Submerged Membrane Module
for MBR
TORAY “MEMBRAY”

“TMR140 Series”
Instruction Manual

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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

TORAY "MEMBRAY" is the submerged membrane module suitable for the membrane bioreactor (MBR) that has been developed based on the polymer science and the membrane fabrication technologies accumulated for a long time in Toray Industries, Inc. "TMR140 Series" is a standard model of "MEMBRAY". This manual explains MBR's features and describes the specifications of "TMR140 Series" and its safe operations including installation, operation, maintenance procedures and peripheral equipments. Operators should thoroughly read this manual to ensure stable operation.

1. Features of MBR

The process flow of the conventional activated sludge method (ASM) and MBR are shown in Fig.I-1 and Fig.I-2, respectively. Unlike ASM, which employs the sedimentation tank, MBR separates sludge with membranes. MBR provide the following advantages:

(1) Small Footprint

In the case of MBR, the biological treatment can be operated at higher MLSS, so the aeration tank is reduced. And MBR does not need a sedimentation tank. As a result, MBR provides smaller footprint of the plant.

(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.

![Fig. I-1  ASM Flow](image1)

![Fig. I-2  MBR Flow](image2)
2. Outline of “TMR140 Series”

TMR140 Series is the membrane module composed of the element block and the aeration block. The element block contains a number of membrane elements stacked at equal clearance, each of which has flat sheet membranes attached on both sides of ABS panel. Each element is connected via polyurethane tube to the permeated water manifold. The aeration block consists of coarse-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 “TMR140 Series”.

![Diagram of TMR140 Series](image)

**Fig. I-3  Appearance of “TMR140-100S”**
(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, thanks to the long element design (1.6 m), a larger membrane area is achieved per footprint, allowing effective use of diffused air.

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 an outstanding high treated water quality and an 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)

![Membrane Surface (photo)](image)

3.0 micron

Fig. I-7  Pore Size Distribution

![Pore Size Distribution](image)
II. FOR SAFE OPERATION OF “TMR140 Series”

Before using “TMR140 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 “TMR140 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 "TMR140 Series" or its part.

- **DANGER**: When installing “TMR140 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 "TMR140 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 "TMR140 Series" for hours in the place where the temperature is higher than 40 degree C or in the place exposed to direct sunlight. Especially ABS supporting panel may be deteriorated with direct sunlight, ultraviolet ray.

- **CAUTION**: Please take adequate measures to protect “TMR140 Series” from sparks caused by welding, fusion cutting or grinding throughout the entire process from installation work to operation startup.

- **CAUTION**: Please protect “TMR140 Series” from freezing at any time.

- **CAUTION**: Please don't pressurize the permeate side of “TMR140 Series”.

- **CAUTION**: Please install the screen with openings of 3.0 mm or under before "TMR140 Series" or the membranes might be polluted and clogged severely with foreign substances brought with the raw water.
## 2. Operation and Maintenance

| WARNING | Don't use permeated 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 tank 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 | ABS supporting panel may get chemical cracks by some organic solvent, such as alcohols and oils, and some synthetic detergents. So don't make ABS panel contact such materials. |
| 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. |
Prevent “TMR140 Series” from freezing at any time.

Please take care not to dry the membranes when taking “TMR140 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.

Please stop the scouring air when the filtration operation stops. In the case of applying the relaxation operation for the filtration, it is not required to stop the scouring air for each relaxation period.

3. Chemical Cleaning of Element

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.

If the chemical agents stick to your skin or clothes, immediately wash it away with enough amount of running water.

If the chemical agents enter your eyes, immediately wash it away with enough amount of running water and see the doctor.

If any abnormality is found in the equipment during chemical cleaning, immediately stop operation and check it.

Don't inject the chemical agents directly from the chemical feed pump to the elements at the chemical cleaning, or the internal pressure of the elements may increase and, the elements may be damaged. Be sure to inject the chemical agents by gravity with less than 10kPa.
| **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 500 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 heavy metals or acids. In particular, toxic chlorine gas is generated when mixing sodium hypochlorite and acids. |
| **WARNING** | Don't mix sodium hypochlorite with oxalic acid or citric acid, or toxic chlorine gas is generated. |
| **CAUTION** | Please stop the scouring air during the chemical cleaning, or the membrane elements might be damaged. |
III. SPECIFICATIONS AND PERFORMANCE OF “TMR140 SERIES”

1. Specifications of Element

Table III-1 and Fig. III-1 shows the specifications and the appearance of the element for TMR140 Series, respectively.

<table>
<thead>
<tr>
<th>Table III-1 Specifications of Element (TSP-50150)</th>
</tr>
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<tbody>
<tr>
<td><strong>Model name</strong></td>
</tr>
<tr>
<td><strong>Membrane configuration</strong></td>
</tr>
<tr>
<td><strong>Application</strong></td>
</tr>
<tr>
<td><strong>Filtration method</strong></td>
</tr>
<tr>
<td><strong>Nominal pore diameter (µm)</strong></td>
</tr>
<tr>
<td><strong>Effective membrane area (m²)</strong></td>
</tr>
<tr>
<td><strong>Dimensions (mm)</strong></td>
</tr>
<tr>
<td>Total width</td>
</tr>
<tr>
<td>Total height</td>
</tr>
<tr>
<td>Thickness</td>
</tr>
<tr>
<td><strong>Weight (kg)</strong></td>
</tr>
<tr>
<td>Dry</td>
</tr>
<tr>
<td>Wet (Reference)</td>
</tr>
<tr>
<td><strong>Main material</strong></td>
</tr>
<tr>
<td>Membrane</td>
</tr>
<tr>
<td>Supporting panel</td>
</tr>
</tbody>
</table>

Fig. III-1 Appearance of Element

2. Specifications of Polyurethane Permeate Tube

Table III-2 shows the specifications of Tube.

<table>
<thead>
<tr>
<th>Table III-2 Specifications of Polyurethane Permeate Tube</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Material</strong></td>
</tr>
<tr>
<td><strong>Inside diameter / outside diameter / total length (mm)</strong></td>
</tr>
</tbody>
</table>

*Allowable temperature limit: 60 degree C
*1 The material name due to the ISO-18064.
### 3. Specifications and Performance of “TMR140 Series” Module

Table III-3 shows the specifications of “TMR140 Series” modules.

<table>
<thead>
<tr>
<th>Table III-3 Specifications of Module</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model name</strong></td>
</tr>
<tr>
<td>Number of membrane elements</td>
</tr>
<tr>
<td>Element block structure</td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
</tr>
<tr>
<td>Height (mm)</td>
</tr>
<tr>
<td><strong>Weight (kg)</strong></td>
</tr>
<tr>
<td>Aeration block (dry)</td>
</tr>
<tr>
<td>Element block (dry)</td>
</tr>
<tr>
<td>Element block (sludge clogging)12</td>
</tr>
<tr>
<td>Material</td>
</tr>
<tr>
<td>Connection flange3</td>
</tr>
<tr>
<td>Air diffuser</td>
</tr>
<tr>
<td><strong>Operating Range</strong></td>
</tr>
<tr>
<td>pH4 of liquid</td>
</tr>
<tr>
<td>MLSS (mg/L)</td>
</tr>
<tr>
<td>Trans-membrane pressure (kPa)</td>
</tr>
<tr>
<td>Cleaning chemicals feed pressure (kPa)</td>
</tr>
<tr>
<td>Cleaning chemicals and chemicals concentration</td>
</tr>
<tr>
<td>Oxalic acid</td>
</tr>
<tr>
<td>Citric acid</td>
</tr>
<tr>
<td>Scouring Air Flow rate5 (NL/min/Module)</td>
</tr>
</tbody>
</table>

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.
4 Except when the chemical cleaning with the designated chemical agents..
5 The air supply equipments such as blower shall be designed based on the standard operating conditions shown in Table VII-1.
Table III-4 shows the performance of "TMR140 Series" modules.

**Table III-4 “TMR140 Series” Module Performance**

<table>
<thead>
<tr>
<th>Model name</th>
<th>TMR140-050S</th>
<th>TMR140-100S</th>
<th>TMR140-200W</th>
<th>TMR140-200D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permeate water quality(^1)</td>
<td>TSS (mg/L)</td>
<td>Not higher than 3.0</td>
<td>Turbidity (NTU)</td>
<td>Not higher than 1.0</td>
</tr>
<tr>
<td>Filtration capacity(^4)</td>
<td>&lt;Reference&gt;</td>
<td>Quantity of water treated (m³/d)</td>
<td>53</td>
<td>105</td>
</tr>
</tbody>
</table>

*1 This value can be attained when operated under the standard operating conditions as specified in this Instruction Manual during a period specified separately by Toray.
*4 Reference value, not guaranteed, in the case of the treatment of sewage at higher than 15 degree C of the temperature.
IV. MEMBRANE FILTRATION PROCESS DESIGN FOR “TMR140 Series”

The standard filtration pattern time chart, the schematic flow diagram of the membrane filtration, the layout of “TMR140 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 “TMR140 Series”.

1. Standard Time Chart

Two kinds of the filtration patterns are available with “TMR140 Series”. One is the simple continuous filtration. And the other is the filtration with relaxation, that is the intermittent filtration.

In the case of the intermittent filtration, the filtration is suspended 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 would be recommended if you need higher filtration flux. The recommended time cycle for the intermittent filtration is 9-minute filtration and 1-minute suspension.

![Fig.IV-1 Recommended Time Chart for Intermittent Filtration](image)

2. Flow Diagram of Membrane Filtration

Two schematic flow diagrams of the membrane filtration process are shown below. One is for the filtration with natural water head and the other is with suction pump. And some explanation is added for the devices used in the membrane filtration process in the latter part.
of this section.

(1) Filtration with natural water head
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). In order to obtain enough suction pressure for the filtration, the permeate water outlet should be located enough below the liquid level of the membrane submerged tank (normally located at the same level as the bottom of the element block).

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. If the piping climbs over the tank wall, it is required to install a suction pump to build a siphon. It is also recommended to make the pipe just before the permeate water outlet U-shape to seal the piping with water.

![Schematic Flow Diagram for Natural Water Head Filtration](image)

The permeate water flow is controlled with the automatic control valve (the permeate control valve). And this control valve fully closes the permeate water line to stop the filtration when the liquid level of the membrane submerged tank gets to the lower limit. 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.
It is recommended to install enough capacity of the buffer tank (the equalization tank) before the membrane submerged tank to equalize the raw water flow and enable stable operation. In this natural water head 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. If the piping of the permeate water line climbs over the tank wall, it is required to build a siphon by the suction pump after every air purge operation.

(2) Filtration with suction pump
The filtration can be also performed with using the suction pump (see Fig. IV-3).

Fig.IV-3  Schematic Flow Diagram for Pump Suction Operation
The permeate water flow is controlled with the automatic control valve (the permeate control valve). And this control valve fully closes and the suction pump stops to stop the filtration when the liquid level of the membrane submerged tank gets to the lower limit. 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.

It is recommended to install enough capacity of the buffer tank (the equalization tank) before the membrane submerged tank to equalize the raw water flow and enable stable operation.

(3) Devices used for Membrane Filtration

Some devices used in the membrane filtration process are explained below. However some other devices than mentioned below might be required to install case by case for the membrane filtration.

a. Fine screen
The raw water should be treated with 3.0 mm or under openings of the screen before the membrane submerged tank, otherwise the membrane is polluted and clogged with foreign substances seriously. It is recommended to use the mesh type screen.

b. Flow control device
A flow rate controller, an automatic control valve combined with a flow meter, should be installed on the permeate water line to control the flow rate of permeate water. In the case of operating a number of “TMR140 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
The probe of the differential pressure measuring instrument should be installed on the permeate water line and in the membrane submerged tank at the same level, to monitor the trans-membrane pressure. In the case of operating a number of “TMR140 Series” modules simultaneously in one train, it is advised to install one differential pressure measuring instrument for one train of the modules.

d. Air supply unit (such as a blower)
This unit supplies air to the air diffusers of “TMR140 Series” module. The air flow rate supplied to the module should be within the range of “Scouring Air Flow Rate” indicated in Table III-3 at any time.

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 the case of operating a number of “TMR140 Series” modules simultaneously in one train, it is advised to install at least one air
flow meter for one train of the modules.

f. Suction pump
A suction pump is required in the case of the filtration with suction pump. It is advised to use a self-priming suction pump having the necessary pumping head.

g. Level switch
Level switch is required to be installed in the membrane submerged tank to control the liquid level.

⚠️ CAUTION
Please install the screen with openings of 3.0 mm or under before the membrane submerged tank, or the membranes might be polluted and clogged severely with foreign substances brought with the raw water. It is recommended to use the mesh type screen.
3. Layout of “TMR140 Series” Modules in Membrane Submerged Tank

(1) Layout of Modules in Membrane Submerged Tank

Fig.IV-4 shows how the liquid circulates in the membrane submerged tank. An upward flow is generated as the air is supplied from 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 agitates sludge liquid. It is very important to arrange the membrane modules with appropriate distances in order to obtain an effective circulation flow.

Fig.IV-4 and Fig.IV-5 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-4  Membrane Module Layout in Membrane submerged Tank (side view)

Fig.IV-5  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 500 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.
* Please contact us in the case of the undulated floor of the tank. It is recommended to install the modules with stands as shown in Fig.IV-6.

![Fig.IV-6 Installation with Stands (side view)](image)

(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 flange (A). (see Fig.IV-9). It is recommended to install the flange connection (B) above the liquid surface on this pipe line in order to disjoint the piping in the case of lifting the modules. Please install branch pipe and valves for cleaning the air diffuser with air jet from the blower. Please make sure to locate the branch pipe within 500mm above the liquid surface. It is recommended to install the automatic cleaning system with automatic valves. Please see VIII-2 for the procedure of cleaning the air diffusers.

Fig.IV-9  Example of Piping to Air diffusers
(2) Piping to the manifold

Fig.IV-10 and Fig.IV-11 give two examples of leading permeated water from the Membrane Submerged Tank. Fig.IV-10 shows downward piping and Fig.IV-11 shows upward piping. The downward piping is for the operation with natural water head. The upward piping is for the operation with suction pump in the case that the pump is located above the Membrane Submerged Tank.

In both upward and downward piping, 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.
V. Installation of “TMR140 Series”

1. Preparatory Procedure

(1) Make sure the transportation plan for “TMR140 Series” including a carry-in route.
(2) Arrange all necessary equipments for unloading “TMR140 Series” from the truck, such as a cargo crane, a wrecker, and 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.

2. Unloading Products

Unload "TMR140 Series" with a cargo crane, or a wrecker, or a forklift.
Please note the followings for unloading "TMR140 Series".
(1) The element block and the aeration block are separately packed and delivered.
The element block contains a fixed number of membrane elements installed in it.
(2) When lifting "TMR140 Series" (or lifting the element block or the aeration block separately), please set a hook on all hang holes and lift it keeping it horizontal.
Please be careful not to damage element nozzles, air diffusers or other components.
Please ensure safety anytime when doing these operations.

- **DANGER**
  When lifting “TMR140 Series”, please attach chains or slings to it and lift it straight upward calmly to prevent “TMR140 Series” from shaking. Never allow any person under “TMR140 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.

3. Checking Products

Please check the followings soon after carrying in “TMR140 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 "TMR140 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 "TMR140 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.
4. Prevent from immersed in the water.
5. Avoid direct sunlight.

[CAUTION]

Please do not leave "TMR140 Series" for hours in the place where the temperature is higher than 40 degree C or in the place exposed to direct sunlight. Especially ABS supporting panel may be deteriorated with direct sunlight, ultraviolet ray.

[CAUTION]

Protect "TMR140 Series" from freezing.

[CAUTION]

Take adequate measures to protect "TMR140 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 install "TMR140 Series" in the membrane submerged tank with the following steps. Please make sure beforehand that all necessary works in the membrane submerged tank are completed and all waste is removed from the tank, such as concrete clusters, scrapes and mill ends.
Please check the tie-in with the assembly drawings attached at the end of this manual. And please contact us beforehand if you want to install the module in the tank without using anchors (e.g., using guide rails instead).

(1) Installation Modules (on the bottom of the membrane submerged tank using anchors)
Please first install the aeration blocks in the membrane submerged tank using anchors. 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.

(2) Plumbing in Air Diffusers
Prior to plumbing in the air diffusers, please flush all pipes out. The air diffuser should be connected to the pipe from air supply unit with the flanges. After plumbing in the air diffusers, please charge the membrane submerged tank with clean water until the aeration blocks are completely submerged in the water, and then supply air to the air diffusers. Please check the air shall be provided evenly for each aeration block and also the air shall be diffused evenly in each aeration block.

(3) Installation Element Blocks
Please take the following steps for each module type and install the element blocks on the aeration blocks:

a. TMR140-050S and 100S
   Please put the element blocks on the aeration blocks and joint both of them using provided bolts.

b. TMR140-200W
   Model "TMR140-200W" consists of two element blocks and one aeration block. Each element block has one manifold and each manifold has one blank flange at one end. Please remove beforehand one blank flange from one of both element blocks which would be an obstacle when jointing those two element blocks. Then, put those two element blocks on the aeration block and joint those element blocks with the aeration block using provided bolts.

c. TMR140-200D
   At first, please put the element block furnished with an intermediate block onto the aeration block, and joint it with the aeration block using provided bolts. And next, please put the other element block on the first element block, and joint it with the other element
block using provided bolts.

(4) Plumbing in Permeate Water Manifold
Please take the following steps for each module type.
The manifold is shipped from the factory with one blank flange furnished at one end. Please connect the manifold to the permeate water line at the other end. 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 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.

a. TMR140-050S and 100S
Please connect one end of the manifold to the permeated water pipe, and leave the other end closed with a blank flange.

b. TMR140-200W
(i) One-side connection
Please loosen the U-bolts on the manifolds, connect one manifold to the other, fasten all U-bolts and check that the manifolds are secured firmly.
And then, connect one end of the joined manifolds to the permeated water pipe. The other end of the manifold should be left closed with a blank flange.
(ii) Two-side connection
Please loosen the U-bolts on the manifolds connect one manifold to the other, fasten all U-bolts and check that the manifolds are secured firmly.
And then, please connect both ends of the joined manifolds to the permeated water pipe.

c. TMR140-200D
Please connect one end of each upper and lower manifold to each upper and lower permeated water line. Please leave the other end closed with a blank flange.

⚠️ DANGER  When lifting “TMR140 Series”, please attach chains or slings to it and lift it straight upward calmly to prevent “TMR140 Series” from shaking. Never allow any person under “TMR140 Series”.  

AIRE-064-1-4
Use chains or slings compatible with lifting weight.

Never climb the module.
Please set up the foothold when installation.
Use protective equipments to ensure the safety.

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:

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

b. Check that the element block is secured on the aeration block.

c. Check that the membrane submerged tank has been cleaned up completely and then remove the protective cover. The presence of soil and dust may cause damages to the module.

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

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

f. Close the air discharge valve.

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. When using only one blower to achieve air diffusion for two or more modules, check that the required amount of air is evenly supplied to each module. Otherwise, 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 that membrane get dried up, the permeability may be decreased seriously. |

2. Seeding Sludge Injection

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

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

1. Get the activated sludge used for the treatment of same kind of wastewater. It is recommended that its MLSS is higher than 20,000 mg/L.
2. Remove foreign matters from the sludge with the mesh screen which opening is 5.0 mm or under and inject it to the tank.
3. The amount of sludge injected should be adjusted to make MLSS of the membrane submerged tank higher than 7,000 mg/L. Please start feed the raw wastewater soon after the sludge injection.
   * Do not use seeding agents.

| CAUTION | Remove foreign matters from the seeding sludge with the mesh screen which opening is 5.0 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. 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 “TMR140 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”

The operating conditions may change from this standard conditions, depending on the characteristics of the sludge, the raw water quality and/or other given operating circumstances.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Operating condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLSS</td>
<td>mg/L</td>
<td>7,000-18,000</td>
</tr>
<tr>
<td>Sludge viscosity*</td>
<td>mPa·s</td>
<td>Not higher than 250</td>
</tr>
<tr>
<td>DO</td>
<td>mg/L</td>
<td>1.0 or more</td>
</tr>
<tr>
<td>pH</td>
<td>-</td>
<td>6-8</td>
</tr>
<tr>
<td>Liquid Temperature</td>
<td>degree C</td>
<td>15 - 40</td>
</tr>
<tr>
<td>Continuous Average Filtration Flux</td>
<td>m³/m²/d</td>
<td>0.75 or less</td>
</tr>
<tr>
<td>Scouring Air Flow Rate</td>
<td>NL/min/Module</td>
<td></td>
</tr>
<tr>
<td>TMR140-50S</td>
<td></td>
<td>650</td>
</tr>
<tr>
<td>TMR140-100S</td>
<td></td>
<td>1300</td>
</tr>
<tr>
<td>TMR140-200W</td>
<td></td>
<td>2600</td>
</tr>
<tr>
<td>TMR140-200D</td>
<td></td>
<td>1500</td>
</tr>
</tbody>
</table>

*Measured by C-type viscometer

**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 | ABS supporting panel may get chemical cracks by some organic solvent, such as alcohols and oils, and some synthetic detergents. So don't make ABS panel contact such materials. |
| 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 “TMR140 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 “TMR140 Series”.

The following shows the operating parameters for the operation of “TMR140 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)
3. Daily Inspection

There are three key items for the stable operation without troubles, those are the trans-membrane pressure, the diffused air conditions and the biological treatment situation. For the control parameters listed in the preceding section, perform inspection as follows:

(1) Trans-membrane pressure
Please check that the trans-membrane pressure is stable. A sudden increase in the trans-membrane pressure suggests the membrane clogging, caused by abnormal diffused air condition or deteriorating sludge properties. In such an event, check the following items and take necessary actions, such as chemical cleaning of the elements.

(2) Diffused air conditions
Please check that the fixed amount of diffused air is supplied and that the air is diffused evenly in the module. Deviation in the scouring air flow rate from the fixed value or uneven diffusion may cause the membrane clogging. 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 fix the leakage, correct valve situation, adjust the blower condition and adjust the scouring air flow rate.

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) Color and smell of activated sludge
In general, the activated sludge suitable for the wastewater treatment should be brownish-red, coagulable and free from odor. If the sludge appears failing to meet these requirements, then measure its MLSS, viscosity, DO, pH, temperature and BOD load. Please take appropriate actions, such as additional injection of seeding sludge, if necessary.

(4) MLSS
MLSS in the membrane submerged tank is normally 7,000 to 18,000 mg/L. If MLSS is too low, please add seeding sludge or stop excess sludge discharge. If MLSS is too high, please increase excess sludge discharge to the sludge storage tank.

(5) Sludge viscosity
It is desirable that the sludge viscosity is not higher than 250 mPa·s. If the sludge viscosity
is too high, please replace the sludge or transfer the sludge to the sludge storage tank until an appropriate viscosity value is attained.

(6) DO
It is desirable that DO value is 1.0 mg/L or more at any point in the membrane submerged tank. If DO is less than 1.0 mg/L, the additional aeration system may be necessary or the raw water flow should be reduced.

(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 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 take corrective measures 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 (i) the liquid-level meter, (ii) the suction pump, and (iii) the trans-membrane pressure, and when necessary, take corrective actions, such as adjusting the control system.
VIII.  Maintenance of “TMR140 Series”

1.  Maintenance Items and Maintenance Frequency

Please perform strictly the following items to maintain “TMR140 Series” in good condition.

(1)  Clean the air diffusers (everyday)
(2)  Chemical cleaning of the element (every 6 months or when the trans-membrane pressure has risen by 5 kPa or more from its initial operating level at the same permeated water flow rate, whichever comes first).
(3)  Replace connection tubes (once in 3 years, or when deteriorated)
(4)  Replace element fixing 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).

*  Be sure to use the specified types of the replacement parts,
*  Please contact us for the detailed specifications and the procurement routes for replacement parts.
*  Insert the tube securely into the foot of the nozzle when replacement.
*  Don't apply excess force to the element and manifold nozzles to prevent damage when replacing permeate tubes or elements.
2. Air Diffuser Cleaning

The clogging of diffuser holes causes uneven air diffusion and membrane clogging, and the elements are broken in the worst case. Please clean the air diffusers at least once a day to prevent such trouble. (it is recommended to install the automatic air diffuser cleaning system with automatic valves).

The air diffusers are cleaned up with the reverse flow of the sludge from the diffuser holes into the diffuser pipes, which is generated by the air jet flow from the blower through the air diffuser pipes to the branch discharge nozzle.

(1) Air diffuser cleaning procedure

(i) Stop filtration.
(ii) Close V1 valve.
(iii) Open V2 valve. At this step, the sludge liquid comes through the diffuser holes into diffuser piping, and is discharged together with the air.
(iv) Keep V2 valve open for about one (1) minute.
(v) Close V2 valve, and then open V1 valve.
(vi) Clean the other line in the same manner as follows.
(vii) Close V3 valve.
(viii) Open V4 valve. At this step, the sludge liquid comes through the diffuser holes into diffuser piping, and is discharged together with the air.
(ix) Keep V4 valve open for about one (1) minute.
(x) Close V4 valve, and then open V3 valve.
(xi) Restart filtration.
3. Chemical Cleaning of Element

Chemical cleaning of element should be conducted when 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. Every 6 months or when the trans-membrane pressure rises by 5 kPa from its initial operating level at the same permeated water flow rate, whichever comes first.

2. If the trans-membrane pressure rises rapidly, please conduct chemical cleaning much earlier. The earlier chemical cleaning is much effective to recover and keep the permeability of the membrane.

3. In the case that the trans-membrane pressure rises by 5kPa within 6 months, it is recommended to observe how many months it takes for the trans-membrane pressure to rise by 5kPa and conduct chemical cleaning periodically. This measure is effective to prolong the life of membranes.

4. Chemical Agents Available 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 VIII-1 shows suitable chemicals and standard cleaning conditions.

| Table VIII-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) <br> (pH is about 12) | 5 L/element | 1 to 3 hours |
| Inorganic matter | Oxalic acid                     | 0.5-1.0wt%            | 5 L/element | 1 to 3 hours |
| Inorganic matter | Citric acid                     | 1-3wt%                | 5 L/element | 1 to 3 hours |
5. Handling of Chemical Agents

The chemical agents used for chemical cleaning are harmful to the health when in contact with the skin. When handling 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 should get into 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 / HOOCCH₂C(OH)(COOH)CH₂COOH

(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.
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.

If chemicals should stick to your skin or clothes, immediately wash it away with a large amount of running water.

If chemicals should enter an eye, immediately wash it away with a large amount of running water and see the doctor.

Store chemicals in a dark, cold place free from direct sunlight.

Use the chemicals storage tanks made of the material suitable for each chemical to prevent corrosion.

Never mix sodium hypochlorite with heavy metals or acids. The mixture with an acid generates toxic chlorine gas.

Never mix sodium hypochlorite with oxalic acid or citric acid. Such mixture generates toxic chlorine gas.
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. Please use a natural water head to inject the chemical, as 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.

![Fig.VIII-1 Chemical Cleaning with Chemical Tank Located at Bottom](image-url)
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.

Fig.VIII-2  Chemical Cleaning with Chemical Tank Located above Membrane Submerged Tank
(2) Precautions for Element Chemical Cleaning

a. Inject chemical by gravity. Keep the gravity pressure below 10kPa. Avoid forcibly applying pressure directly with the pump. A higher pressure will damage elements.

b. Submerge the module completely in the tank and inject chemical. Please maintain the top of the module at least 500 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.

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

- **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 by gravity with the pressure of lower than 10kPa.

- **WARNING**
  Before starting injecting chemical to elements, confirm that the liquid surface is more than 500 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 “TMR140 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. In the case of lifting only the element block, please disconnect the manifold from the permeate water line and disjoint the bolts jointing the element block with the aeration block. If you lift the element block of TMR140-200W, please disconnect one manifold from the other. And you can lift up the element block using chains or slings.

3. In the case of lifting the aeration block along with the element block, please firstly disconnect the manifold from the permeate water line and the air diffuser from the air supply line. Secondly please remove the anchors fixing the aeration block on the tank floor. And you can lift up the aeration block along with the element block using chains or slings.

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

When lifting “TMR140 Series”, please attach chains or slings to it and lift it straight upward calmly to prevent “TMR140 Series” from shaking. Never allow any person under “TMR140 Series”.

Use chains or slings compatible with lifting weight.
## IX. Replacement Parts List

Please contact us for the details of the specifications.

<table>
<thead>
<tr>
<th>Name</th>
<th>Frequency</th>
<th>Type No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>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>element fixing gasket</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TMR140-050S</td>
<td>Middle</td>
<td>GASKET140-050M</td>
</tr>
<tr>
<td></td>
<td>Side</td>
<td>GASKET140-050S</td>
</tr>
<tr>
<td>TMR140-100S</td>
<td>Middle</td>
<td>GASKET140-100M</td>
</tr>
<tr>
<td></td>
<td>Side</td>
<td>GASKET140-100S</td>
</tr>
<tr>
<td>200W 200D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Element</td>
<td>When the specified filtration flux is not gained even after chemical cleaning or when deteriorated</td>
<td>TSP-50150</td>
</tr>
</tbody>
</table>
X. Troubleshooting

Most of troubles in the operation of “TMR140 Series” are related to abnormal air diffusion, increased trans-membrane pressure, decreased permeated water flow rate and bad permeated water quality. The following table shows such troubles and corrective actions against them:

<table>
<thead>
<tr>
<th>Problem</th>
<th>Cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The air diffusion rate is below the standard level.</td>
<td>The blower is broken.</td>
</tr>
<tr>
<td></td>
<td>The air diffusers are clogged.</td>
<td>Clean the air diffusers.</td>
</tr>
<tr>
<td>2</td>
<td>The air diffusion is uneven in the module or between modules.</td>
<td>The air diffusers on the module are clogged.</td>
</tr>
<tr>
<td>3</td>
<td>The permeated water flow rate has decreased. Or the trans-membrane pressure has increased.</td>
<td>Membrane clogging has worsened.</td>
</tr>
<tr>
<td></td>
<td>Sludge accumulated on the membrane surface because of uneven air diffusion</td>
<td>Inspect the blower and clean the air diffusers to improve air diffusion.</td>
</tr>
<tr>
<td></td>
<td>Abnormal properties of sludge have worsened its filterability.</td>
<td>Improve sludge properties.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Prevent entry of abnormal components, such as oils.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Adjust the BOD load.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Adjust the raw water quality (add nitrogen, phosphorous, etc.)</td>
</tr>
<tr>
<td>4</td>
<td>The concentration of suspended solids in the permeate water has increased.</td>
<td>An element or tube has fractured.</td>
</tr>
<tr>
<td></td>
<td>A leakage has occurred in the permeated water piping.</td>
<td>Inspect the faulty part* and correct the fault.</td>
</tr>
<tr>
<td></td>
<td>Germs are generated on the membrane or the permeate line.</td>
<td>To clean the permeated water piping, inject into it a sodium hypochlorite solution with an effective chlorine concentration of 100 to 200 mg/L.</td>
</tr>
</tbody>
</table>

*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.
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