

V. INSTALLATION OF “TMR090 SERIES”

1. Preparatory Procedure

(1) Make sure the transportation plan for “TMR090 Series” including a carry-in route.

(2) Arrange all necessary equipments for unloading “TMR090 Series” from the truck, such as a forklift.

(3) Prior to installation, please confirm that all necessary works in the membrane submerged tank are completed. All waste from the tank, such as concrete clusters, scrapes and mill ends, should be removed completely. Also, please confirm that there is no leakage of water or air from the tanks or pipes.

2. Unloading/lifting Products

Unload "TMR090 Series” with suitable equipment such as forklift.

Please note the followings for unloading "TMR090 Series".

(1) The element block and the aeration block are separately packed together in cardboard box and delivered. The element block contains a fixed number of membrane elements installed in it.

(2) Do not hoist the delivered cardboard box which contains element block(s) and aeration block(s). Please use forklift for moving the box on site.

(3) Do not stand or sit on the top of the box.

(4) When lifting "TMR090 Series", please set a hook on all hang holes and lift it keeping it horizontal with chains or slings. Please use special hanger (drawing attached) in case of limited hanging space.

(5) Please be careful not to damage element nozzles, air diffusers, permeate manifolds or other components.

(6) Please ensure safety anytime when doing these operations.

DANGER

When lifting “TMR090 Series”, please attach chains or slings to it and lift it straight upward calmly to prevent “TMR090 Series” from shaking. Never allow any person under “TMR090 Series”.

DANGER

Please use chains or slings compatible with lifting weight.

DANGER

Be sure to set down the module where there is no obstacle. Otherwise, the module may topple down and get damaged.

DANGER	Don't apply a strong force to air diffusers when moving the module. Otherwise, the air diffusers may get damaged.

3. Checking Products

Please check the followings soon after carrying in “TMR090 Series”:

(1) All items are delivered as stated in the shipping ticket.

(2) No damage is caused in transit.

(3) The protective covers are fit in the right position.

4. Storage Products

Please store "TMR090 Series" indoors under lower than 40 degree C of the temperature, keep it horizontal and avoid direct sunlight to prevent the membrane from deterioration.

Throughout the entire process of installation work from transportation to operation startup, please take adequate measures to protect the elements and other components from damage. Especially please protect them from sparks caused in welding, fusion cutting or grinding, using fireproof sheets or other protective measures.

If “TMR090 Series” is to be stored outdoors unavoidably during construction period, please minimize the period of outdoor storage, and also comply with the following requirements:

(1) Maintain the temperature below 40 degree C.

(2) Prevent from freezing.

(3) Prevent from getting wet and dew condensation.

(4) Prevent from immersed in the water.

(5) Avoid direct sunlight.

CAUTION	Never leave "TMR090 Series" for hours where the temperature is higher than 40 degree C or where exposed to direct sunlight.
CAUTION	Protect “TMR090 Series” from freezing.
CAUTION	Take adequate measures to protect “TMR090 Series” from sparks caused in welding, fusion cutting or grinding.
CAUTION	Protect the element from damages. Don't put any heavy objects on the module. Protect it from collision with other object.

CAUTION	Be careful not to damage the rubber parts of air diffusers and element fixing brackets.

5. Installation Products

Please check the followings before module installation:

(1) All the necessary works in the membrane submerged tank has been completed.

(2) Tank and pipes have been cleaned.

(3) Please confirm that there is no leakage of water or air from the tanks or pipes.

(4) Operation checks of major equipments, including pumps, blowers, sensors and control system, have been confirmed by clean water test.

Please check that the element fixing brackets and tubes are properly fit in the module as described in Section 8, "Replacement of Element Fixing Brackets" in Chapter VIII,.

(1) Installation Module

The air diffusers should be set horizontal in order to achieve uniform scouring aeration.

The maximum allowable levelness error for the air diffusers is 3/1,000 on the top surface of the aeration block in both lateral and longitudinal directions.

Basically there are two ways of placing module depending on whether guiderail system is applied or not.

In case that guide rail system is applied for easy lifting up/down, bolt connection of module and bottom of the tank is not necessary. During installation, you just have to put the module on the tank along with guide rail. In this case, guide rails serve as safety against overturning and positioning means.

Other way is just simply setting the module onto the membrane tank and connecting them by using anchor bolts.

Please be sure to take adequate measures after installation, to protect the elements and other components from damage, such as covering with fireproof sheets.

(2) Plumbing in Air Diffusers

The connection of the air diffuser has an internal thread. There is one connection in the air diffuser of TMR090-050S and two connections in the air diffuser of the TMR090-100S. Please get and use the fit hose nipples and other parts to connect the air diffuser to the air supply line.

Before starting the filtration operation, please feed clean water to the membrane submerged

tank to make the modules completely submerged and then supply the air to the air diffusers to check the air is provided evenly to each air diffuser and the air is diffused evenly within each module. (Refer to Section 1, "Clean Water Test" of Chapter VI, "Start of Operation.")

(3) Plumbing in Permeate Water Manifold

The manifold is shipped from the factory with one blank flange fit to one side. Please connect the permeate water line to the manifold at the other side. It is requested for the buyer to get and use the flange fit for the connection of the manifold. As the manifold is designed to allow fine adjustment of height with the brackets on its both ends, please adjust the brackets to install manifold horizontally or to raise the permeated water outlet side a little higher than the other side in order to prevent the air from accumulating in the manifold.

Please flush out the permeate water line before connection. Don't apply pressure to the permeate side of the element, or the element may get damaged.

DANGER	When lifting “TMR090 Series”, please attach chains or slings to it and lift it straight upward calmly to prevent “TMR090 Series” from shaking. Never allow any person under “TMR090 Series”.
DANGER	Use chains or slings compatible with lifting weight.
DANGER	Never climb the module. Please set up the foothold when installation. Use protective equipments to ensure the safety.
CAUTION	Don't apply pressure to the permeate side.

VI. START OF OPERATION

1. Clean Water Operation

(1) Checks and Arrangements

At first, please make the following inspections and arrangements in this order:

a. Check that the air diffusion pipe and the permeated water pipes are connected properly.

b. Check that the membrane submerged tank has been cleaned up completely and then remove the protective cover from top of the module.

c. Open the air discharge valve to release air from inside the membrane element before feeding clean water to the membrane submerged tank.

d. Feed clean water (tap water or filtered water) to the membrane submerged tank up to the operating liquid level.

e. Close the air discharge valve after feeding water.

CAUTION	Open the air discharge valve before feeding clean water to the membrane submerged tank. Close the air discharge valve after feeding water.

CAUTION	Don't use natural ground water for clean water operation, as it may contain much amount of iron, manganese, calcium, and silica which may cause the clogging in the membrane.

(2) Clean water operation

After feeding clean water to the membrane submerged tank, please start clean water operation in accordance with the following procedure:

a. Start the blower to supply air to the air diffusers. Check that the required amount of air is supplied to the air diffusers and the air is diffused evenly within each module.

* Foaming may occur in the membrane submerged tank during clean water operation. This phenomenon is caused by the dissolution of biodegradable hydrophilic components contained in the membrane. Operation can be continued regardless of the foaming.

b. In case of using one blower to supply air for two or more modules, check that the required amount of air is evenly supplied to each module. Otherwise, adjust the opening of the valve installed on a branch pipe of the air supply line from the air header pipe to the diffuser, or modify the piping structure (such as the diameter of the header pipe) to attain uniform air supply.

c. Check the control devices work well during the clean water operation.
d. Start filtration with clean water. Measure and record the trans-membrane pressure and water temperature at designed filtration rates (at a normal, maximum and minimum flow rate). Maintain such records.
e. Stop the filtration and the air supply as soon as the above tests finish.

CAUTION	Don't conduct clean water operation for a long time. Clean water operation tends to cause membrane clogging.

CAUTION	Keep the membrane wet once it gets wet with clean water operation. If those membranes get dried up, the permeability may be decreased seriously.

2. Seeding Sludge Injection

The membrane may get clogged seriously if you filter the wastewater without activated sludge, so don't fail to seed sludge before starting filtration.

Please inject the seeding sludge to the membrane submerged tank with the following steps:

(1) Transport fresh and healthy activated sludge from the other wastewater treatment plant treating the same kind of wastewater. Activated sludge with higher MLSS concentration and higher MLVSS/MLSS ratio is preferable. Initial MLSS concentration of the membrane submerged tank shall be preferably 7,000 mg/L or higher, at least 3,000 mg/L.
(2) Supply the seed sludge through the screen to the tank.
(3) Please start feeding the raw wastewater soon after the sludge injection.
(4) Do not use seeding agents.
(5) Do not use silica-based anti-foam agent in case of foaming.

CAUTION	Remove foreign matters from the seeding sludge with the mesh screen which opening is 3.0 mm or under before injection.

3. Actual Filtration Operation

Following the seeding sludge injection, please start the air diffusion, the filtration and the raw wastewater feed.

Attention needs to be paid to this start-up operation such as:

(1) Start filtration with much lower flux than design value, especially when seeding

sludge MLSS does not reach 7,000 mg/L, and gradually increase the flux considering F/M ratio. Initial seeding sludge is not yet acclimataized to the MBR operation and in such condition filtration with higher flux may lead to membrane fouling.

(2) Sludge parameters such as MLSS and sludge filterability should be checked frequently to assess the actual sludge condition.

(3) Check the air diffuser cleaning procedure and confirm it works. Details for the procedure are given in the chapter VIII

(4) Once the permeate water flow is stabilized, please measure and record the trans-membrane pressure and the liquid temperature. The details for operation control are given in the next chapter.

VII. OPERATION CONTROL

1. Standard Operating Conditions

Table VII-1 shows standard operating conditions for “TMR090 Series”.

These operating parameters such as MLSS, sludge viscosity, DO (dissolved oxygen concentration) and pH should be kept in the range of the standard operation conditions given in Table VII-1 in order to ensure stable operation.

The raw water should be treated with the proper pretreatment facilities before the membrane modules to remove foreign matters which is harmful to the membrane such as big chunks of suspended solid or oil.

Please use an alcohol-based antifoaming agent* if necessary.

* Recommended: *Kurita Water Industries “Kuriless P.F-663”*
Schill & Seilacher “Structol SB2032”

Table VII-1 Standard Operating Conditions for “TMR090 Series”

Parameter		Unit	Operating condition
MLSS		mg/L	7,000-18,000
Sludge viscosity*		mPa·s	Not higher than 100 ** Not higher than 250 ***
DO		mg/L	1.0 or more
pH		-	6-8
Liquid Temperature		degree C	15 - 40
Continuous Average Filtration Flux		$m^3/m^2/d$ (m/d)	0.75 or less
		$L/m^2/h$ (LMH)	31.2 or less
Scouring air flow rate	TMR090-050S	NL/min/Module	650
	TMR090-100S		1,300

* Measured by single cylinder rotary viscometer.

** B type viscometer, e.g. VT-03F by Rion Co., Ltd.

*** C type viscometer, e.g. TVC-5 by Toki Sangyo Co., Ltd.

WARNING Don't use the permeate water for drinking.

WARNING Analyze the quality of the permeate water to ensure that the water quality meets the intended purpose before actual use.

CAUTION Don't use chemicals, toxic agents, oils or other substances that can adversely affect activated sludge.

CAUTION

Avoid abrupt changes in pH, temperature, trans-membrane pressure or any other conditions even if they are within the standard operating conditions (Table VII-1).

CAUTION

Replace consumable parts regularly after inspection.

CAUTION

Protect the modules from freezing.

2. Operating Parameters

The performance of “TMR090 Series” varies in accordance with the raw water quality and the operating conditions. It is recommended to monitor and record the values of operating parameters in order to achieve the stable operation and the expected performance with “TMR090 Series”.

The following shows the operating parameters for the operation of “TMR090 Series”:

(1) Scouring Air Flow rate (blower air flow)
(2) Diffusion pressure (blower discharge pressure)
(3) Permeated water flow rate
(4) Trans-membrane pressure (TMP)
(5) Permeated water quality (BOD, COD, turbidity, T-N, T-P, TSS etc.)
(6) Liquid temperature of membrane submerged tank
(7) Raw water quality (BOD, COD, turbidity, T-N, T-P, etc.)
(8) Excess-sludge discharge rate
(9) DO (dissolved oxygen concentration) of membrane submerged tank
(10) pH of membrane submerged tank
(11) MLSS
(12) Sludge viscosity
(13) Sludge volume (SV30 or SV60)
(14) Sludge filterability

3. Basic Control Philosophy

Listed below is the basic control philosophy for operating “TMR090 Series”. Please note that this is a basic one and detailed control philosophy for each project shall be examined carefully on a case-by-case basis.

(1) Suction pump: Run intermittently by timer (9 min on/1 min off), VFD control for flow rate, stop filtration by low MBR tank level or high TMP. It will never run when no air comes to MBR tank, and to ensure enough sludge mixing when restarting, pump is allowed to run after one minute delay from starting MBR air flow. It will stop during air diffuser cleaning.

(2) Membrane scouring blower: 24/7 continuous operation except in the case of long operation stop by no feed or low membrane submerged tank water level (in that case, 5 min per hour intermittent aeration).

(3) Membrane submerged tank water level: Low -> stop filtration for membrane protection, High -> stop wastewater feed.

(4) TMP: High (+5kPa from initial) -> Alarm for chemical cleaning, High High (20kPa or above) -> Alarm, then stop filtration.

4. Daily Inspection

For the operating parameters listed in the preceding section, perform inspection periodically, at least once per week, as follows. Please check trends of these data and take necessary actions before too late.

(1) Trans-membrane pressure

Please check that the trans-membrane pressure is stable. Please carry out chemical cleaning before the trans-membrane pressure increase by 5 kPa (50 mbar) from its initial operating level at the same permeated water flow rate. Sudden increase in the trans-membrane pressure suggests the membrane clogging caused by abnormal diffused air condition, too high flux, concentration of the sludge in membrane submerged tank or deteriorating sludge properties. In such an event, check the operating condition and biological condition and take necessary actions and carry out chemical cleaning of the elements.

(2) Diffused air conditions

Please check that the fixed amount of air within the standard range is supplied from the diffuser by checking air flow-meter and pressure gage of the air supply line. Also, check that the air is diffused evenly within one module and also evenly among modules. Deviation in the scouring air flow rate from the standard intensity may cause the membrane clogging in the weak zone and element damage in the strong zone. So in such a case, stop filtration, and check the leakage from the piping, valve situation and the blower condition. If necessary, take appropriate actions, such as adjusting the scouring air flow rate. If extraordinary uneven diffusion still continues, conduct the air diffuser inspection and cleaning procedure described in Section 2, Chapter VIII.

CAUTION

If the scouring air flow rate drops or becomes extremely irregular or if air supply is stopped, then immediately stop filtration to prevent membrane clogging.

(3) Activated sludge characteristics

The activated sludge of the membrane bioreactor should be self-cohesive and free from odor. The color of the activated sludge is typically brown, however differs among plants, depending on wastewater component, organic load and so on. If unexpected change is observed in

sludge characteristics, check the operating condition, such as BOD load, MLSS concentration, DO, pH, temperature and/or wastewater component, and take appropriate actions.

(4) MLSS

MLSS concentration in the membrane submerged tank should be normally 7,000 to 18,000 mg/L. If MLSS is too low, please decrease excess sludge discharge rate. If MLSS is too high, please check the return activated sludge flow rate and if it is low, please increase the RAS rate at proper value. If RAS rate is proper, please increase excess sludge discharge rate.

(5) Sludge viscosity

It is desirable that the sludge viscosity is not higher than 250 mPa・s (Measured by C-type viscometer). If the sludge viscosity is too high, please check the operating condition and biological condition, such as F/M ratio, and take necessary actions.

(6) DO

Any point in the aeration tank and the membrane submerged tank should be kept at oxic condition. If DO is less than 1.0 mg/L, take necessary actions such as increasing the air-flow rate of the biological aeration unit, or lower the sludge concentration by increasing excess sludge discharge rate. In case the blower and air piping for membrane scouring is not separated from the biological aeration system, control the membrane scouring air flow rate at fixed value without being affected by DO control in oxidation process.

(7) pH

The desirable pH range is 6 to 8. If pH is out of this range and the activated sludge property is not good, please adjust pH by gradually adding acid or alkali.

(8) Liquid temperature

The desirable liquid temperature is 15 degree C to 40 degree C. If the temperature is out of this range and the activated sludge property is not good, it is recommendable to install temperature control device to cool or heat the liquid.

(9) Liquid level

Check the liquid level of the membrane submerged tank is kept in the appropriate range. If this requirement is not met, check the situation of the control system, particularly the

condition of the level meter, pumps or membranes, and when necessary, take corrective actions.

(10) Sludge volume (SV30 or SV60)

This is almost same as what is usually measured in the CAS plant, the only difference is that MBR sludge needs to be diluted by permeate water (5-fold) to be measureable with usual method. This SV value can be an on-site indicator of sludge property and we recommend conducting this measurement routinely and checking the trend of the daily value in association with other inspection items. In case of abrupt decrease in SV value, check the operating condition and biological condition, and take necessary actions.

(11) Sludge filterability

Paper filtration method is simple and reliable method to grasp the filtration property of the sludge. Please see the method described in attached document. We recommend conducting paper filtration test and measurement of TOC and/or turbidity of filtered water routinely. In case of abrupt decrease in filterability and/or increase in TOC/turbidity, check the operating condition and biological condition, and take necessary actions.

(12) Pretreatment system

In addition to operating parameters for the operation of “TMR090 Series”, please check the state of the pretreatment system (particularly the fine screen system) regularly and remove the accumulated trashes whenever necessary.

VIII. MAINTENANCE OF “TMR090 SERIES”

1. Maintenance Items and Maintenance Frequency

To maintain the performance of “TMR090 Series”, perform the following at specified intervals:

(1) Clean the air diffusers (when extraordinary uneven diffusion is found).

(2) Chemical cleaning of the element (when the trans-membrane pressure has risen by 5 kPa (50 mbar) or more from its initial operating level at the same permeated water flow rate or every 6 months, whichever comes first).

(3) Replace connection tubes (once in 3 years, or when deteriorated)

(4) Replace element comb gaskets (once in 3 years or when deteriorated, whichever comes first).

(5) Replace elements (when the specified treatment flow rate is not gained even after chemical cleaning or when deteriorated, whichever comes first).

(6) Replace air diffusers (once in 3 years or when extraordinary uneven diffusion is detected even after cleaning, whichever comes first).

CAUTION	Be sure to use the specified types of the replacement parts.
CAUTION	Please contact TORAY for the detailed specifications and the procurement routes for replacement parts
CAUTION	Insert the tube securely into the foot of the nozzle when replacing the tube.
CAUTION	Don't apply excess force to the element and manifold nozzles to prevent damage when replacing permeate tubes or elements.,
CAUTION	Don’t re-use the old permeate tubes once disconnected from the nozzles since the connection tightness of the tubes are reduced.
CAUTION	Be careful not to scratch the membrane surface during element replacement works.

2. Air Diffuser Cleaning

"TMR090 Series" is equipped with fine-bubble air diffusers, which significantly reduces the daily cleaning operation of air diffusers compared to the coarse-bubble diffusers. Usually in domestic wastewater treating cases, no operation change is required. However, in the unlikely event of diffuser clogging, uneven air diffusion may cause membrane clogging and elements damage in the worst case.

To prevent possible event of diffuser clogging, please check the value of air flow-meter and pressure gage of the membrane air supply line regularly and check that the fixed amount of air within the standard range is supplied. Also, check that the air is diffused evenly within one module and also evenly among modules.

If extraordinary value of the air-flow rate or uneven diffusion is inspected, please clean the air diffusers according to the following procedure:

Air diffuser cleaning procedure

(1) Repeat the operation of turning on and off the blower several times or increasing and decreasing the blower air flow several times. This operation expands and contracts the rubber part of air diffusers and thus removes the sludge on their surface. From a preventive maintenance point of view, installation of automatic diffuser cleaning system is one way. If the air flow rate or uneven diffusion is not resolved with this operation, please try the next action described below.

(2) Lift the module and take it out of the tank to the safety and steady place. Gently scrub the diffusers with a brush or use pressured water to remove the contamination from their surface. Generally, the diffusers can be cleaned with a tap water hose. If lime or other substance is tightly stuck to the diffusers, use a high-pressure cleaner to remove them. The cleaning time is five to ten seconds per air diffuser, though it depends on the contamination situation or the water pressure.

(3) If the problem with the diffuser is not resolved with above procedure, please contact Toray.

CAUTION

Be careful not to damage the rubber parts of air diffusers.

3. Chemical Cleaning of Element

Chemical cleaning of element should be conducted before the trans-membrane pressure rises to excess. Such a pressure increase can be caused when contaminants clog the pores of the membrane surface. The timing of chemical cleaning is determined as follows:

(1) When the trans-membrane pressure rises by 5 kPa (50 mbar) from its initial operating level at the same permeated water flow rate or every 6 months, whichever comes first. For example, if an MBR was operated at 7 kPa (70 mbar) TMP in its initial period, then 12 kPa (120 mbar) is the TMP trigger for chemical cleaning.

(2) The earlier chemical cleaning is much effective to recover and keep the permeability of the membrane. From a preventive maintenance point of view, please conduct chemical cleaning at the earlier stage of TMP increase; otherwise the trans-membrane pressure will rise rapidly and become difficult to recover the permeability by normal chemical cleaning procedure.

(3) In the case that the trans-membrane pressure rises by 5 kPa (50 mbar) within 6 months, it is recommended to observe how many months it takes for the trans-membrane pressure to rise by 5 kPa (50 mbar) and conduct chemical cleaning periodically within safety interval. This measure is a sure way to conduct effective chemical cleaning and leads to extension of membrane life time.

(4) When the permeability of the membrane is not recovered by only once chemical cleaning, there is a chance to recover permeability by carrying it out repeatedly.

4. Chemical Agents Used for Chemical Cleaning

It is quite important to select chemicals for the chemical cleaning in accordance with the type of adherent contaminant. Cleaning under inappropriate cleaning conditions or using the wrong chemicals may cause poorer filtration performance or damage the membrane. Please select chemicals suitable for each contaminant. Table III-1 shows suitable chemicals and standard cleaning conditions.

Table III-1 Cleaning Chemicals and Standard Cleaning Conditions by Contaminant

Contaminant	Chemical	Solution concentration	Amount used	Hold time
Organic matter	Sodium hypochlorite	2,000-6,000 mg/L (Effective chlorine concentration) (pH is about 12)	3 L/element	1 to 3 hours
Inorganic matter (either of the two chemicals)	Oxalic acid*	0.5-1.0wt%	3 L/element	1 to 3 hours
	Citric acid	1-3wt%	3 L/element	1 to 3 hours

* Oxalic acid should not be applied when wastewater contains calcium, since calcium oxalate may form on the membrane surface which can choke membrane pores.

5. Handling of Chemical Agents

The chemical agents used for chemical cleaning are harmful to the health when in contact with the skin. When you handle chemicals, wear protective goggles, protective gloves and other protectors. Make sure to check the details of its material safety data sheet (MSDS) and the instructions given below beforehand. If the chemicals get in contact with your skin, follow the MSDS and take adequate actions for each chemical.

(1) Sodium hypochlorite solution / NaClO

(A) Handling precautions

(a) Ventilate well. Avoid heat sources and sparks. Also avoid contact with acids.

(b) Handle the chemical container with great care. Avoid toppling, bumping or dragging it.

(c) Take care not to cause leak, spillover or spattering. Don't cause dust or vapor.

(d) Firmly seal the container after use.

(e) Thoroughly wash your hands and face and rinse out your mouth after using chemicals.

(f) Don't eat or drink anything in the working place except in a designated place.

(g) Don't bring gloves or other contaminated protectors into the rest area.

(h) Forbid unauthorized entry to the place where chemicals are handled.

(i) Wear appropriate protectors to avoid inhalation, eye or skin contact, and direct contact with your clothes.

(j) Provide local ventilation in the case of handling chemicals outdoors.

(B) Storage precautions

(a) Store the container in a dark, cold place. Avoid direct sunlight. Firmly seal to prevent direct contact with air.

(b) Use corrosion-resistant containers for storage.

(2) Oxalic acid / $(COOH)_2$

(A) Handling precautions

(a) Keep away from strong acids and bases.

(b) Handle the chemical container with great care. Avoid toppling, bumping or

dragging it.

(c) Take care not to cause leak, spillover or spattering. Don't cause dust or vapor.

(d) Firmly seal the container after use.

(e) Thoroughly wash your hands and face and rinse out your mouth after using chemicals.

(f) Don't eat or drink anything in the working place except in a designated place.

(g) Don't bring gloves or other contaminated protectors into the rest area.

(h) Forbid unauthorized entry to the place where chemicals are handled.

(i) Wear appropriate protectors to avoid inhalation, eye or skin contact, and direct contact with your clothes.

(j) Provide local ventilation in the case of handling chemicals outdoors.

(B) Storage precautions

(a) Store the container in a dark, cold place. Avoid direct sunlight. Firmly seal to prevent direct contact with air.

(b) Use corrosion-resistant containers for storage.

(3) Citric acid / $HOOCCH_2C(OH)(COOH)CH_2COOH$

(A) Handling precautions

(a) Keep away from strong acids and bases.

(b) Handle the chemical container with great care. Avoid toppling, bumping or dragging it.

(c) Take care not to cause leak, spillover or spattering. Don't cause dust or vapor.

(d) Firmly seal the container after use.

(e) Thoroughly wash your hands and face and rinse out your mouth after using chemicals.

(f) Don't eat or drink anything in the working place except in a designated place.

(g) Don't bring gloves or other contaminated protectors into the rest area.

(h) Forbid unauthorized entry to the place where chemicals are handled.

(i) Wear appropriate protectors to avoid inhalation, eye or skin contact, and direct contact with your clothes.

(j) Provide local ventilation in the case of handling chemicals outdoors.

(B) Storage precautions

(a) Store the container in a dark, cold place. Avoid direct sunlight. Firmly seal to

prevent direct contact with air.

(b) Use corrosion-resistant containers for storage.

 **WARNING**	The chemical agents used for chemical cleaning are harmful to the health. When handling chemicals, wear protective goggles, protective gloves and other protectors. Make sure to check the details of its material safety data sheet (MSDS) beforehand.
 **WARNING**	If chemicals should stick to your skin or clothes, immediately wash it away with a large amount of running water.
 **WARNING**	If chemicals should enter an eye, immediately wash it away with a large amount of running water and see the doctor.
 **WARNING**	Store chemicals in a dark, cold place free from direct sunlight.
 **WARNING**	Use the chemicals storage tanks made of the material suitable for each chemical to prevent corrosion.
 **WARNING**	Don't mix sodium hypochlorite with acids, including oxalic acid or citric acid; otherwise toxic chlorine gas is generated.
 **CAUTION**	Don't mix sodium hypochlorite with heavy metals.

6. Chemical Cleaning Procedure

(1) Element Chemical Cleaning Procedure

Firstly please slowly inject the chemical via the permeated water nozzle into the elements until it percolates through the membranes. Do not apply too high pressure (>10 kPa or 100 mbar) when injecting the chemical. Some injecting methods are shown below.

a. Chemical Cleaning with the chemical tank located at the bottom (Fig.VIII-1)

(i) Confirm that the chemical injection valve is closed and that the chemical feed pump is stopped.

(ii) Provide the chemical tank with specified amounts of chemical.

(iii) Stop filtration, stop aeration and close the filtrate valve.

(iv) Start the chemical feed pump and check that the chemical circulates.

(v) Slowly open the chemical injection valve to start injecting the chemical.

(vi) After injecting the specified amount of chemicals to the elements, stop the chemical feed pump.

(vii) Hold the equipments for 1 to 3 hours.

(viii) Close the chemical valve, open the filtrate valve, and start aeration. Then, restart filtration operation.

* The chemical may remain in the permeated water in an early stage of filtration (for a period of 2 or more intermittent cycles). Send back the permeated water to the raw water tank, or dispose of it in accordance with applicable legal standards for waste disposal. Before restarting the normal operation, check the pH and/or Cl concentration of the permeated water.

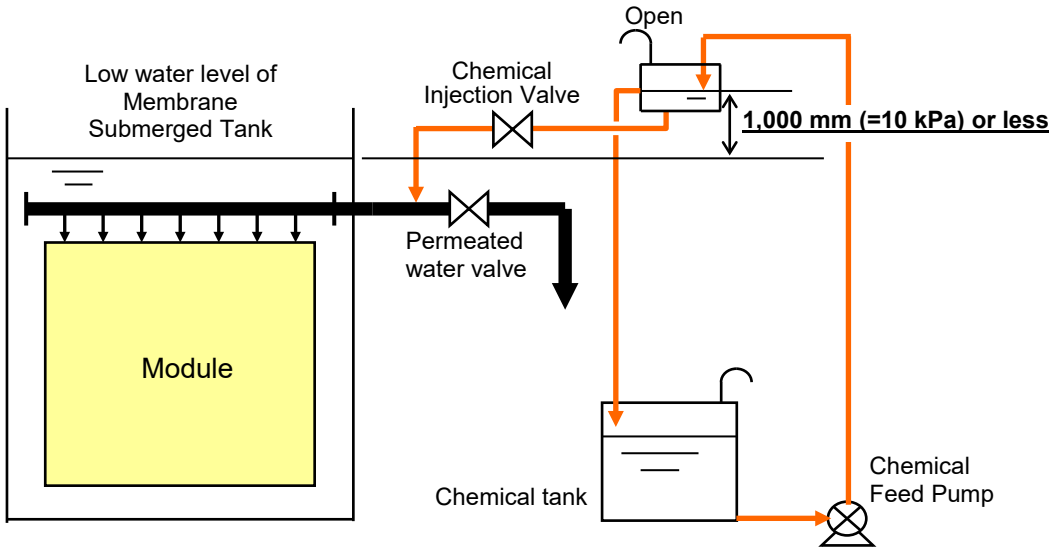


Fig.VIII-1 Chemical Cleaning with Chemical Tank Located at Bottom

b. Chemical cleaning with the chemical tank located above the membrane submerged tank (Fig.VIII-2)

(i) Confirm that the chemical injection valve is closed.

(ii) Provide the chemical tank with specified amounts of the chemical.

(iii) Stop filtration, stop aeration, and close the filtrate valve.

(iv) Slowly open the chemical injection valve to inject chemicals.

(v) After injecting the chemical, hold the equipment for 1 to 3 hours.

(vi) Close the chemical valve, open the filtrate valve, and start aeration. Then, restart filtration operation.

* The chemical may remain in the permeated water in an early stage of filtration (for a period of 2 or more intermittent cycles). Send back the permeated water to the raw water tank, or dispose of it in accordance with applicable legal standards for waste disposal. Before restarting the normal operation, check the pH and/or Cl concentration of the permeated water.

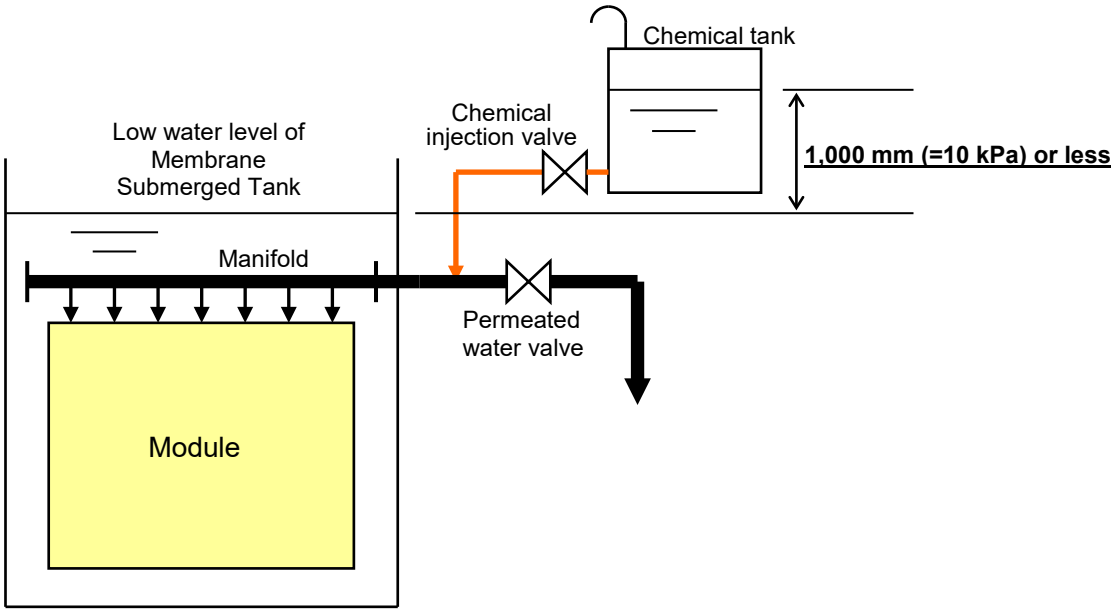


Fig.VIII-2 Chemical Cleaning with Chemical Tank Located above Membrane Submerged Tank

c. Chemical cleaning with the chemical feed pump and relief valve (Fig.VIII-3)

(i) Confirm that the chemical feed pump is stopped and the top of relief piping is located at 1 m or lower height from membrane submerged tank water level.

(ii) Provide the chemical tank with specified amounts of chemical.

(iii) Stop filtration, stop aeration and close the permeated water valve.

(iv) Surely open the relief valve.

(v) Start the chemical feed pump.

(vi) Confirm the smooth return of the chemical to Chemical tank when it spouts from the outlet of relief piping. If the spouting is too much, adjust the feeding rate of chemical.

(vii) After injecting the specified amount of chemicals to the elements, stop the chemical feed pump.

(viii) Hold the equipments for 1 to 3 hours.

(ix) Close the relief valve, open the permeated water valve, and start aeration. Then, restart filtration operation.

* The chemical may remain in the permeated water in an early stage of filtration (for a period of 2 or more intermittent cycles). Send back the permeated water to the raw water tank, or dispose of it in accordance with applicable legal standards for waste disposal. Before restarting the normal operation, check the pH and/or Cl concentration of the permeated water.

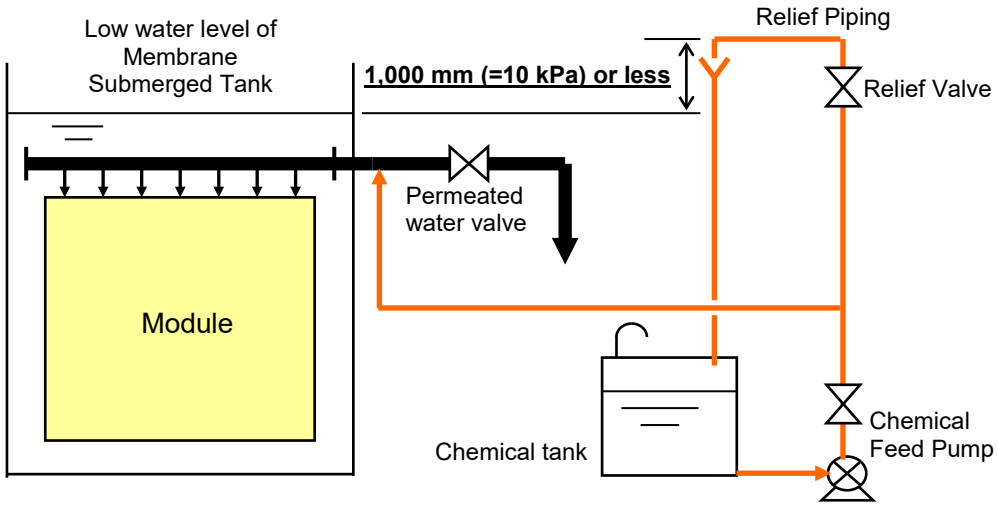


Fig.VIII-3 Chemical Cleaning with the Chemical Feed Pump and Relief Valve

WARNING

If chemical is injected without opening relief valve, the internal pressure of the elements will increase and the elements will get damaged. Be sure to open the relief valve before injecting chemical.

WARNING

Chemical may spout from relief piping. Adjust the chemical feeding rate not to let it spout out of the pioing and keep away from relief piping when the chemical feed pump is running. Use the safety protectors such as goggles and gloves.

(2) Precautions for Element Chemical Cleaning

a. Keep the injecting pressure below 10 kPa (100 mbar). Avoid forcibly applying pressure directly with the pump or by any other means. A higher pressure will damage membrane elements and modules. Please note that injecting pressure may rise up after injecting half of the chemical.

b. Submerge the module completely in the tank and inject chemical. Please maintain the top of the module at least 300 mm below the liquid surface for the safety reason.

c. Though higher temperature gives more effective cleaning, please maintain the temperature below 40 degree C. Conversely, lower temperature causes poorer cleaning effects and hampers the recovery of the membrane permeability. Please try to maintain the temperature of the liquid as high as possible within the range below 40 degree C.

d. After chemical cleaning, a small amount of chemical remains inside the elements and the permeate water line. When resuming the filtration operation, please send back the permeated water to the raw water tank until the permeated water is free from effects of the chemical (for a period of at least 2 intermittent cycles), or dispose of it in accordance with applicable legal standards for waste disposal.

e. If sodium hypochlorite cleaning is immediately followed by acid cleaning or in reverse order, do make sure that the both chemicals are never mixed at any tank or pipe (especially injection line). Otherwise such mixture generates toxic chlorine gas.

f. If permeate is used as cleaning solution make up water, residual calcium in the make up water may precipitate when NaOCl is mixed into the water. If a high calcium concentration is expected in the make up water, confirm the possibility of precipitation by a bench-scale NaOCl addition test and if whitish precipitation of calcium is found, use tap water for the make up water.

WARNING

If an abnormality is found in the equipment during chemical cleaning, immediately stop the operation.

WARNING

Never mix sodium hypochlorite with oxalic acid or citric acid. Such mixture generates toxic chlorine gas.

WARNING

If chemical is injected forcibly directly with the chemical feed pump or by any other means, the internal pressure of the elements will increase and the elements will get damaged. Be sure to inject chemical with the pressure of lower than 10 kPa (100 mbar).

WARNING	Before starting injecting chemical to elements, confirm that the liquid surface is more than 300 mm higher than the top of the module.
CAUTION	Stop the aeration during chemical cleaning, or the membrane may get damaged.

7. Lifting Procedure

Please take the following steps to lift “TMR090 Series” modules for maintenance,
in the case that the modules are installed on the bottom of the tank with using anchors.

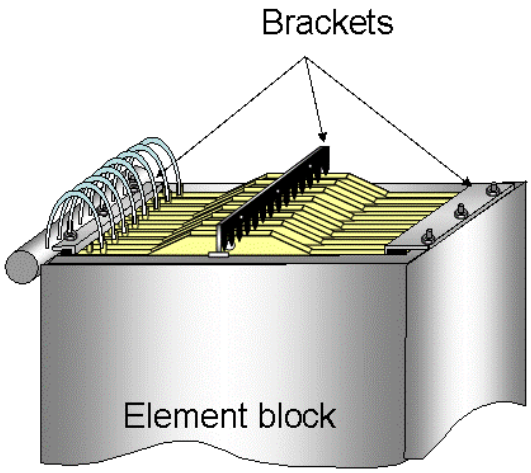
(1) Discharge completely activated sludge liquid from the tank.
(2) Remove the anchors.
(3) Disjoint the connection of the manifold and the air diffuser and lift the modules.

Please contact us beforehand if the modules are installed on the bottom of the membrane submerged tank in the way other than using anchors.

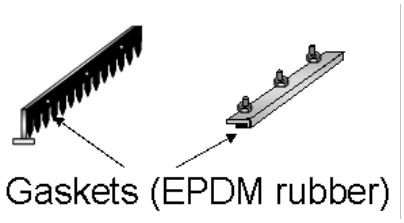
DANGER	When lifting “TMR090 Series”, please attach chains or slings to it and lift it straight upward calmly to prevent “TMR090 Series” from shaking. Never allow any person under “TMR090 Series”.
DANGER	Use chains or slings compatible with lifting weight.
CAUTION	Clean the air diffusers when lifting the modules and doing maintenance. If the sludge accumulated on the surface of air diffusers are dried up, the rubber parts of air diffusers may get damaged.

8. Replacement of Element Fixing Gaskets

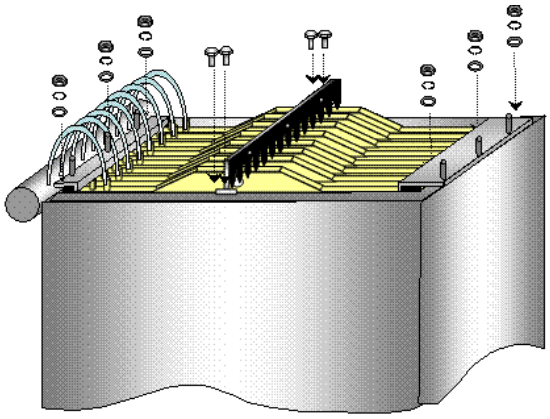
Please at first lift "TMR090 Series" modules out of the tank according to the lifting procedure described above and take the following steps to replace the element fixing comb gaskets (EPDM rubber). The bolt size is M10.



(1) Remove the three element fixing brackets from the element block (one center bracket and two side brackets).



(2) Replace the comb gaskets from each bracket. The gaskets consist of several parts according to the type of module. Detailed information will be provided separately.



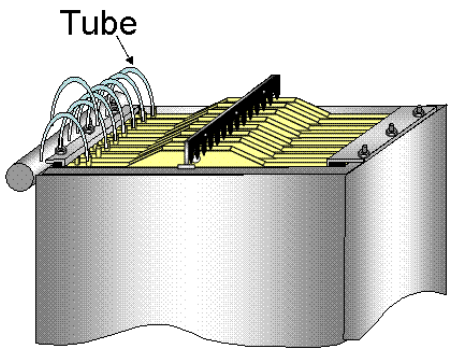
(3) Install element fixing brackets on the element block.
After installation, check that comb gaskets are touching elements flat.

CAUTION

Take care not to damage the gaskets (EPDM rubber) of the element fixing bracket.

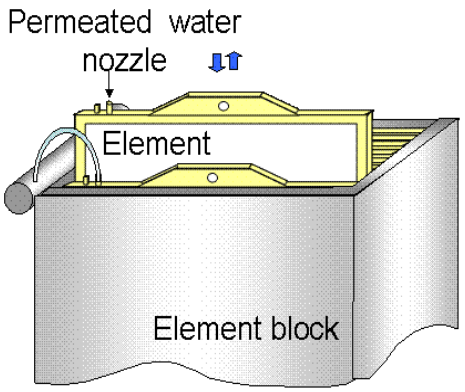
9. Element Replacement

Please at first lift "TMR090 Series" module out of the tank according to the lifting procedure described in the former section and replace elements.



(1) Pull the permeate tubes, which are to be replaced, out from element nozzles and manifold nozzles.
* Pull out tubes straight up.

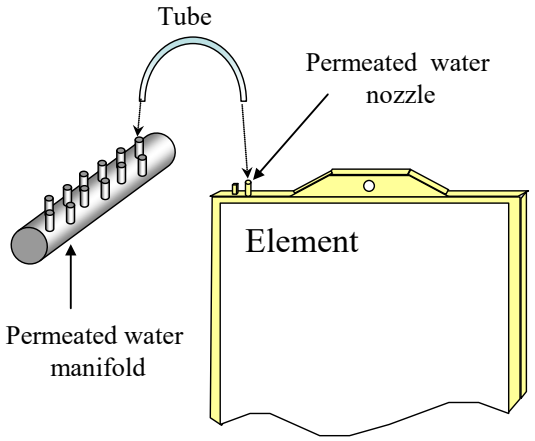
(2) Remove three element fixing brackets from the element block according to the element fixing bracket replacement procedure above.



(3) Pull up elements vertically one by one. Using the element pullout tool (option tool) is recommended.

(4) Insert new elements into the element block along the guides. Be careful not to damage the membrane surface.

(5) Fit the three element fixing brackets to the element block according to the element fixing bracket replacement procedure described above.

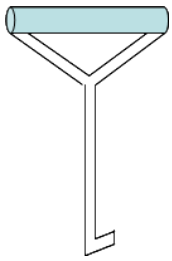


(6) Fit tubes straight down to element nozzles and manifold nozzles.
* Insert tubes deeply into the nozzles. Confirm that all manifold nozzles are connected to element nozzles with tubes.

CAUTION	Be careful not to damage the comb gaskets (EPDM rubber) of the element fixing bracket.
CAUTION	Be careful not to damage the element during the element replacement works. Particularly, be careful not to scratch the membrane surface.

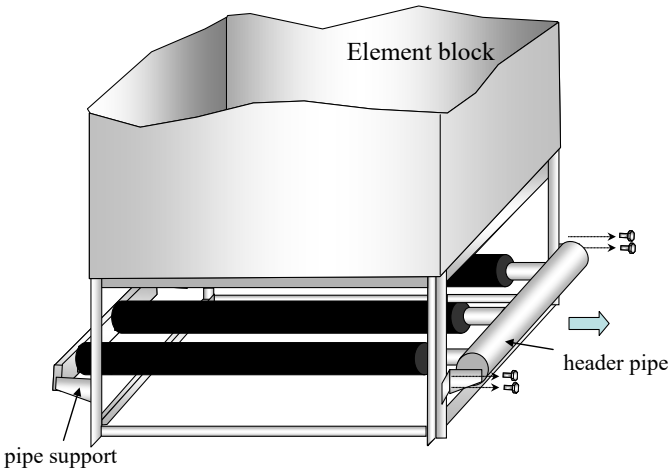
Optional extras:

The tool to pull up an element



10. Air Diffuser Replacement

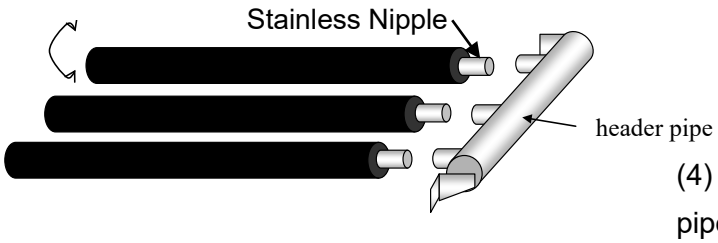
At first, please lift the module out of the tank according to the lifting procedure described in the former section. Then, take the following steps to replace the air diffuser. Bolt size is M10. TMR090-050S has one header pipe and TMR090-100S has two header pipes. TMR090-100S has six air diffuser pipes with two different lengths.
The following figures show the case of TMR090-050S.



(1) Disjoint the header pipe from the aeration block.

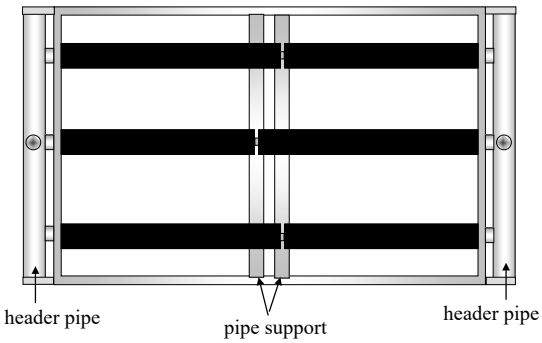
(2) Unscrew the air diffuser pipes from the header pipe.

(3) Seal the nipples of new air diffusers with Teflon seal tape.



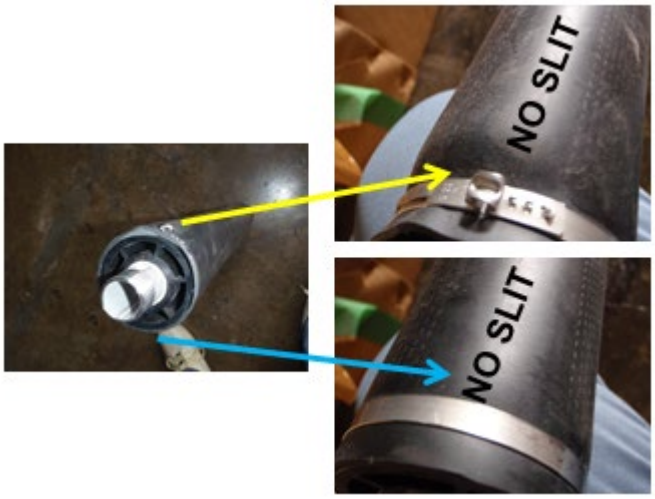
(4) Joint the new air diffusers to the header pipes. Please use the pipe wrench to tighten the joint (Don't fasten tight by grabbing the rubber part of the diffuser). Please make sure that the surface of the rubber part having no holes (slits) must face upward or downward (The surface on which stainless clamps are fixed must face upward or downward).

TMR090-100S Aeration block (top view)

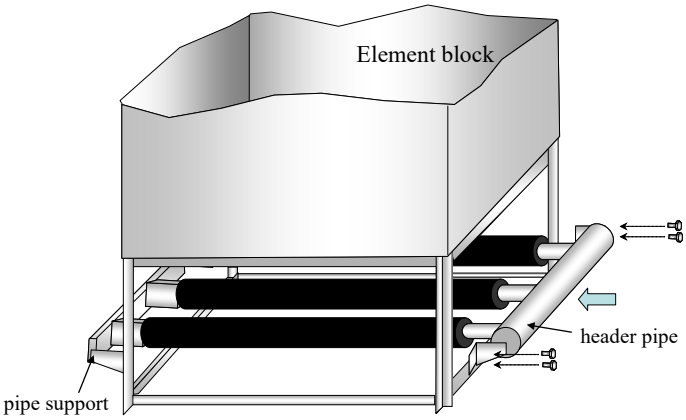


In case of TMR090-100S, since two different lengths of the rubber diffusers are to be handled, please take enough care to joint air diffusers considering the position of

the pipe support and the length of the diffuser pipes.



No Slit Area shall be located at top and bottom when connecting to the header pipe.



(5) Fit the header pipes to the aeration block while fixing air diffusers on the pipe supports.

CAUTION

Be careful not to damage the rubber parts of air diffusers.

11. Storage Products after Use

Please take the following steps to preserve the used “TMR090 Series” modules for a long time until future re-operation.

(1) Drain the sludge in the membrane submerged tank.
(2) Clean the modules with clear water and wash out the remaining sludge on the module surface as well as tank wall using hose. Never apply high pressure washing machine.
(3) Fill the clear water into the tank to let the modules completely submerged and maintain its water level until the next start up.
(4) Periodical dosing of sodium hypochlorite helps inhibit the growth of algae/microorganism during the storage, however hypo concentration in the tank has to be low (<50 ppm) to prevent from possible damage to the module (stainless steel) by long-time exposure.
(5) In case aeration of the tank is required, its duration shall be short enough (<5 minutes per hour) to avoid putting stress to membrane elements by “aeration without filtration”.
(6) Before re-commissioning of the modules, it is strongly recommended to conduct chemical cleaning to the modules for the sake of removing biofilm grown on the membrane surface and piping.

In case storage period is not long (within 24 hours), periodical sprinkling of water to modules especially membrane surface and putting non-transparent sheet onto the modules for protection against direct sunlight and wind are effective for creating wet condition of membrane.

CAUTION

Keep the membrane wet once it gets wet with operation. If that membrane gets dried up, its permeability may be decreased seriously.

12. Disposing Procedure

When disposing of the membrane after use, please follow below general procedure.

(1) Clean up the membrane module with water. After that it is better to dry up the module for your easy handling.
(2) Dispose of the module or each constituent following local regulation for waste disposal (landfill, incineration...). When required by regulation, disassemble the module and segregate its constituent accordingly (e.g. combustible/incombustible).
(3) Regarding membrane, do not burn it without appropriate facilities since harmful Hydrogen Fluoride (HF) gas will be generated during incineration. If it needs to be incinerated, please apply a service of a qualified waste disposing company.

WARNING

Don't burn the membranes without appropriate facilities since harmful Hydrogen fluoride (HF) gas is generated at burning. When dispose membranes, please apply a service of a qualified waste disposing company.

IX. REPLACEMENT PARTS LIST

Please contact us for the details of the specifications,

<table>
<tr><th colspan="4">Name</th><th>Frequency</th><th>Type No.</th></tr>
<tr><td colspan="4">Permeate Tube</td><td>Every 3 years or when deterioration detected, whichever comes first</td><td>EBL-TUBE-050
EBL-TUBE-100
(50 sets/100 sets)</td></tr>
<tr><td rowspan="4">Element fixing comb gasket</td><td rowspan="2">TMR090-050S</td><td>Middle</td><td rowspan="4">Every 3 years or when deterioration detected, whichever comes first</td><td>GASKET090-050M</td></tr>
<tr><td>Side</td><td>GASKET090-050S</td></tr>
<tr><td rowspan="2">TMR090-100S</td><td>Middle</td><td>GASKET090-100M</td></tr>
<tr><td>Side</td><td>GASKET090-100S</td></tr>
<tr><td colspan="4">Element</td><td>When the specified filtration flux is not gained even after chemical cleaning or when deteriorated</td><td>TSP-50100</td></tr>
<tr><td rowspan="2">Air diffuser</td><td>Length 762mm</td><td>50S,100S</td><td rowspan="2">When the rubber is deteriorated or the aeration holes is plugged severely</td><td>DIFUSSER090-100S</td></tr>
<tr><td>Length 682mm</td><td>100S</td><td>DIFUSSER090-100S</td></tr>
</table>

X. TROUBLESHOOTING

Most of troubles in the operation of “TMR090 Series” are related to abnormal membrane scouring aeration, too late chemical cleaning, lack of maintenance of the pretreatment system. The following table shows such troubles and countermeasures against them:

Table IX-1 Troubleshooting

	Problem	Cause	Action
1	The air diffusion rate is below the standard level.	The blower is broken	Check the blower.
		The air diffusers are clogged.	Clean the air diffusers.
2	The air diffusion is uneven in the module or between modules.	The air diffusers are clogged.	Clean the air diffusers..
		Uneven valve opening of the air supply line to each module.	Adjust the vale opening rate.
		The bottom of the element block is stuck with trash.	Check the pretreatment system. Inspect the module. Correct operation and maintenance works of the pretreatment system.
3	The permeated water flow rate has decreased. Or the trans-membrane pressure has increased.	Membrane clogging.	Carry out chemical cleaning.
		Sludge accumulated on the membrane surface because of uneven air diffusion.	Inspect the blower and clean the air diffusers to improve air diffusion.
			Carry out chemical cleaning.
		Abnormal properties of sludge have worsened its filterability.	Improve sludge properties. ・ Adjust the excess sludge discharge rate. ・ Prevent entry of abnormal components, such as oils. ・ Adjust the BOD load. ・ Adjust the raw water quality (add nitrogen, phosphorous, etc.)
4	The concentration of suspended solids in the permeate water has increased.	An element or tube has fractured.	Seal the element and manifold nozzle*1.
		A leakage has occurred in the permeated water piping.	Inspect the faulty part*2 and correct the fault.
		Germs are generated on the membrane or the permeate line.	To clean the permeated water piping, inject into it a sodium hypochlorite solution with an effective chlorine concentration of 100 to 200 mg/L.

*1: Even if a cause is found in the tube, there still is the possibility of contamination inside the element. Thus, seal the element and manifold nozzle.

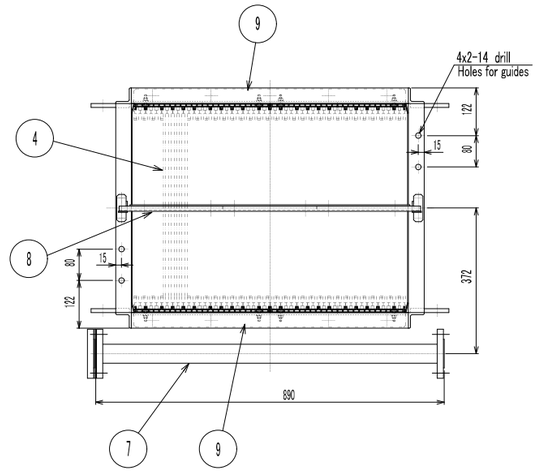
*2: To check the piping joints and welds for leakage with a pressure being applied, be careful not to apply pressure to the membrane modules.

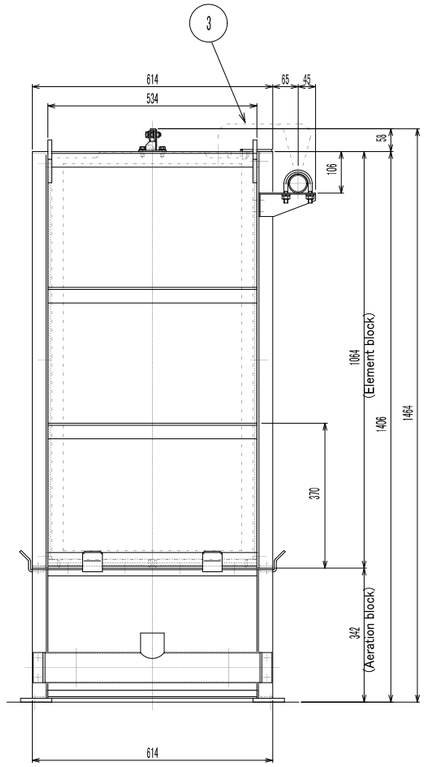
XI. APPENDIX

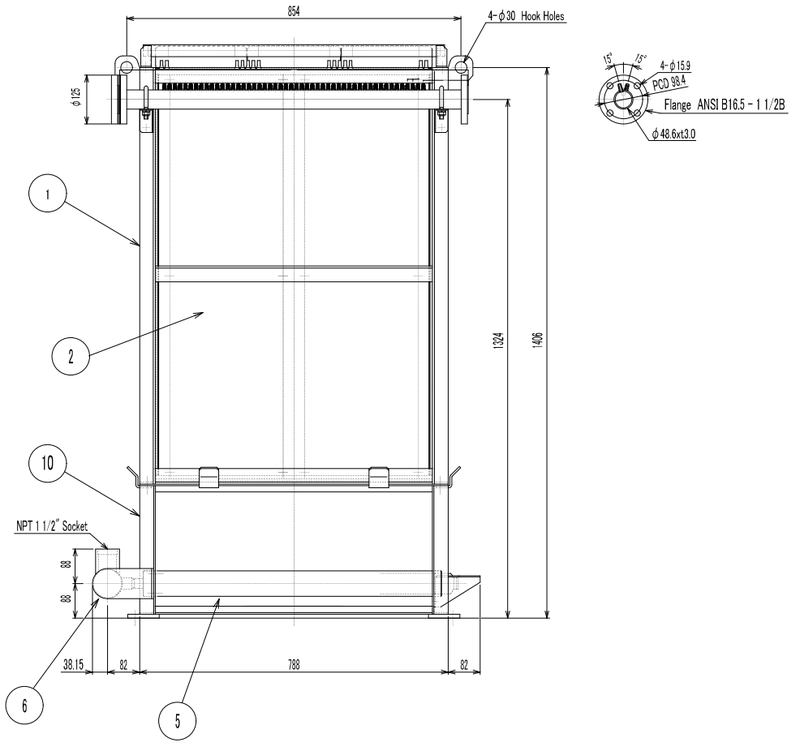
Following information is provided in the separate-attached document:

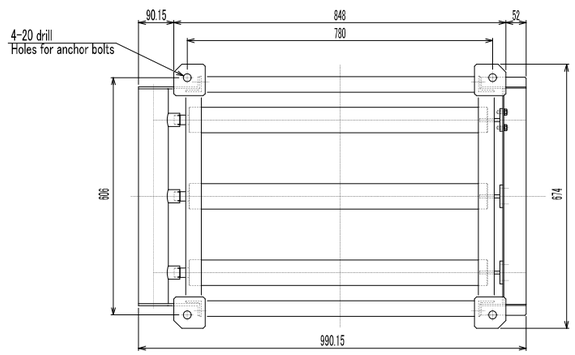
(1) Assembly of Modules.
(2) Assembly of Brackets.
(3) Assembly of Guide Rail System.
(4) Assembly of Hangers.
(5) Assembly of Element-pick-up tool.
(6) Procedure of Paper filter test.

NO.	DRWG.NO.	NAME		MATL.	SPEC.	G1	G2	G3
1		Flame(Element Block)		SUS304		1		
2		Side Panel		ABS		4		
3		Tube		Polyurethane		50		
4		Element		PVDF, ABS		50		
5		Diffuser	Rubber	EPDM		3		
			Pipe	PVC				
6		Header Pipe		SUS304		1		
7		Manifold		SUS304		1		
8		Bracket(Center)	Holder	SUS304		1		
			Gascket	EPDM				
9		Bracket(Side)	Holder	SUS304		2		
			Gascket	EPDM				
10		Flame(Aeration Block)		SUS304		1		









Weight(dry) 265kg

REF.DWG.NO.	TITLE OF REF.DWG.

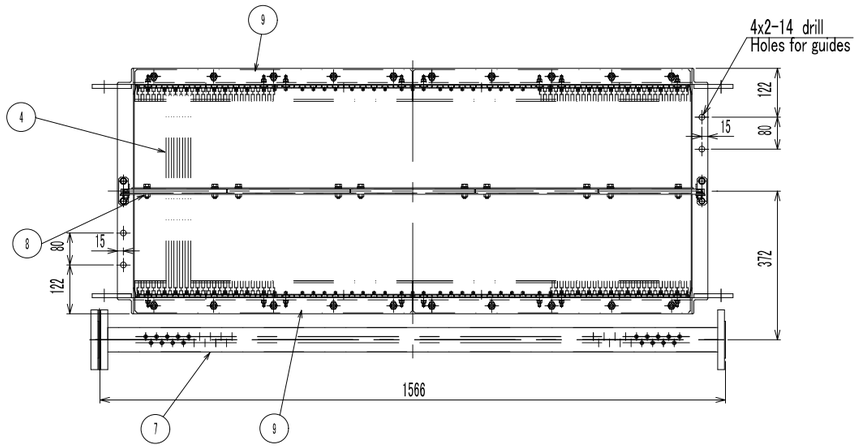
LET	REVISION	DATE	BY	APPROVED

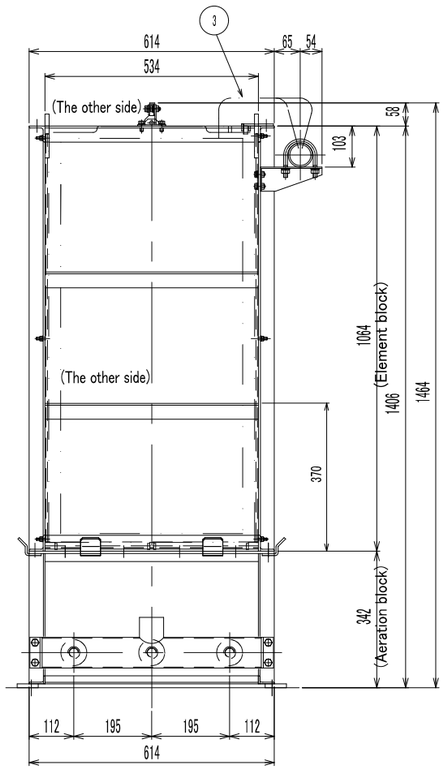
APPROVED	TORAY INDUSTRIES, INC. 'TORAY'		MATL.
PROJECT MANAGER			DRWG.Name. Assembly of Module TMR090-050S
MECHANICAL			
INSTRUMENTAL	SCALE 1/8	DATE	
ELECTRICAL	DRAWN F.NAGATA	DESIGNED Y.TANAKA	ORDER No.
ENG.DEPT MANAGER	CHECKED	APPROVED Y.TANAKA	DRWG.No. SS-08-001 REV. ◇

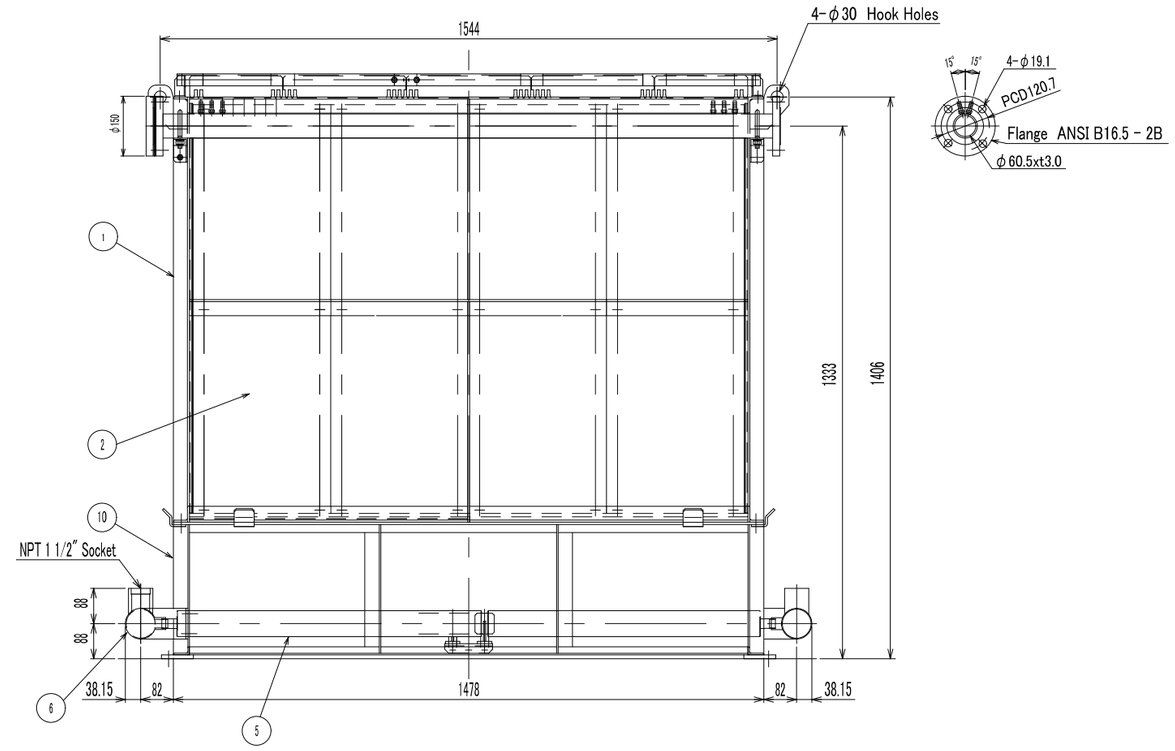
A-1

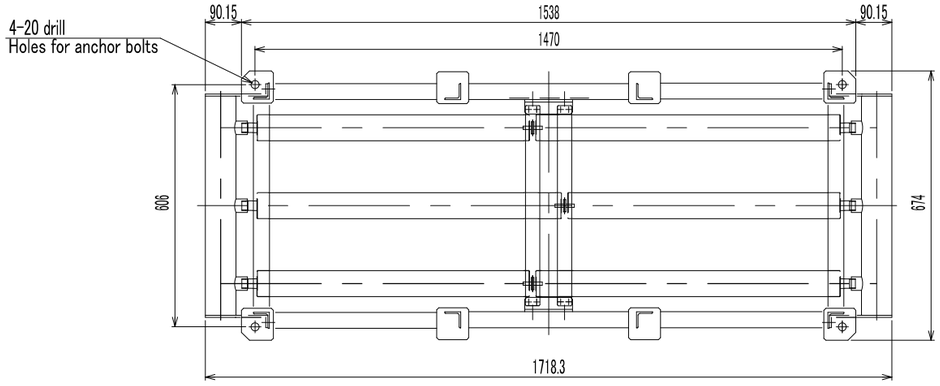
ISSUED TO

NO.	DRWG.NO.	NAME		MATL.	SPEC.	G1	G2	G3
1		Flame(Element Block)		SUS304		1		
2		Side Panel		ABS		8		
3		Tube		Polyurethane		100		
4		Element		PVDF, ABS		100		
5		Diffuser	Rubber	EPDM		6		
			Pipe	PVC				
6		Header Pipe		SUS304		2		
7		Manifold		SUS304		1		
8		Bracket(Center)	Holder	SUS304		1		
			Gascket	EPDM				
9		Bracket(Side)	Holder	SUS304		4		
			Gascket	EPDM				
10		Flame(Aeration Block)		SUS304		1		









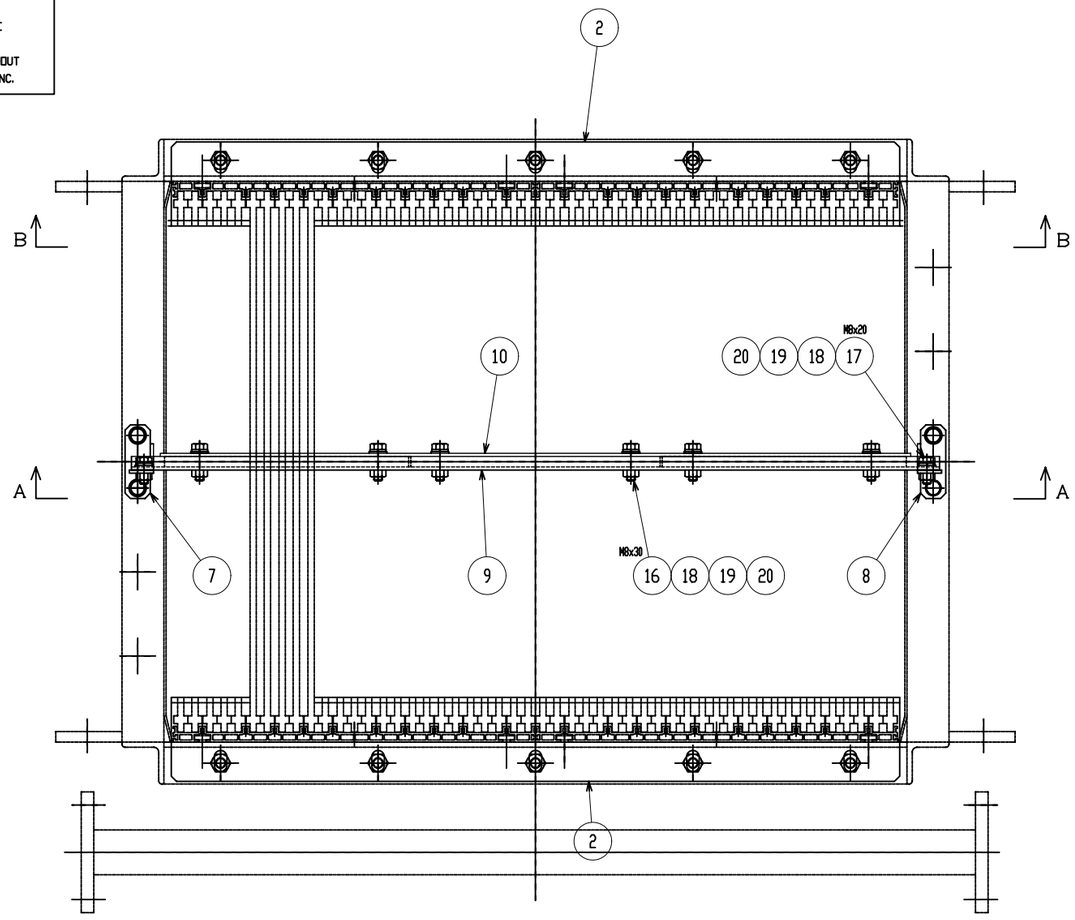
Weight(dry) 460kg

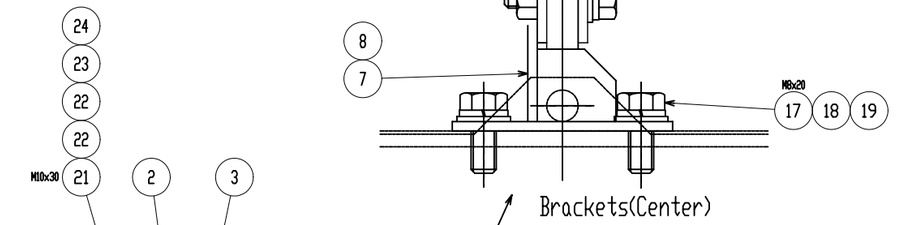
REF.DWG.NO.	TITLE OF REF.DWG.

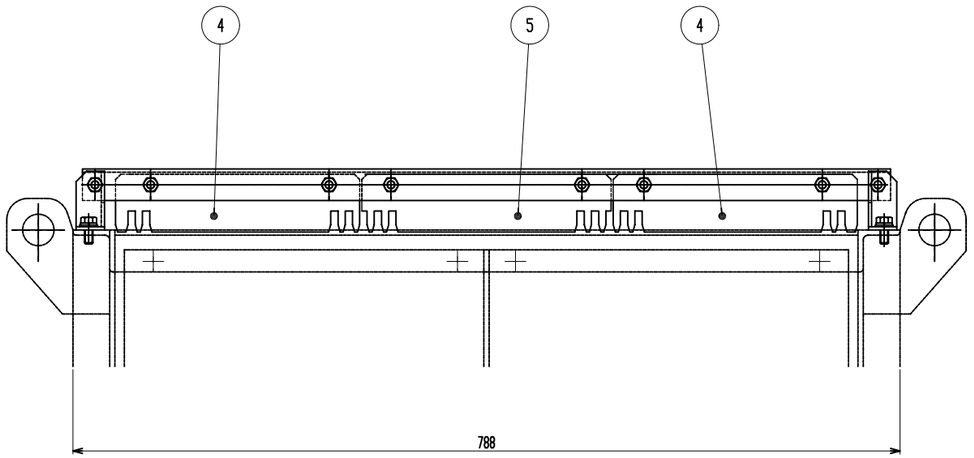
LET	REVISION	DATE	BY	APPROVED

APPROVED	TORAY INDUSTRIES, INC. 'TORAY'		MATL.	A-1
PROJECT MANAGER			DRWG.Name. Assembly of Module TMR090-100S	
MECHANICAL				
INSTRUMENTAL	SCALE 1/8	DATE		
ELECTRICAL	DRAWN F.NAGATA	DESIGNED Y.TANAKA	ORDER No.	DRWG.No. 07-029-001-C REV. 0
ENG.DEPT MANAGER	CHECKED	APPROVED Y.TANAKA		ISSUED TO

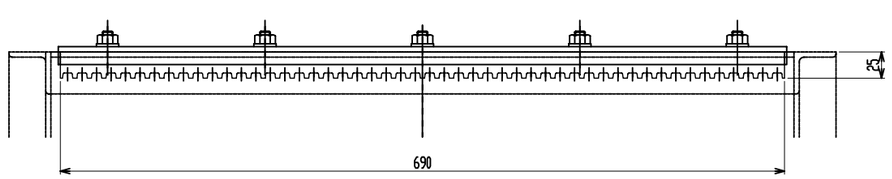
NO.		DRWG.NO.	NAME	MATL.	SPEC.	G1	G2	G3
1	1	SS-08-004	Assembly			0		
2	3	07-029-017	Element Stopper(U)	SUS304		2		
3	3	07-029-016	Gasket	EPDM		2		
4	3	SS-07-118	Gasket(UE1)	EPDM		2		
5	3	SS-08-013	Gasket(UM)	EPDM		1		
6			Blank					
7	3	07-029-018-01	S Bracket(U)	SUS304		1		
8	3	07-029-018-02	S Bracket(U)	SUS304		1		
9	3	SS-08-014	S Support	SUS304		1		
10	3	SS-08-015	S Plate	SUS304		1		
11			Blank					
12			Blank					
13			Blank					
14			Blank					
15			Blank					
16			Hexagon Head Bolts	SUS304	M8×30	6		
17			Hexagon Head Bolts	SUS304	M8×20	6		
18			Spring Washers	SUS304	M8	12		
19			Plain Washers	SUS304	M8	12		
20			Hexagon nuts	SUS304	M8	8		
21			Hexagon Head Bolts	SUS304	M10×30	10		
22			Spring Washers	SUS304	M10	10		
23			Plain Washers	SUS304	M10	10		
24			Hexagon nuts	SUS304	M10	20		
25								







SectionA-A



SectionB-B

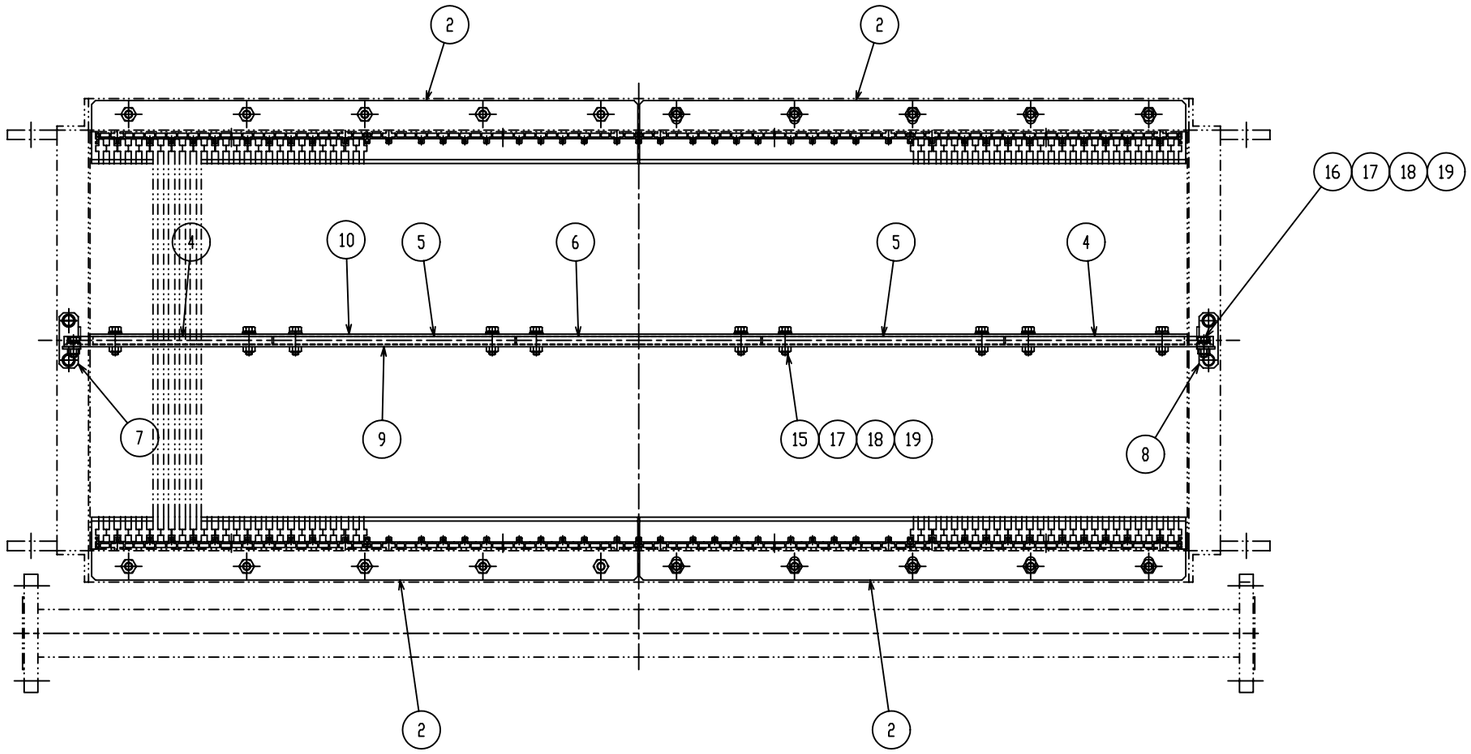
1

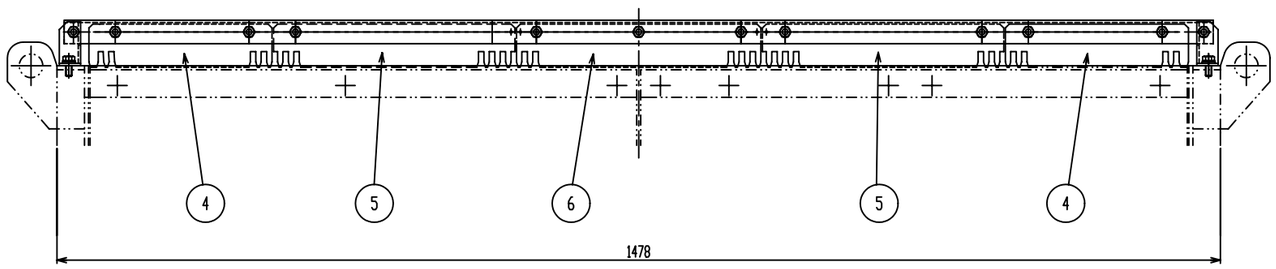
A-1

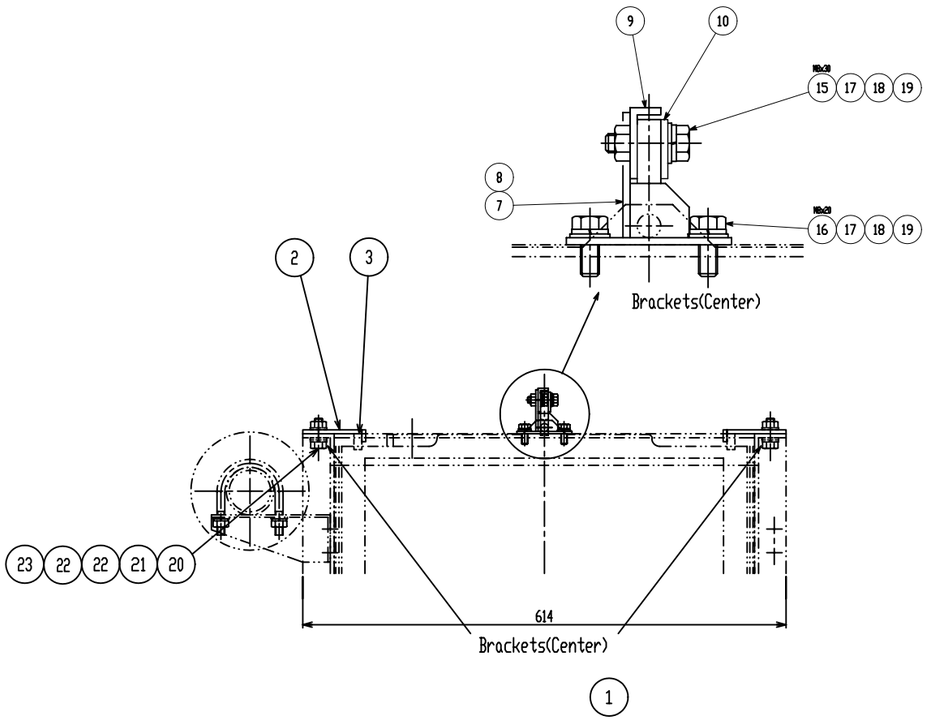
APPROVED	TORAY INDUSTRIES, INC. 'TORAY'			MATL.
PROJECT MANAGER				DRWG.Name. Assembly of Brackets
MECHANICAL				TMR090-050S
INSTRUMENTAL	SCALE 1/3	DATE '08-11-24		ORDER No.
ELECTRICAL	DRAWN F.NAGATA	DESIGNED Y.TANAKA		DRWG.No. SS-08-004 REV. ◇
ENG.DEPT MANAGER	CHECKED	APPROVED Y.TANAKA		ISSUED TO

LET	REVISION	DATE	BY	APPROVED

REF.DWG.NO.	TITLE OF REF.DWG.







NO.	DRWG.NO.	NAME	MATL.	SPEC.	G1	G2	G3
1	1 07-029-002	Assembly			0		
2	3 07-029-017	Element Stopper(U)	SUS304		4		
3	3 07-029-016	Gasket	EPDM		4		
4	3 SS-07-118	Gasket(UE)	EPDM		2		
5	3 SS-07-119	Gasket(UM1)	EPDM		2		
6	3 SS-07-120	Gasket(UM2)	EPDM		1		
7	3 07-029-018-01	S Bracket(U)	SUS304		1		
8	3 07-029-018-02	S Bracket(U)	SUS304		1		
9	3 SS-07-126	S Support	SUS304		1		
10	3 07-029-019	S Plate	SUS304				
11		Blank					
12		Blank					
13		Blank					
14		Blank					
15		Hexagon Head Bolts	SUS304	M8x30	10		
16		Hexagon Head Bolts	SUS304	M8x20	6		
17		Spring Washers	SUS304	M8	16		
18		Plain Washers	SUS304	M8	16		
19		Hexagon nuts	SUS304	M8	16		
20		Hexagon Head Bolts	SUS304	M10x30	20		
21		Spring Washers	SUS304	M10	20		
22		Plain Washers	SUS304	M10	40		
23		Hexagon nuts	SUS304	M10	20		
24							
25							

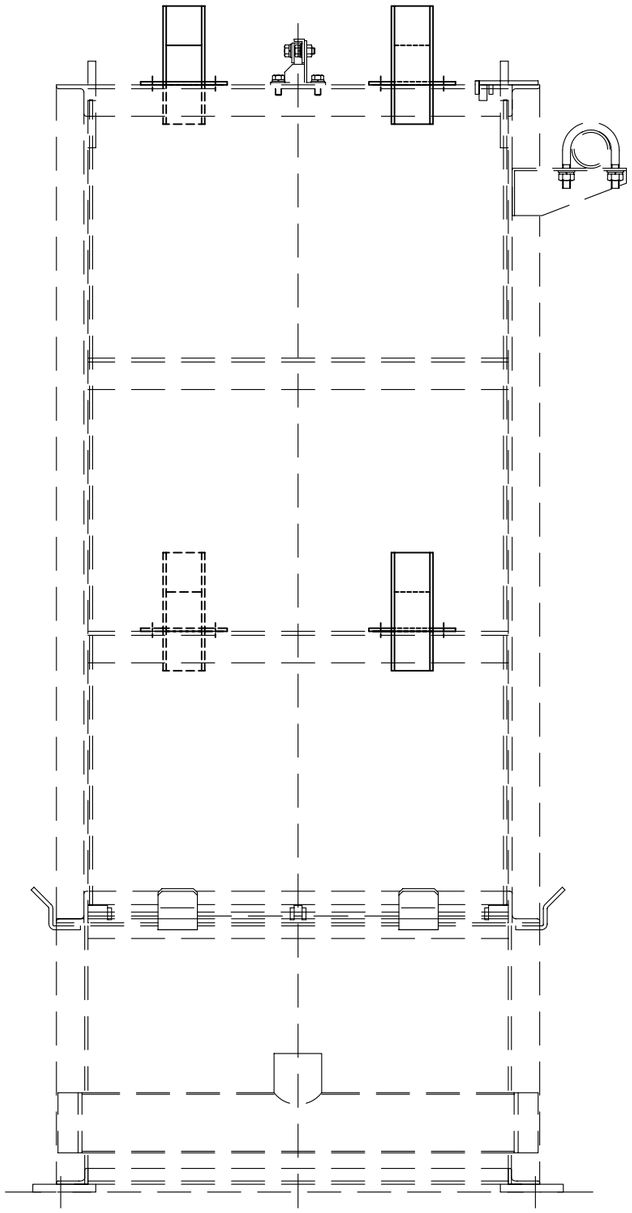
REF.DWG.NO.	TITLE OF REF.DWG.

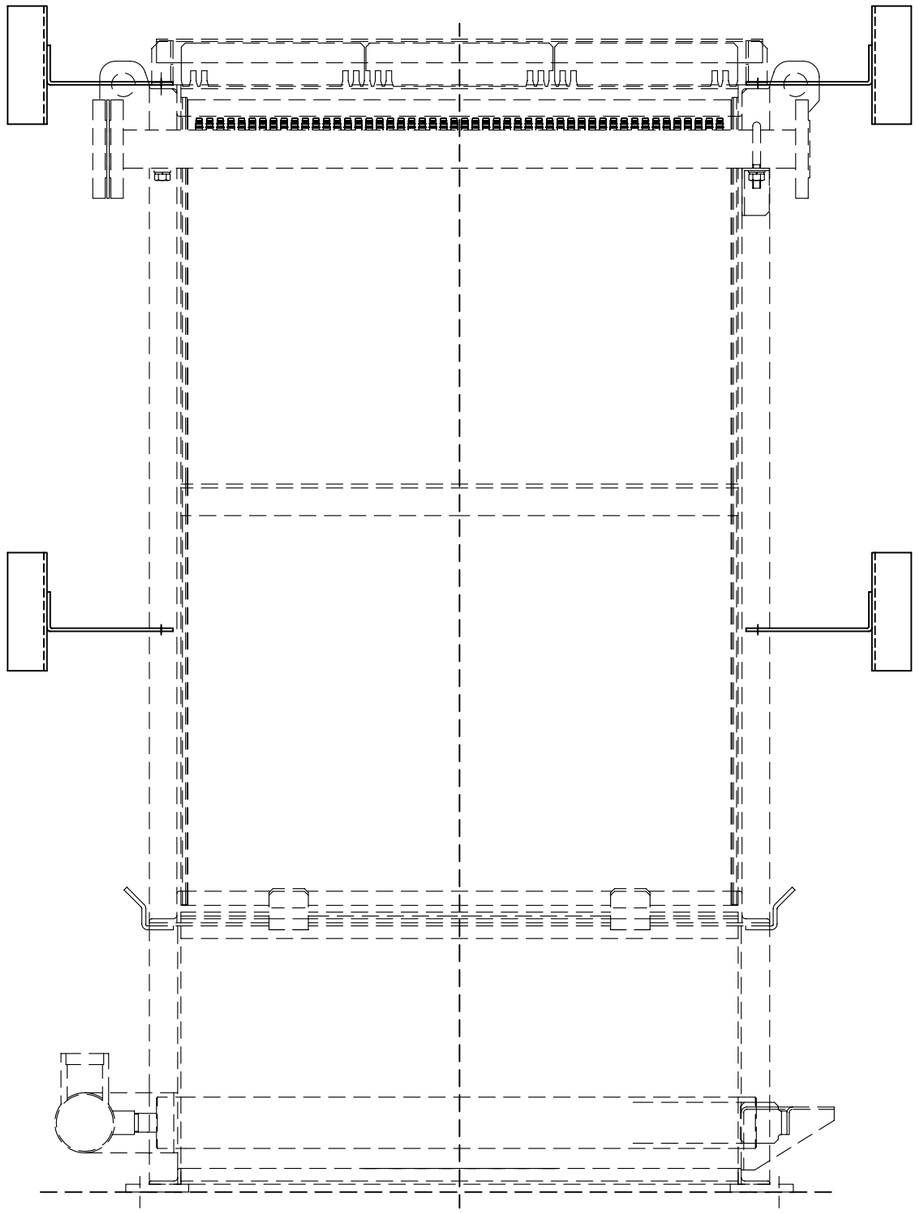
LET	REVISION	DATE	BY	APPROVED

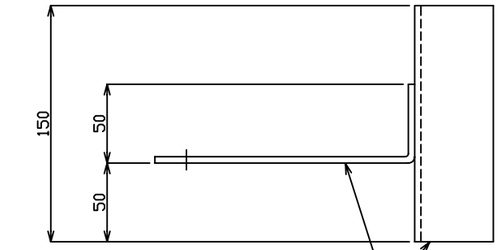
APPROVED	TORAY INDUSTRIES, INC. 'TORAY'			MATL.
PROJECT MANAGER				DRWG.Name. Assembly of Bracket
MECHANICAL				TMR090-100S
INSTRUMENTAL	SCALE 1/4	DATE 02/02/'08		ORDER No.
ELECTRICAL	DRAWN F.NAGATA	DESIGNED Y.□□DAKA		DRWG.No. 07-029-002 REV. ◇0
ENG.DEPT MANAGER	CHECKED	APPROVED Y.TANAKA		ISSUED TO

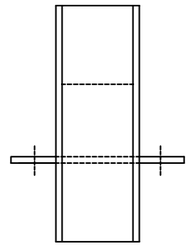
A-1

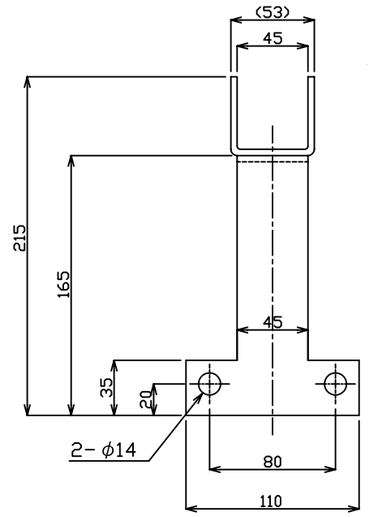
NO.	DRWG.NO.	NAME	MATL.	SPEC.	G1	G2	G3











guide(s=1/2)

REF.DWG.NO.	TITLE OF REF.DWG.

LET	REVISION	DATE	BY	APPROVED

APPROVED	
PROJECT MANAGER	
MECHANICAL	
INSTRUMENTAL	
ELECTRICAL	
ENG.DEPT MANAGER	

TORAY INDUSTRIES, INC.
"TORAY"

SCALE	1/4	DATE	29/06/'09
DRAWN	Y.TANAKA	DESIGNED	Y.TANAKA
CHECKED		APPROVED	Y.TANAKA

MATL.

DRWG.Name.
Ass'y of Guides
TMR090-050S

ORDER No.

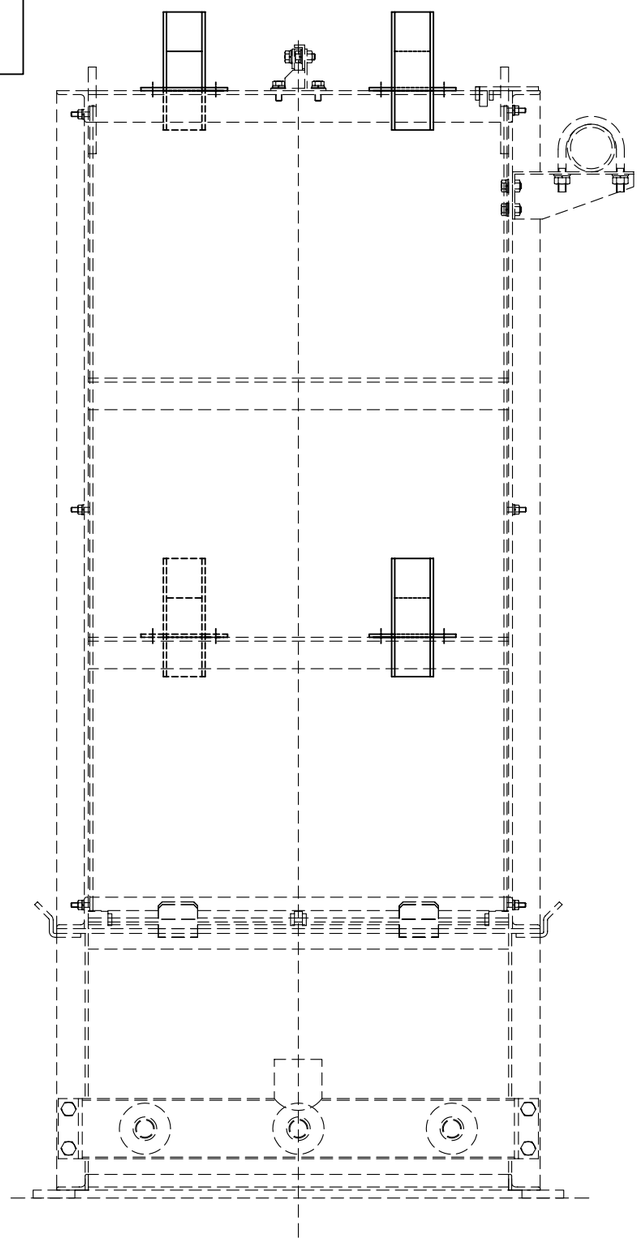
DRWG.No.
SS-08-033

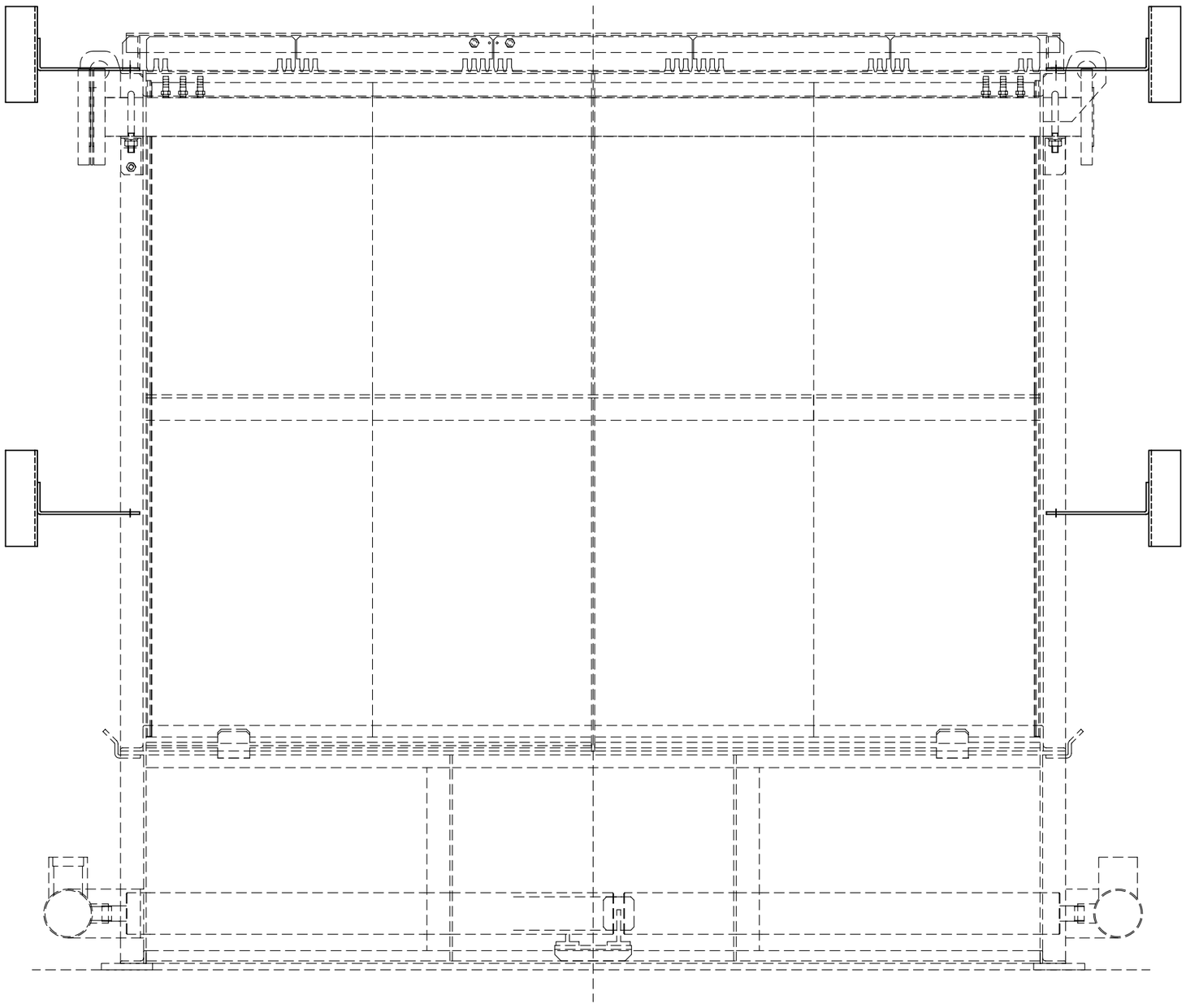
REV. ◇

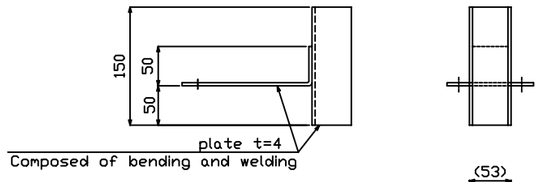
ISSUED TO

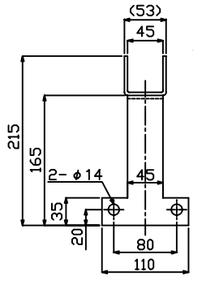
A-1

NO.	DRWG.NO.	NAME	MATL.	SPEC.	G1	G2	G3









guide

REF.DWG.NO.	TITLE OF REF.DWG.

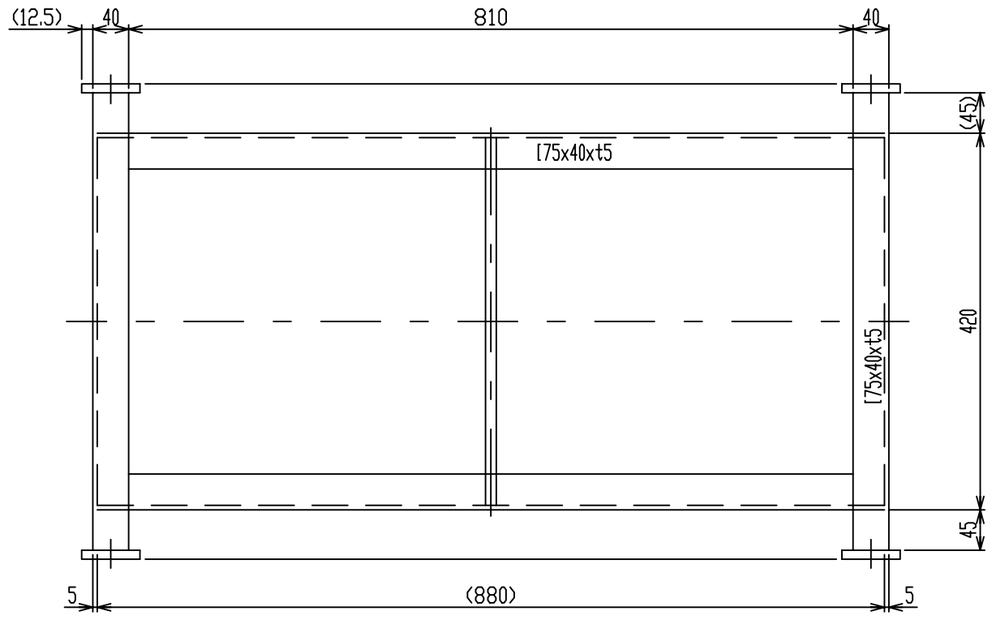
LET	REVISION	DATE	BY	APPROVED

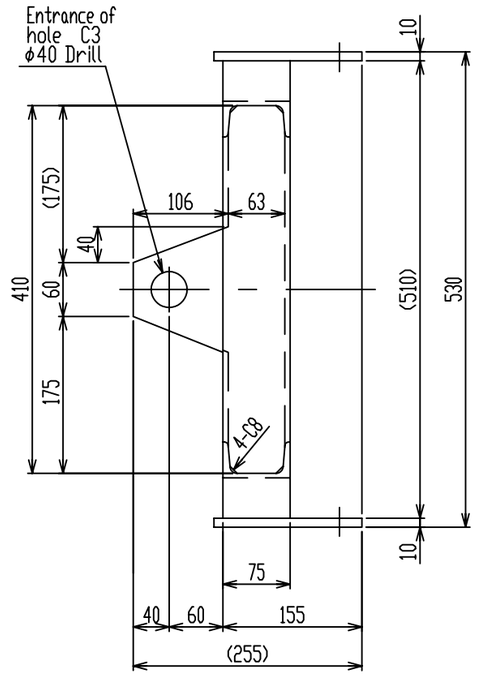
APPROVED	TORAY INDUSTRIES, INC.				MATL.
PROJECT MANAGER	'TORAY'				DRWG.Name. Ass'y of Guides
MECHANICAL					TMR090-100S
INSTRUMENTAL	SCALE 1/4	DATE 29/06/'09			
ELECTRICAL	DRAWN Y.TANAKA	DESIGNED Y.TANAKA			ORDER No.
ENG.DEPT MANAGER	CHECKED	APPROVED Y.TANAKA			DRWG.No. SS-008-034 REV. ◊

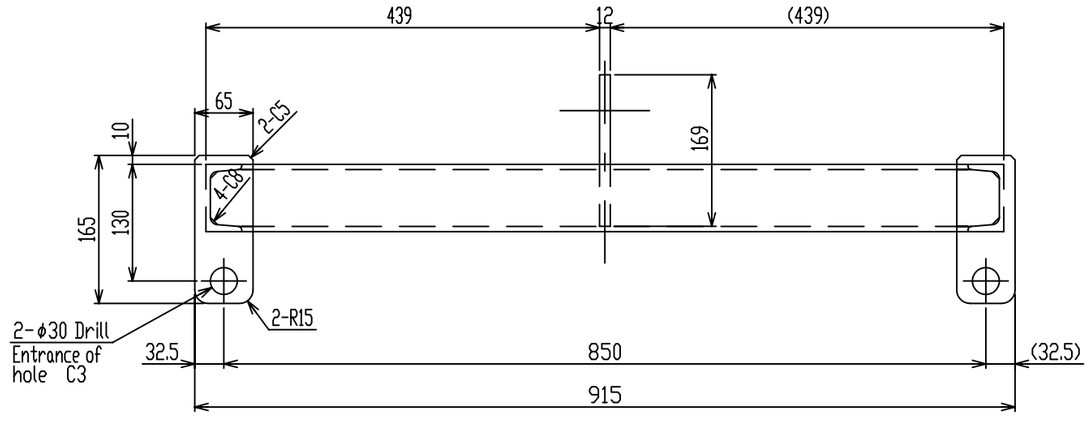
A-1

ISSUED TO

NO.	DRWG.NO.	NAME	MATL.	SPEC.	G1	G2	G3	G4







(1) ~

1.Composed of Welding
2.with ▽5 to be weld unless direction
3.Welding Surface to be smooth with G finish
4.Welded parts to be washed with acid
5.All Corner Chamfering C0.2~0.3

A-2

REF.DWG.NO.	TITLE OF REF.DWG.

LET	REVISION	DATE	BY	APPROVED

APPROVED
PROJECT MANAGER
MECHANICAL
INSTRUMENTAL
ELECTRICAL
ENG.DEPT MANAGER

TORAY INDUSTRIES, INC.
MF & UF Membrane Products Dept.
'TORAY'

SCALE	1/5	DATE	28/06/'09
DRAWN	Y.TANAKA	DESIGNED	Y.TANAKA
CHECKED		APPROVED	Y.TANAKA

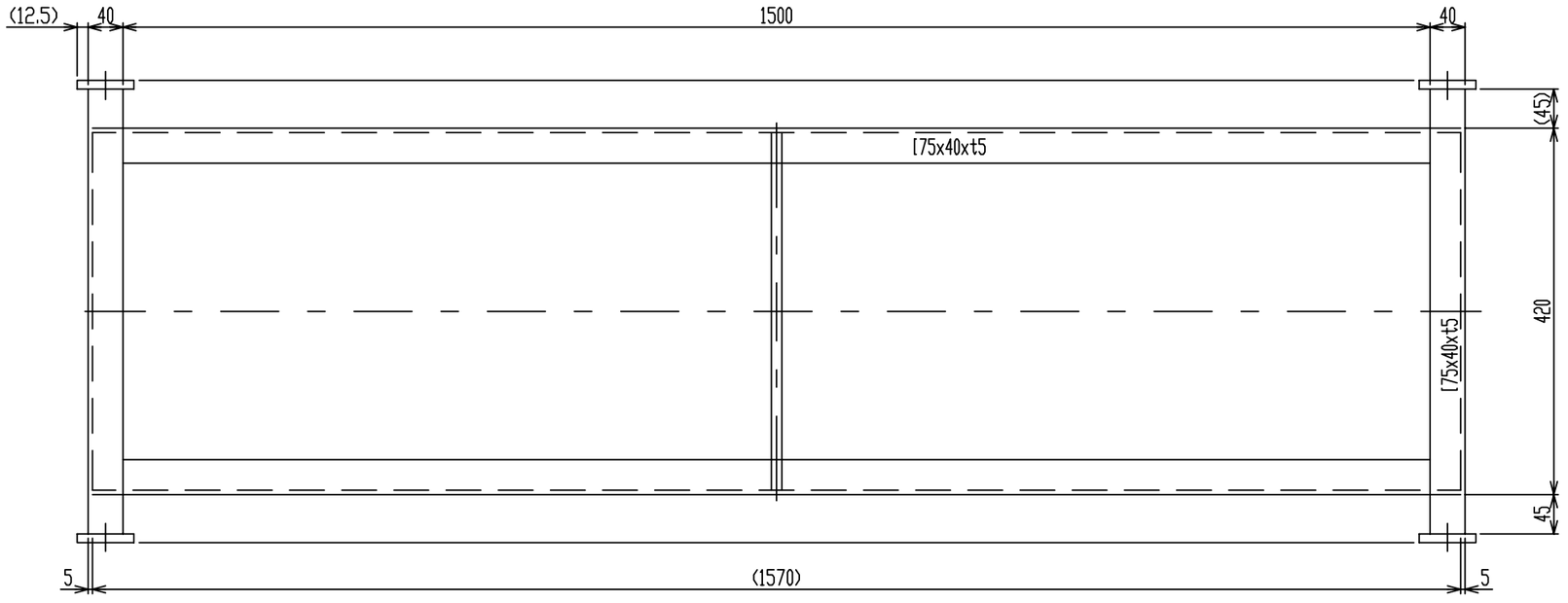
MATL. Rolled Steel for General Structure (JIS G 3192,JIS G 3193 or these equivalent)

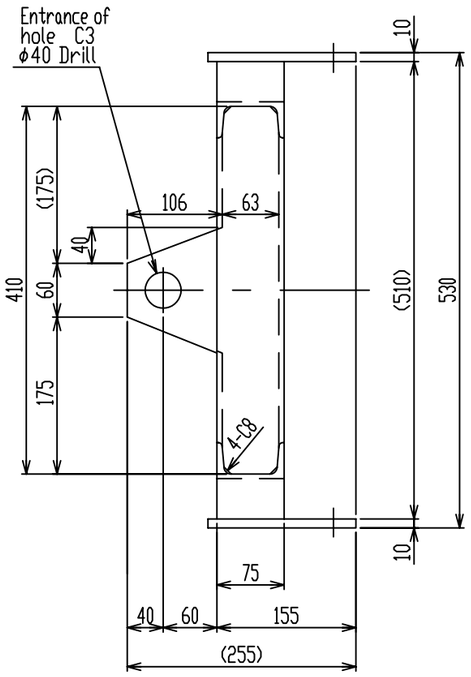
DRWG.Name.
MEMBRAY Hanger
TMR090-050S

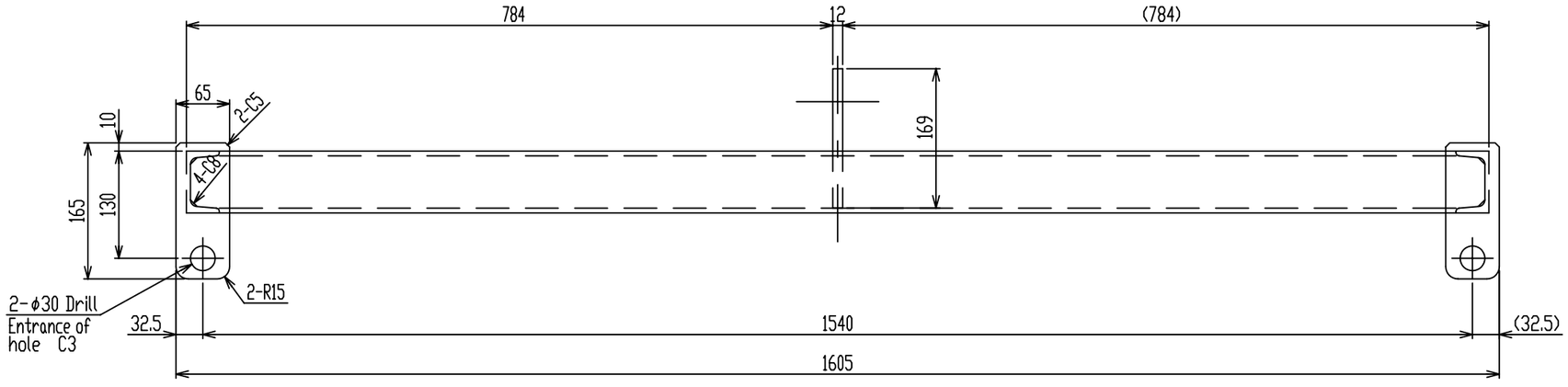
ORDER No.	DRWG.No.	REV.
	SS-08-031	0

ISSUED TO

NO.	DRWG.NO.	NAME	MATL.	SPEC.	G1	G2	G3	G4







(1)

1.Composed of Welding
2.with 5 to be weld unless direction
3.Welding Surface to be smooth with G finish
4.Welded parts to be washed with acid
5.All Corner Chamfering C0.2~0.3

A-2

REF.DWG.NO.	TITLE OF REF.DWG.

LET	REVISION	DATE	BY	APPROVED

APPROVED
PROJECT MANAGER
MECHANICAL
INSTRUMENTAL
ELECTRICAL
ENG.DEPT MANAGER

TORAY INDUSTRIES, INC.
MF & UF Membrane Products Dept.
'TORAY'

SCALE	1/5	DATE	28/06/'09
DRAWN	Y.TANAKA	DESIGNED	Y.TANAKA
CHECKED		APPROVED	Y.TANAKA

MATL. Rolled Steel for General Structure (JIS G 3192,JIS G 3193 or these equivalent)

DRWG.Name. MEMBRAY Hanger

TMR090-100S

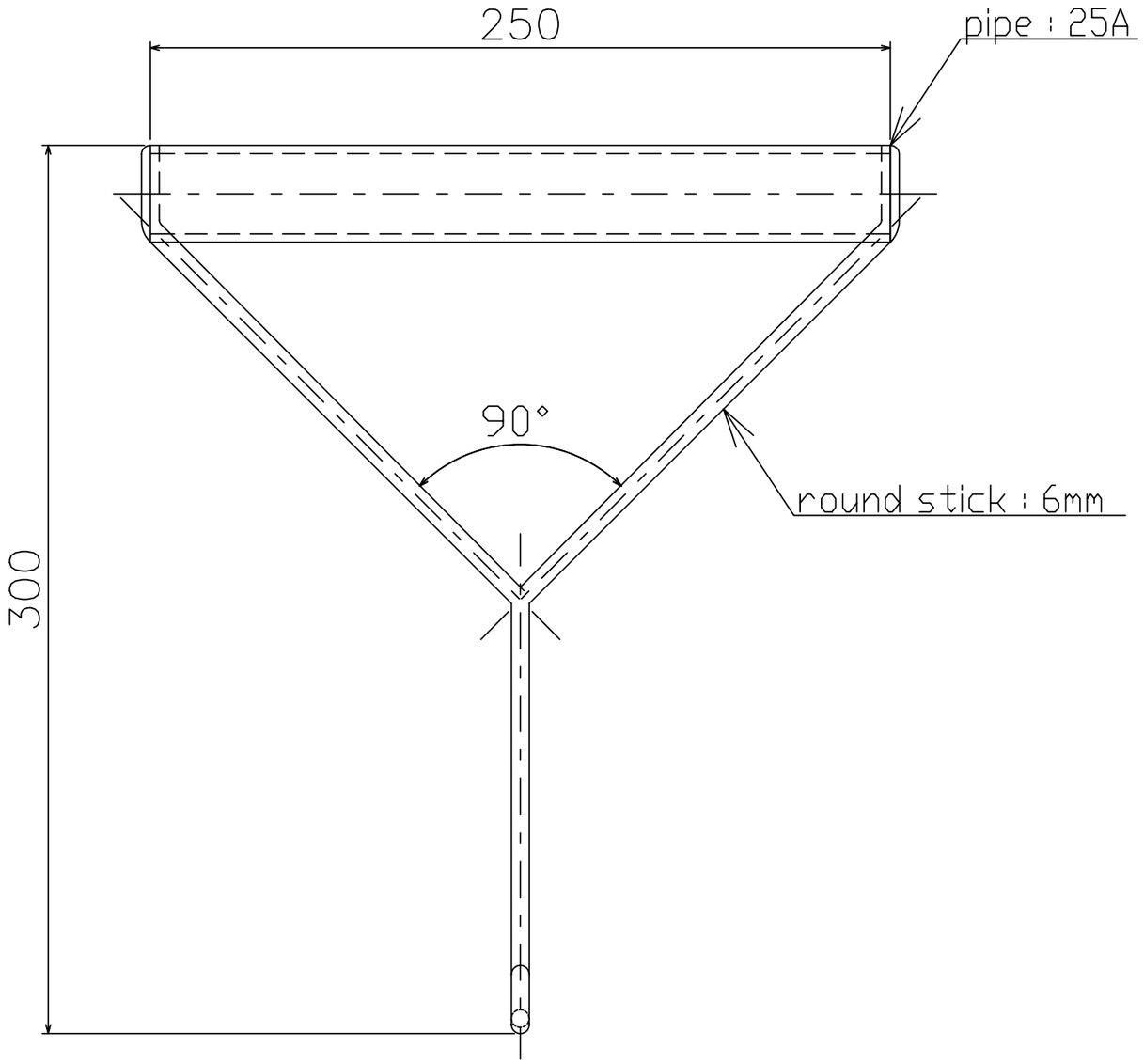
ORDER No.

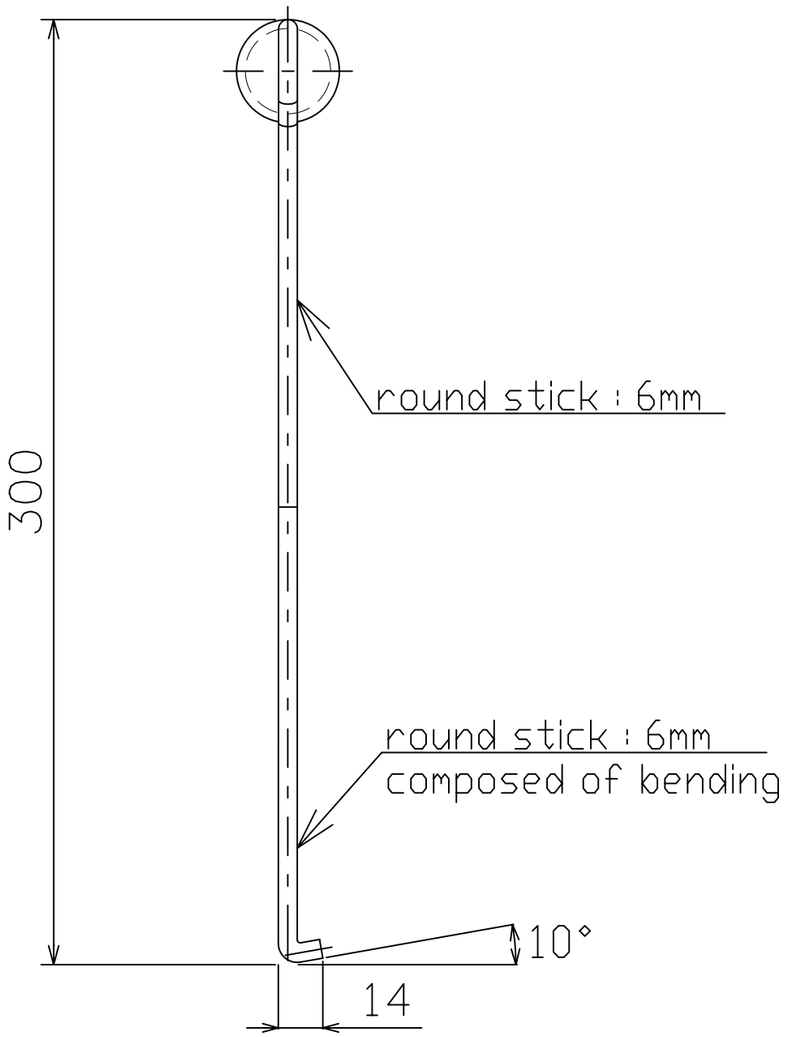
DRWG.No. SS-08-032

REV. 0

ISSUED TO

NO.	DRWG NO.	NAME	MATL.	SPEC.	G1	G2	G3





REF.DWG.NO.	TITLE OF REF.DWG.

LET	REVISION	DATE	BY	APPROVED

APPROVED
PROJECT MANAGER
MECHANICAL
INSTRUMENTAL
ELECTRICAL
ENG.DEPT MANAGER

TORAY INDUSTRIES, INC.
"TORAY"

SCALE	1/1	DATE	29/06/'09
DRAWN	Y.TANAKA	DESIGNED	Y.TANAKA
CHECKED	Y.TANAKA	APPROVED	Y.TANAKA

MATL.

DRWG.Name.
taking out tool
TMR090-050S / TMR090-100S

ORDER No.

DRWG.No. SS-08-035

REV. 1

ISSUED TO

A-1

December 13th, 2011

The paper filtration test measurement procedure

1. Make a filter paper folded (Fig 1).Use filter paper equivalent to No.5C which has a diameter of 185mm (See below tables for reference.)

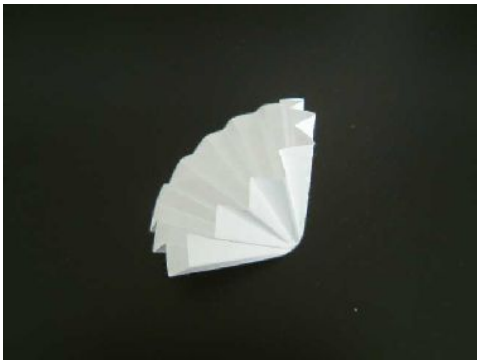


Fig 1. Filter paper folded

2. Set the filter paper onto a funnel.
3. Prepare 50mL of activated sludge in a measuring cylinder.
4. Pour 50mL of the sludge into the filter paper, and start measuring filtration time.
5. After 5 minutes, check the filtration volume.

   <Criteria>

   More than 10 mL: Good filterability

   5~10 mL: Subtle

   Less than 5 mL: Bad filterability
6. Additionally it is advisable to check the turbidity and/or TOC (Total Organic Carbon) of the filtrated water which can be an indicator of membrane foulant such as so-called EPC. Measure it routinely and check its trend.

Standards of filter paper

Used by TORAY	JIS P 3801	ASTM E832-81
No.5C	5C	ClassG

Typical specifications of the filter paper

	No.5C
Mass (g/m^2)	118
Thickness (mm)	0.22
Permeated particle size (μm)	1
Catching efficiency (0.3 μmDOP%)	93
Ash (%)	0.01