

Instruction Manual for SEPAREL® PF Modules

Hollow Fiber Membrane Module

PF (Internal Perfusion Flow) Series

- PF-001D Series
- PF-004D Series
- PF-015 Series
- PF-030 Series



PF-001D

PF-004D

PF-015

PF-030

Before using the SEPAREL® PF series, be sure to read this instruction manual to ensure safe and proper use.

DIC will not have any liability to a customer or end user in connection with any costs and damages arising directly or indirectly from any defective modules.

We are not responsible for any usage, installation, or any other handling done by the customer. The module must be used, installed, and handled responsibly by the customer.

INSTRUCTION MANUAL

■ About this Instruction Manual

This instruction manual explains how to handle SEPAREL® PF degassing modules, such as the PF-001D, PF-004D, PF-015, and PF-030 series, with precautions to be followed for your safety.

Before using the SEPAREL® PF series, be sure to read this instruction manual to ensure safe and proper use.

Depending on use conditions, proper methods for usage and storage may differ even though there are descriptions about usage methods, storage methods, and risks associated with the product module within this manual.

Please note that this manual does not describe all information about risks related to usage and storage of the product.

Although the content of this instruction manual is based on reliable testing and measurement results, no guarantees are provided for its accuracy.

DIC does not have any responsibility for anything described or not described in this manual.

The details of this instruction manual may be modified for improved reliability of the SEPAREL® PF series or to account for changes in its design.

INSTRUCTION MANUAL

■ Warranty, Warranty Period

【Warranty】

At the time of delivery, DIC warrants that the Separel module will be free from defects in material and workmanship and meet the specifications supplied to the customer by DIC.

【Warranty Period】

The following Warranty Period is applied only if customer use of the Separel module is in accordance with the instructions contained in this manual, the specification sheet and Warranty Statement.

(1) Water

Maximum **12** months from the date of delivery of the module

- This warranty period is applied only if customer refers to P.11, 3-3 (1).
- The above warranty will be voided in the event that water of unspecified quality is used.

(2) Liquids other than water

- Water-Based Liquid : Maximum **12** months from the date of delivery of the module*1
- Non-Water-Based Liquid : Maximum **6** months from the date of delivery of the module*1

***1 The warranty periods shown above are strictly to demonstrate the maximum warranty period available for the modules. Any actual warranty period will be based upon the results of compatibility tests of the module with all liquids which may come in contact with the module. The compatibility testing procedures will be informed to the customer by DIC. It is the customer's responsibility to conduct the compatibility tests and provide the results thereof to DIC. In accordance with the results of the compatibility test, any warranty period will be determined through consultations between DIC and the customer. DIC and the customer will agree in writing to the warranty period, as well as, terms of use for the module ("Warranty Statement").**

If a liquid other than water (2) is used, only several SEPAREL products are applicable—please refer to Table 1 below.

Table 1 Correspondence table

Model	Liquid	
	① Water	② Liquids other than water (Developing solution, Inkjet Inks and so on)*2
PF-001D series	○	○
PF-004D series	○	○
PF-015 series	○	×
PF-030 series	○	×

*2 Limited to liquids for which fluid compatibility has been verified. The PF-F Series listed may also be used for Chemicals and Solvents.

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■ Warranty Remedy

【Warranty Remedy】

During the applicable warranty period as specified in the Warranty Statement, any defective module will be replaced free of charge by DIC in cases where a defect is found under normal use in accordance with this instruction manual and under use and storage conditions specified in the specification sheet and Warranty Statement.

This is the sole remedy available to the customer under this warranty. **DIC will not have any liability to a customer or end user in connection with any costs and damages arising directly or indirectly from any defective modules.**

We are not responsible for any usage, installation, or any other handling done by the customer. The module must be used, installed, and handled responsibly by the customer. **The above warranty will be voided in the event that a liquid which has not been specified for use between the customer and DIC, as specified in the Warranty Statement, is used in the module or by any other use, installation or handling that is not in accordance with the instructions contained in this manual, the specification sheet and Warranty Statement.**

This module is consumable. DIC recommends that customers replace the module within the warranty period.

■ Regarding Reproduction and Photocopying of this Manual

- ◆ Reproduction of this manual in whole or in part is strictly prohibited.
- ◆ The content of this manual are subject to change without notice.
- ◆ SEPAREL® is a registered trademark of the DIC Corporation.

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1. BASIC PRECAUTIONS

- 1-1. Maintain use, handling, and storage conditions described in specifications.
- 1-2. SEPAREL is consumable. We recommend replacement within the warranty period.
- 1-3. We are not responsible for any usage, installation, or other handling done by the customer. Make sure that the product is used, installed, and handled responsibly.
- 1-4. Do not feed the following liquids into SEPAREL—oxidizing agents (highly concentrated chlorine water, ozone water, etc.), strong acids, strong bases, organic solvents, alcohol, oils, or any other liquid which is not compatible with the liquid and materials that SEPAREL modules are composed of.
- 1-5. Do not remove the end-cap of SEPAREL modules..
- 1-6. Do not shake or shock the module.
- 1-7. Protect the module from direct exposure to the sun.
- 1-8. Do not freeze the module.
- 1-9. Strictly maintain the quality of supplied liquid, temperature, and pressure based on the specifications stipulated under the item number for each module.
- 1-10. Refer to the cleaning guidelines before cleaning with

In cases where liquid that has not been deemed compatible by DIC is used, no warranty will apply to the product.

2. UPON RECEIPT

- 2-1. Check the label and shape of the module to confirm that the type and series number are the same as that of which you ordered.
- 2-2. Check whether no damage was sustained during transportation. If you find any damage, notify your sales representative immediately.
- 2-3. Do not physically shock or shake the SEPAREL module during unloading or storage.

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3. Installation

3-1. Place of Installation:

Install SEPAREL in accordance with conditions specified in the specification sheet,

- No exposure to direct sunlight
- No physical shock or shaking
- No contact with dust, moisture, corrosive gas, or liquid
- Easy access for maintenance, inspection, repair, and replacement

3-2. Method of Installation:

- Set the vacuum port downward to smoothly purge liquid derived from vapor.
- If you fix SEPAREL with a U-band, make sure not to loosen the fitting. Do not apply too much pressure when fixing SEPAREL with a U-band as too much pressure may damage the module. Putting a cushion between SEPAREL and U-band may prevent damage to the module.

3-3. Connection of the SEPAREL Module:

- Clean pipe/tube before connecting to prevent/remove dust, rust, oil, etc.
- Do not apply too much pressure to the connection.
- Do not shake or shock the SEPAREL module. Shaking or shocking SEPAREL may damage the module even if it is a light impact.
- Because the housing of the SEPAREL module is composed of PP, polypropylene, excess pressure to the connector may cause damage to the connecting port. Excess pressure to connecting port may shave thread and cause resin particles to appear in the liquid side.
- Do not touch hollow fibers.
- When you add a connector, adjust the insertion depth and not the screw part to touch hollow fibers. If the screw part touches the hollow fibers, the hollow fibers may become damaged.
- Depending on the type of connector, recommended conditions of connector insertion may differ. For detailed conditions, including torque value, contact us.
- The liquid feeding pump is recommended to be placed in front of the SEPAREL module.
- When you uninstall the SEPAREL module, be careful to not damage it.
- If a connecting part is shaped as a tube fitting, insert a tube to a directed depth.

INSTRUCTION MANUAL

3. Installation

1) Liquid In:

- Install security devices, such as a pressure reducing valve and/or safety valve, to make sure that pressure will not be beyond the maximum operating pressure.
- If you use a solenoid valve, select one which does not cause sudden opening/shutting.
- If you use two modules in parallel, properly measure the liquid flow into both modules and ensure that liquid flow is equal.
- If impurities and large particles remain in liquid, install a filter in front of the SEPAREL module.
- Use RO water or higher quality water for the water supply.
 - ▼ In the event water of a water quality lower than RO water is used:
 - ① Please ensure the remaining chloride concentration is, $\leq 1\text{mg/L}$.
 - ※ You can use water with over 1mg/L, but any warranty period will be determined through consultations between DIC and the customer.
 - ② To stop performance degradation by fouling in the film surface and clogging by particle debris, please refer to the following table and use a pre-filter. Specifically, since soluble compounds included in well water, a branch and tap water are easy to penetrate filtration and adhere to the surface of the filtration membrane, please use water in combination with the recommendations in following table. If you have any questions, please contact DIC Corporation.

Liquid in phase	30 micron filter
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- In regard to the shell side, refer to the table below:

Gas in phase	0.2 micron filter: In the case of high purity applications 1.0 micron filter: In the case of general industrial applications
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INSTRUCTION MANUAL

3. Installation

2) Liquid Out:

- There is a possibility that particles are generated by the SEPAREL module. To prevent a problem with such particle occurrence, install a filter behind the module. The most suitable filtration size depends on your use conditions. For more details, please contact DIC.
- Note that back pressure to the SEPAREL module should be avoided.

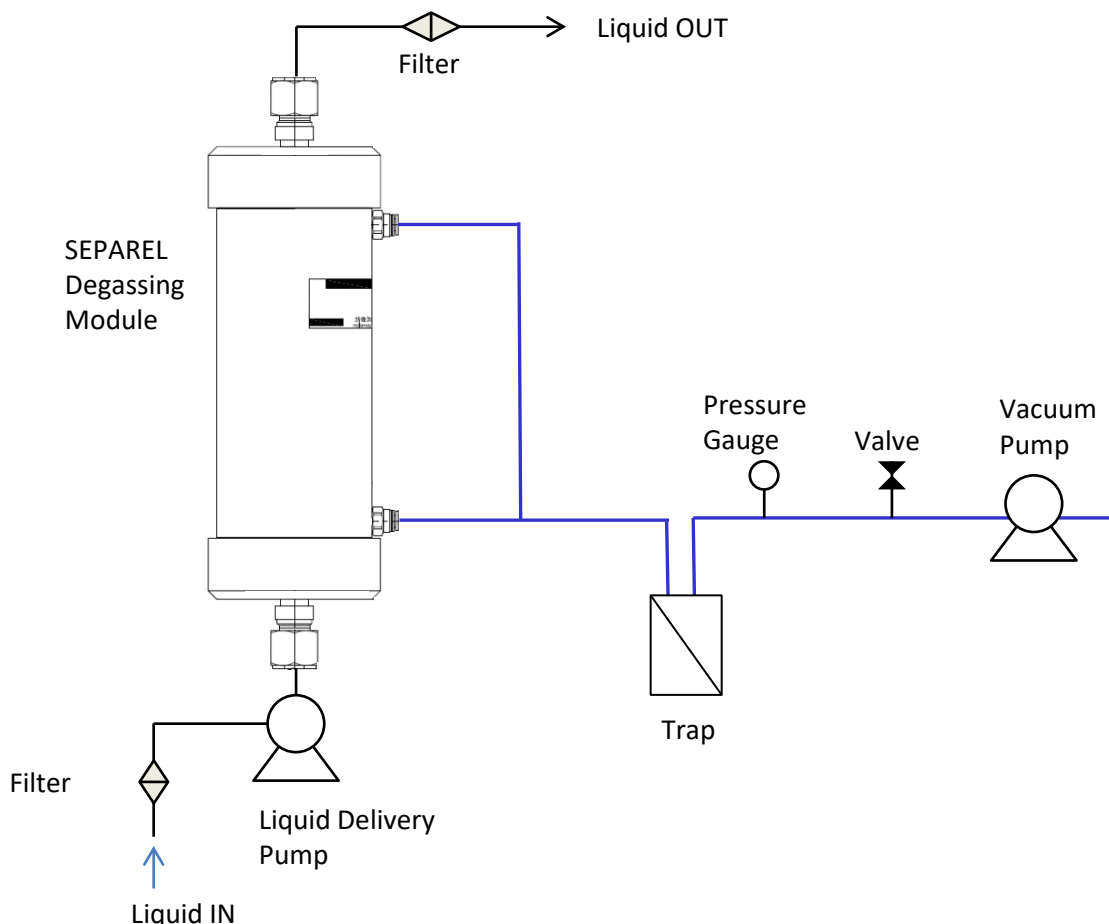
3) Vacuuming:

- Installed vacuum lines must always be facing downwards. If it is pointed upwards, liquid generated from vapor may block the vacuum line.
- Install a trap to detect leaked liquid and to prevent the vacuum pump from damage due to vapor and leaked liquid. A trap is also effective in preventing leaked liquid from feeding into other modules using the same vacuum line and the trap is effective for measuring leaks.
- Install a drain cock at the lowest point of a connection pipe.
- Install a vacuum meter near a module.
- No excess pressure must be given to a joint.
- Install a leak valve in order to release air from vacuum.
- In order to avoid a backward flow of water/oil from a vacuum pump, install a non-return valve.
- The vacuum side of the module will be saturated with vapor after the degasification of vapor and volatile gas. Vapor condensation may also occur due to surrounding conditions. Furthermore, the condensation amount largely depends on the liquid amount. Neglecting condensation may lower the degasification performance or cause problems in the vacuum pump. This condensation phenomenon is not unusual.
- The shell side should be designed with exclusive vacuum lines. Use screws, plumbing dope, and plumbing tape to prevent plumbing leaks (air leaks) in the exclusive vacuum lines. Plumbing leaks affect gas removal efficiency.
- Avoid long pipes or loops and minimize objects that may cause pressure volume loss, such as elbows.
- The plumbing for the shell side should be arranged so that it can manage the steam load.
- For junctions, use correct parts that are in compliance with the standards of vacuum use. Connections utilizing improper products will cause leaks.

INSTRUCTION MANUAL

3. Installation

Example of Installation



※It is possible particles may be present and pass through the module. If there is any trouble with such particles, please install a filter and filter the liquids after they exit the SEPARREL module, but before application.

**The above example is for your reference.
Depending on use conditions, the above example may not be suitable.**

※Optimal flow direction differs by use conditions and the above flow direction is not always the correct direction. For suitable flow direction, contact us.

INSTRUCTION MANUAL

4. Start-Up

- 4-1. Open a valve on the outlet side first. Next, open a valve on the inlet side gradually to make the liquid flow rate and pressure lower than the designated value for actual use until liquid is filled. Do not flow liquid at a very high flow rate nor at a very high pressure. Even if it is instantaneous, very high flow rates or pressure may damage hollow fibers and cause leakage. For efficient removal of remaining air in the liquid area of SEPAREL modules, filling the liquid with a vacuum is recommended. During the vacuuming process, check the airtightness of the vacuum line and not the air that is leaked from pipe, connector, and SEPAREL module.
- 4-2. Observe liquid quality, temperature, and pressure specified in the specification sheet.
- 4-3. Do not allow the gas phase pressure (hollow fiber outer pressure) to exceed the liquid phase pressure (hollow fiber inner pressure).
- 4-4. Do not flow oxidizing agents, such as highly concentrated chlorine water and ozone water, strong acids, strong bases, organic solvents, oil, or any other liquid which has not been confirmed as compatible by DIC. The warranty will not apply if liquid, which has not been confirmed as compatible by DIC, is used.
- 4-5. Do not change the flow rate dramatically in order to ensure that the hollow fibers are not damaged by drastic pressure fluctuations.
- 4-6. If vacuum pressure is very strong, and conditions are close to a perfect vacuum situation, stop the vacuum pump when liquid flow has stopped. Strong vacuuming for an extended period of time without liquid flow may freeze and damage hollow fibers via vaporization heat and liquid may leak from the damaged hollow fibers.
- 4-7. Check the items below periodically. If obvious deterioration is found, replace with a new degassing module .

Start-up Procedure for SEPAREL PF-series

▼ Vacuum Mode

- (1) Start up the vacuum pump in accordance with the specifications prepared by the vacuum pump manufacturer:
- (2) Perform vacuum pumping of the module.
- (3) Adjust the pressure on the vacuum pumping side to the specified value.

INSTRUCTION MANUAL

5. Shutoff and Storage

5-1. Shutdown Procedure

- (1) Open the leak valve of the vacuum exhaust pipe. Upon confirming that the vacuum has been released, shut down the vacuum pump.
- (2) Close the valve on the liquid supply side then close the valve on the treated liquid side.

5-2. Precautions when Handling the Module during Shutdown Periods

- (1) Store under the storage conditions stipulated in the specifications.
- (2) Let the water flow for 30 minutes once a day to prevent bacteria growth.
- (3) If the prescribed mentioned in (2) is not applicable for the use of ultrapure water, etc., it is also effective to enclose the module by micro-pressuring an inert gas, such as nitrogen gas, from the vacuum port of the module at 0.05MPa.
- (4) In case of a long-term shutdown, remove the module from the pipe and drain the water. Upon thorough draining, send nitrogen gas or dry air (free from oil mist, trash, etc.) from the water supply entrance to dry the interior of the module.

6. Restart

- (1) Let the water start to flow after flushing the inside of the module.
- (2) Discharge the drain of the vacuum exhaust pipe before starting the vacuum pump.

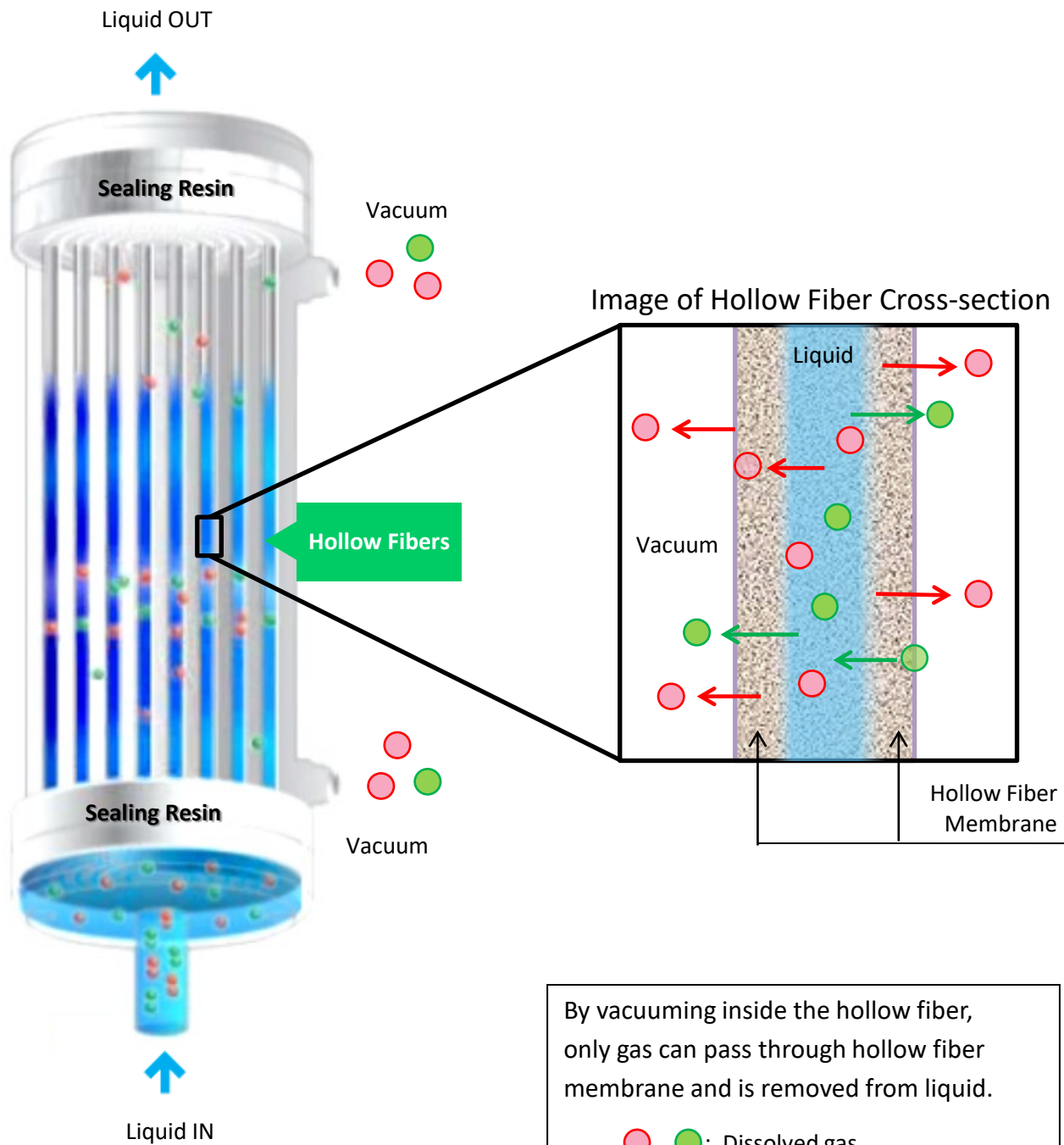
Maintenance

It is necessary to have regular checkups to maintain the performance of the degasification module. Check the items described in the following table and record the results.

Items of Measure	Frequency Guideline for Measurement	Set Value	Item to Check
Water Supply Value	More than once a day	Design value	
Liquid Supply Pressure	More than once a day	Design value	Make sure that it does not exceed the maximum water supply pressure as stipulated in the specifications.
Liquid Supply Temperature	More than once a day	Design value	Make sure that it does not exceed the limit of liquid supply temperature stipulated in the specifications.
Pressure Difference in Module	More than once a day	Design value	An increase of more than 0.05MPa (0.5kg/cm ²) from the initial difference pressure may clog or contaminate the hollow fiber. Either cleanse or replace the module.
Vacuum	More than once a day	Design value	When degradation of the setup value has occurred, please check the following 3 points. <ul style="list-style-type: none"> • Air leakage from the vacuum exhaust piping • Liquid leakage from vacuum exhaust piping • Trouble with the vacuum pump
Confirmation of Drain (Trap) of Vacuum Line	More than once a week		A large amount of liquid may be found in the vacuum line, which can be considered a leak. In this case, replace the module.
Dissolved Oxygen (D/O) in dealt Liquid	More than once a week		If target D/O value is not attained, check the following. <ul style="list-style-type: none"> • D/O in inlet water • Inlet water volume • Inlet water temperature • Vacuum power

INSTRUCTION MANUAL

REFERENCE DATA 1: Basic Principles of Degassing



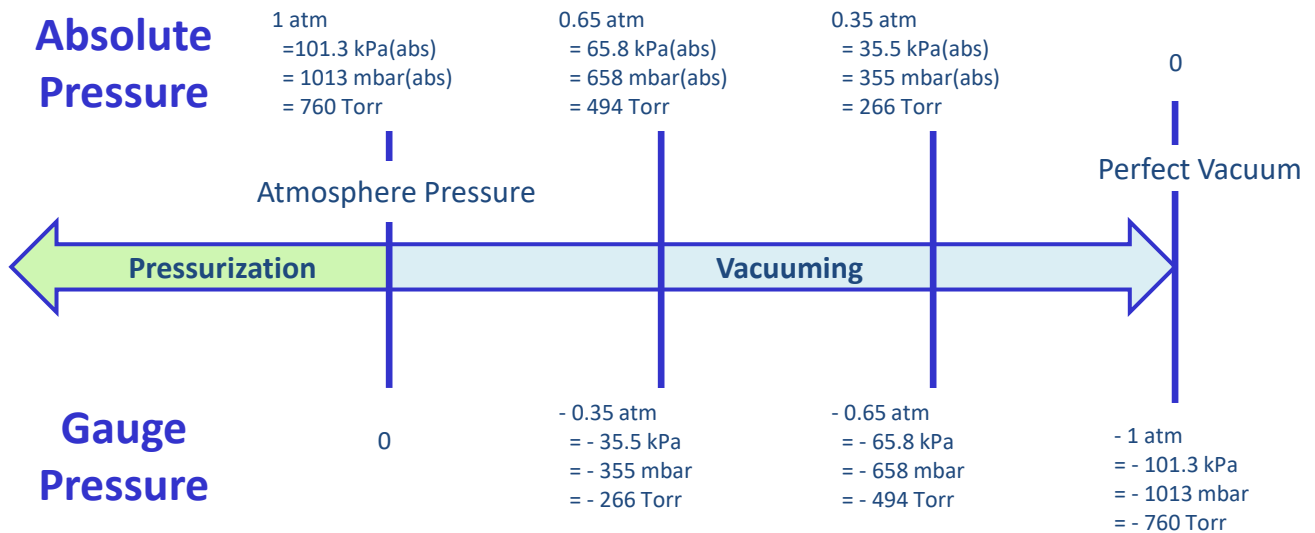
By vacuuming inside the hollow fiber, only gas can pass through hollow fiber membrane and is removed from liquid.

● ● : Dissolved gas

INSTRUCTION MANUAL

REFERENCE DATA 2: Vacuum Pressure Degree

- Note that the vacuum pressure degree in our data sheet is mainly indicated by absolute pressure, not by gauge pressure.



< Absolute Pressure >

For vacuuming conditions, every value should be 0 or plus. It cannot be minus.

< Gauge Pressure >

For vacuuming conditions, every value should be 0 or minus. It cannot be plus.

(Reference : Absolute pressure — Gauge pressure = 1atm)

※ The value for maximum pressure resistance is indicated by gauge pressure.

INSTRUCTION MANUAL

REFERENCE DATA 3: Setting Value of Vacuum Pressure Degree

As the vacuum pressure degree approaches a perfect vacuum, degassing performance is improved. However, if the vacuum pressure degree is too strong yet close to perfect pressure, liquid may evaporate and penetrate through the membrane. As a result, the composition of liquids may change. Therefore, DIC recommends following the exact vacuum pressure degree.

1. For Water or Aqueous Liquid

Recommended Degree of Vacuum : 5kPa(abs) ~ 10kPa(abs)
= 50mbar(abs) ~ 100mbar(abs)

※The above pressure is the recommended value when using the module at 15-30°C. When using the module at temperatures lower than 15°C or higher than 30°C, please contact DIC for more details.

※The above vacuuming pressure is not suitable for every application. Depending on applications, composition, and target degassing performance, the most suitable vacuuming value may be different from the above value.

< Reference : Saturated Water Vapor Pressure >

Temperature (°C)	kPa(abs)	Torr	mbar
15	1.7	12.8	17
20	2.3	17.3	23
25	3.2	24	32
30	4.2	31.5	42

2. For Non-Aqueous Liquid.

Recommended Vacuuming Degree: We recommend setting weaker degrees (higher in value) than the recommended saturated vapor pressure of the liquid.

Ex : In cases where saturated vapor pressure is 8kPa(abs), we recommend a weaker vacuum degree than 10kPa(abs).

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REFERENCE DATA 4: Setting Value of Vacuum Pressure Degree

Make sure that the liquid feeding pressure at the inlet port is lower than the maximum pressure value described in the specification sheet.

If the feeding pressure exceeds the maximum value, even momentarily, the hollow fiber may be damaged and ink may leak into the vacuum line.

※ The warranty will not apply in cases where liquid feeding pressure exceeds the maximum pressure value specified in the specification sheet.

Product	Maximum Pressure Resistance
PF-001D series	0.3 MPa (= 3 bar)
PF-004D series	0.3 MPa (= 3 bar)
PF-015 series	0.3 MPa (= 3 bar)
PF-030 series	0.3 MPa (= 3 bar)

Even if liquid feeding pressure is lower than the specified maximum pressure, an increased flow rate will cause lesser degassing performance. On the other hand, if the flow rate is too low, degassing cannot be efficient. Therefore, DIC supplies recommended flow ranges in the table below.

※ The recommended flow range below was calculated when using water. In the case of high viscosity liquid, a suitable flow range will be more narrow.

Product	Flow Area
PF-001D series	0.6 - 60 L/h
PF-004D series	3 - 180 L/h
PF-015 series	50 - 500 L/h
PF-030 series	100 - 1,000 L/h

INSTRUCTION MANUAL

REFERENCE DATA 5: Inner Volume

Product	Inner Volume at Liquid Port
PF-001D series	Approx. 30 mL
PF-004D series	Approx. 170 mL
PF-015 series	Approx. 800 mL
PF-030 series	Approx. 2000 mL

**The above values are for reference and are not guaranteed values.
Actual volume may differ by connection type.**

INSTRUCTION MANUAL

REFERENCE DATA 6: Troubleshooting

Problems	Probable Causes	How to Solve the Problem
Dissolved gas concentration is higher than specified or performance deteriorates after use	• Stains on the degasification module.	• Cleansing of degasification module (refer to the Cleansing Guidelines).
	• The dust cover during transportation is not removed.	• Confirm that the dust plug for transportation is removed from the vacuum port.
	• Occurrence of an air leak in vacuum line.	<ul style="list-style-type: none"> • Re-tighten the flange connection on the gas side. • Perform a leak test by adding pressure to the gas line: <ul style="list-style-type: none"> - Liquid soap testing: Find bubbles - Pressure testing: Observe pressure decrease after pressing - Use an electronic leak detection system
	• Vacuum degree is low due to a vacuum-related air leak.	<ul style="list-style-type: none"> • Confirm that a properly-sized vacuum system for the system is selected and that a properly-sized vacuum manifold is selected to handle the vapor load of the system. This will create a proper system. • Check for air leaks in the system. If the dissolved gas concentration at the exit is within the limit values of the sizing estimate, it is very likely that the leak is happening in the vacuum line behind the degasification module. If water is found inside the degasification module, try to maintain a vacuum state by removing liquid using a vacuum pump. Find the area where liquid has collected inside the vacuum pipe. <ul style="list-style-type: none"> - Confirm that the vacuum line is connected to the vacuum system by slanting it downward from the degasification module. If it is not, redo the piping. - Remove the vacuum pumping line from the degasification module. If the water leak exceeds 20ml/min, contact DIC. - Since flocculated water tends to collect easily, have the vacuum manifold insulated. • Install a vacuum pump that has larger capacity. • Contact the DIC Corporation.

INSTRUCTION MANUAL

REFERENCE DATA 6: Troubleshooting

Problems	Probable Cause	How to Solve the Problem
Dissolved gas concentration is higher than specified or performance deteriorates after use	• Condensation inside the degasification module or vacuum line.	<ul style="list-style-type: none"> • If the degasification module is still wet at shutdown, there is a possibility that flocculation of water is happening on the shell side (inside the hollow fiber). - Purge the flocculated water inside the hollow fiber with gas to remove it. - Send the sweep gas until no water droplets are found at the gas exit port. - If the above treatments are not successful, contact the DIC Corporation.
	• Liquid temperature is lower than the designated temperature.	• Raise the temperature.
	• Liquid volume is higher than the design specifications.	• Lower the liquid volume.
	• Liquid flow volumes among the systems of the degasification modules are not equal.	<ul style="list-style-type: none"> • Check the flow volume of the systems. • Adjust the valves to make the flow volume equal.

INSTRUCTION MANUAL

REFERENCE DATA 6: Troubleshooting

Problems	Probable Cause	How to Solve the Problem
Pressure loss is significant on the lumen side.	• The dust cover for transportation is not removed.	• Confirm that the dust cover/end cap plug is removed.
	• Accumulation of minute particles on the vacuum side	<ul style="list-style-type: none"> • Check the filter system. • Cleanse the degasification module (refer to the Cleansing Guidelines). • Replace the degasification module. • Check the flow volume to ensure that it is not exceeding the maximum flow volume. - Refer to the specifications.
A large amount of liquid has entered into the inside of the hollow fiber.	• Check if the water supply is connected to the vacuum port.	• Redo the plumbing in compliance with specifications.
	• The central seal nut is loose.	<ul style="list-style-type: none"> • Confirm that plumbing is correct. • If problems persist, please contact DIC.
	• The O-ring on the lumen side of the degasification module is not attached.	• Same steps as above.
	• Breakthrough (wet-out) due to the contamination of surfactant, oil, and alcohols in the degasification module.	<ul style="list-style-type: none"> • Cleanse the degasification module. • Drain the liquid and dry the hollow fiber. Refer to the Cleansing Guidelines for the drying procedure.
Hardening while tightening the nut.	• Sudden tightening.	• Turn slowly so that the screw tread is not destroyed.
Hardening while tightening the nut.	• Frictional wear of the screw thread due to electric tools.	• Turn slowly so that the screw tread is not destroyed.

INSTRUCTION MANUAL

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