IWAKI PUMPS

IWAKI
Pneumatic Drive Bellows Pump

FN-40

Instruction Manual

⚠ Read this manual before use of product

Thank you for having selected IWAKI's Pneumatic Drive Bellows Pump FN-40 model Series. This instruction manual, which is divided into 5 sections, namely "Safety Section," "Outline Section," "Installation Section," "Operation Section" and "Maintenance Section," deals with the correct handling and operation procedures for the pump. To make maximum use of the pump and to ensure safe and long operation of the pump, please read this manual thoroughly and carefully prior to operating the pump.

Contents

This instruction manual should be kept on hand by the end user for quick reference. It is recommended that each user, after reading the instruction manual thoroughly, place it in a position close to the pump system and where it may be easily accessed by any user at any time whenever necessary.

Important Instruction

For the Safe and Correct Handling of the Pump

- Read the "Safety Instructions" sections carefully to prevent accidents involving your customers or other personnel and to avoid damage or loss of other assets. Always follow the instructions and advice found in these sections.
- Observe and abide by the instructions described in this manual. These instructions are very important for protecting pump users from potentially dangerous conditions and situations related with the use of the pump system.
- The symbols relate to the following meanings described below:

⚠ **Warning**	**Nonobservance or misapplication of the contents of the "Warning" section could lead to a serious accident, including death or injury.**
⚠ **Caution**	**Nonobservance or misapplication of the contents of the "Caution" section could lead to serious physical injury to the user or serious damage to the product.**

Types of Symbols

⚠ Indicates that "Warning" or "Caution" must be exercised. Inside this triangle, a concrete and practical image provided as a warning or caution message is depicted.

⃠ Indicates a prohibited action or procedure. Inside or near this circle, a concrete and practical image of the activity to be avoided is depicted.

❗ Indicates an important action or procedure which must be performed or carried out without fail. Failure to follow the instructions herein can lead to malfunction or damage to the pump.

Safety Section

⚠ WARNING

- **Look around**
  Make sure there is no one around the pump when opening air supply valve such as electro-magnet valve or so. The ON/OFF switch is not provided on the pump.
  When air supply valve is opened, the pump starts operation.


Caution

- **Do not remodel pump**
  Never try to remodel the pump. Remodeling may be a cause of serious accident or damage. Iwaki takes no responsibility for accidents or damages that may result due to any remodeling without first obtaining permission from Iwaki.


No Remodeling

- **For specified application only**
  The use of a pump in any application other than those clearly specified may result in injury or damage to the pump. Use the pump strictly in accordance with the pump specifications and application range.


Prohibited

- **Do not drain**
  Never discharge hazardous liquid, including but not limited to chemical liquid, over the ground or floor in the plant directly.
  Abide by local regulations when disposing of hazardous substances.


Prohibited

- **Do not touch**
  Touching the pump or piping which is extremely hot due to the circulation of a hot liquid may cause severe burns. Arrange adequate hand-protective measures when feeding a liquid at temperatures higher than 50 °C.


DO not touch

⚠ CAUTION

- **Turn off power**
  When maintenance or other works are done, pay attention so that other person can be turn on power by mistake. Be sure the power is turn off when the works are done.
  Especially, at the noisy or poor visible place, put the notice “Men at work” to make other person notify. Turning on power by mistake causes person injury.


Power off

- **Wear protectors**
  Never fail to wear protective gear (protective goggles, cap, mask, acid-resistant gloves) when disassembling, assembling, or maintaining the pump. In addition, clean the pump carefully with pure water before working on the pump.


Wear protective gear

- **Qualified operator only**
  The pump must be operated only by operator(s) who have been trained in the safe operation of the pump.


Caution

Safety Section

⚠ CAUTION

- **Storage limit**
  Do not store the pump in places where an explosive atmosphere is located, dust is generated, or corrosive gas (such as chlorine gas) is present. Otherwise, a fire may be caused or the health of personnel may be jeopardized.

- **Ventilate site**
  When handling a toxic liquid or odorant, ventilate the working site well. In addition, wear protective gear (protective mask, goggles, gloves, etc.).

- **Disposal of used pump**
  Disposal of used or damaged pumps must be done in accordance with local laws and regulations. (Consult a licensed industrial waste products disposing company.)

- **Send-back to Iwaki**
  When sending the pump back to Iwaki, drain the liquid out of the pump and clean thoroughly with water to prevent any accidents during transportation.

- **Pump stroke speed**
  Do not run the pump at a stroke speed higher than the max. stroke speed which is shown on the item 4. Specifications on page 9. A stroke speed higher than Max. stroke speed shortens the life of the bellows.

- **Supply air pressure**
  Supply air pressure must be maintained within specified supply air pressure range. Otherwise, the bellows may be deformed.

Liquid temperature range	Supply air pressure range
10 ~ 100 deg.C	0.147 ~ 0.245 (MPa)

- **Liquid temperature range**
  Pumped liquid temperature should be 10 ~ 100 deg.C.

- **Prohibited liquids**
  Do not operate the pump with the following liquids.
  · Liquid easily crystallized
  · Liquid containing slurry
  · Low electric conductivity liquid such as hydrocarbon.

- **Difficult liquids to be handled**
  Stripper, solvent-type liquid, hydrazine or fuming sulfuric acid are difficult to be handled. Refer to 1. Before use on page 13.

Safety Section

⚠ CAUTION

- **Air exhaust port**
  Do not narrow the air exhaust port (for example by reducing the tube diameter). Otherwise the bellows may be deformed due to the residual pressure.
  (This pump is equipped with silencer at air exhaust port.)

- **During pump operation**
  · Make sure to open both the suction and discharge-side valves fully. In addition, confirm that the piping is fully supplied with liquid.

- **Stopping pump operation**
  · When stopping pump operation, release the pressure on the discharge side first. Otherwise, the bellows may be deformed due to the residual pressure on the pump discharge side.
  · If a valve is provided on the discharge side, do not close the valve upon stopping the pump. The resulting impactive pressure may deform the bellows or connecting plate.

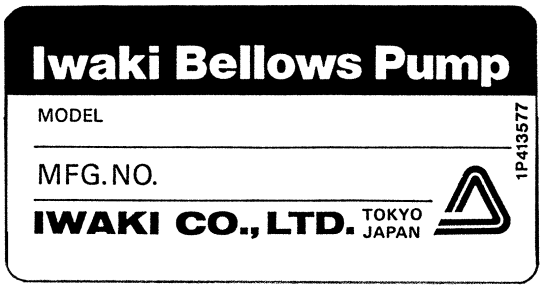
- **Static electricity**
  When low electric conductivity liquids such as ultra-pure water and fluor inactive liquid (e.g. Fluorinert™) are handled, the static electricity may be generated in the pump, which may cause static discharge and pump break down. Take countermeasures to avoid and remove the static electricity.

- **Ambient temperature**
  Pump must be used at ambient temperature of 10 ~ 40 deg.C.

OUTLINE OF PRODUCT

This section deals with operating principle, type and specifications of the pump as an introduction of the pneumatic drive bellows pump.

1. Unpacking and Inspection

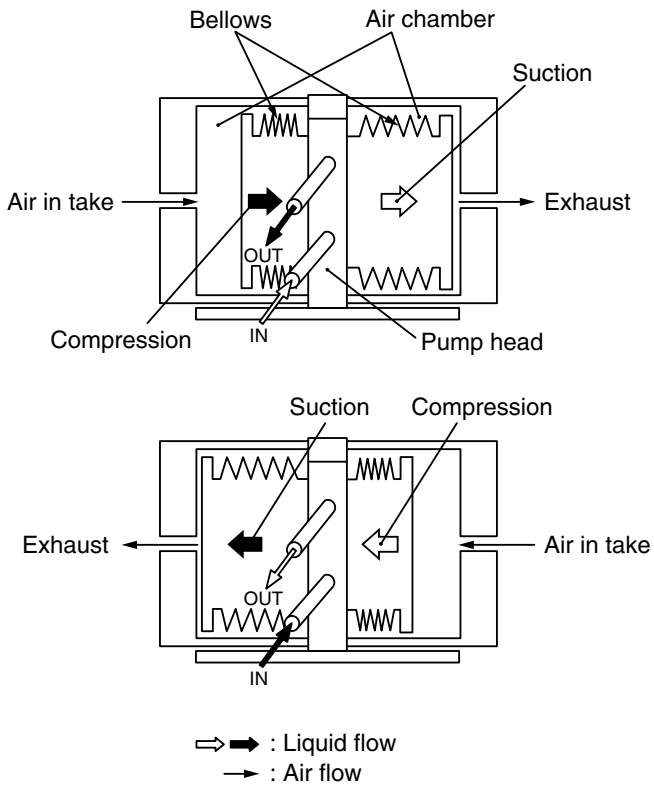


After unpacking the product, check the following points to ascertain that the product is exactly as you ordered. If you find anything wrong, please contact your dealer.

[1] Does the model indicated on the nameplate represent what you ordered?

[2] Has the pump or any part of it been damaged as the result of an accident or mishandling during transportation?

2. Operation Principle



Suction/compression: Created by bellows stroke

2.1 Operating Principle

Iwaki's pneumatic drive bellows pumps are made entirely of fluororesin and designed for semiconductor manufacturing processes as well as chemical feeding.

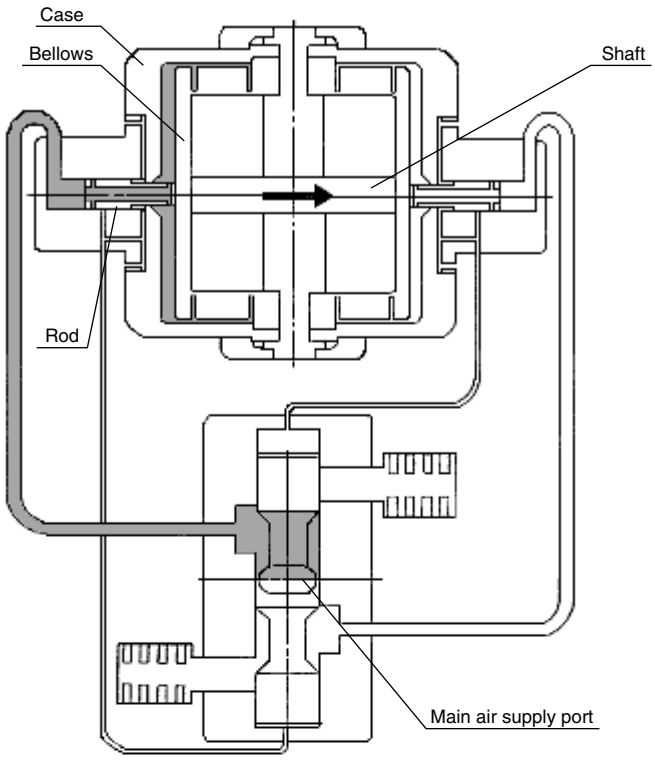
The pump unit consists of two air chambers and a pair of bellows. These bellows move reciprocally in the air chambers for suction and discharge, by which the liquid is pumped continuously.

[1] Liquid is sucked into the pump head through the suction port by the expansion (suction motion) of the bellows.

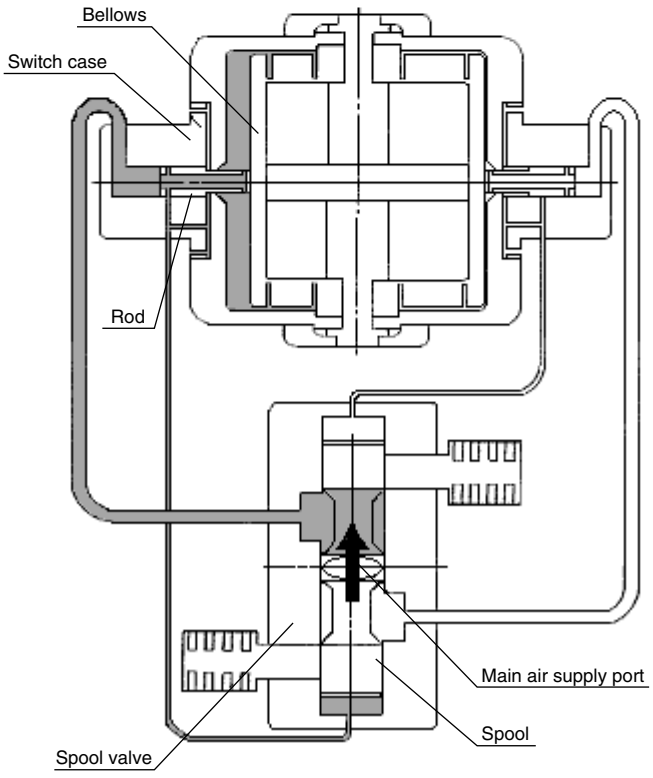
[2] The liquid is then forced out of the pump head through the discharge port by the compression(discharge motion) of the bellows.

2.2 Air switching mechanism

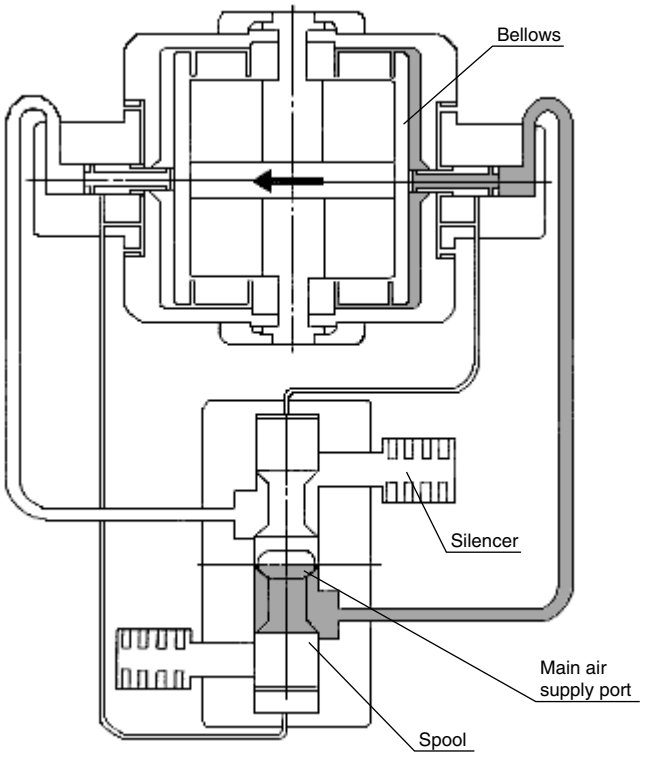
The air supplied from main air supply port goes to the left side case and pushes left side bellows to right. Right side bellows also moves to right by the shaft which is pushed by the left side bellows. At the same time the air passes through the rod of left side switching mechanism and the rod being pushed by air moves with the bellows.



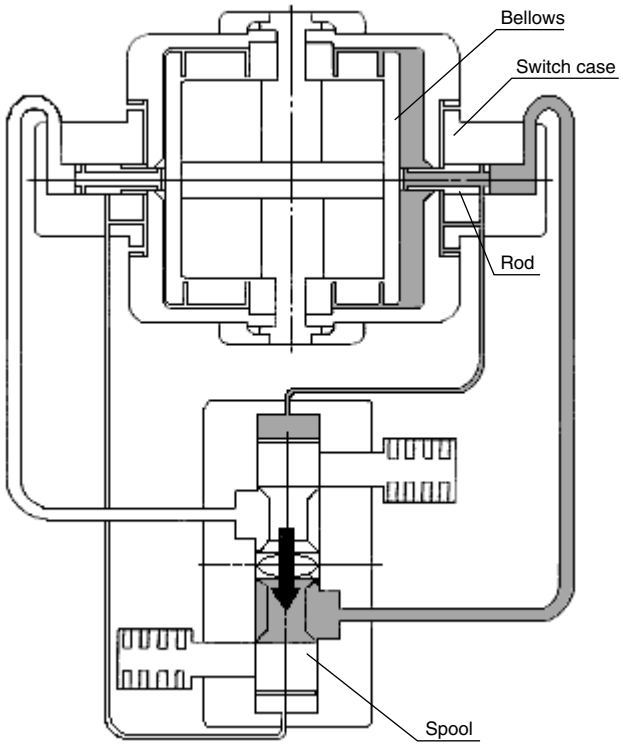
When the bellows comes to the right stroke end, a hole of left side rod and that of switch case are linked together and the main air is divided to go to spool valve as pilot air. The pilot air pushes up the spool, which closes the main air supply port to stop the supply of main air into left side case.



The spool which is pushed up by pilot air comes to the top end and the main air is changed from left to right. At the same time, the main air which is supplied to left side so far is exhausted through a right side silencer. And the right side bellows is pushed to left by the air supplied to the right side.



When the bellows come to left end, a hole of right side rod and that of switch case are linked and the main air is divided into spool valve as pilot air which pushes down the spool. By repeating these strokes, the pump automatically makes reciprocating movement.



3. Identification Codes

FN - 40 01
(1) (2) (3)

(1) Pump series name
FN : For transfer ambient and medium temperature liquid (perfectly non metallic pump)

(2) Max. discharge capacity
40 : 40 litters per minute

(3) Special version code
No symbol : Standard
01 : Special version (01, 02…)

4. Specifications

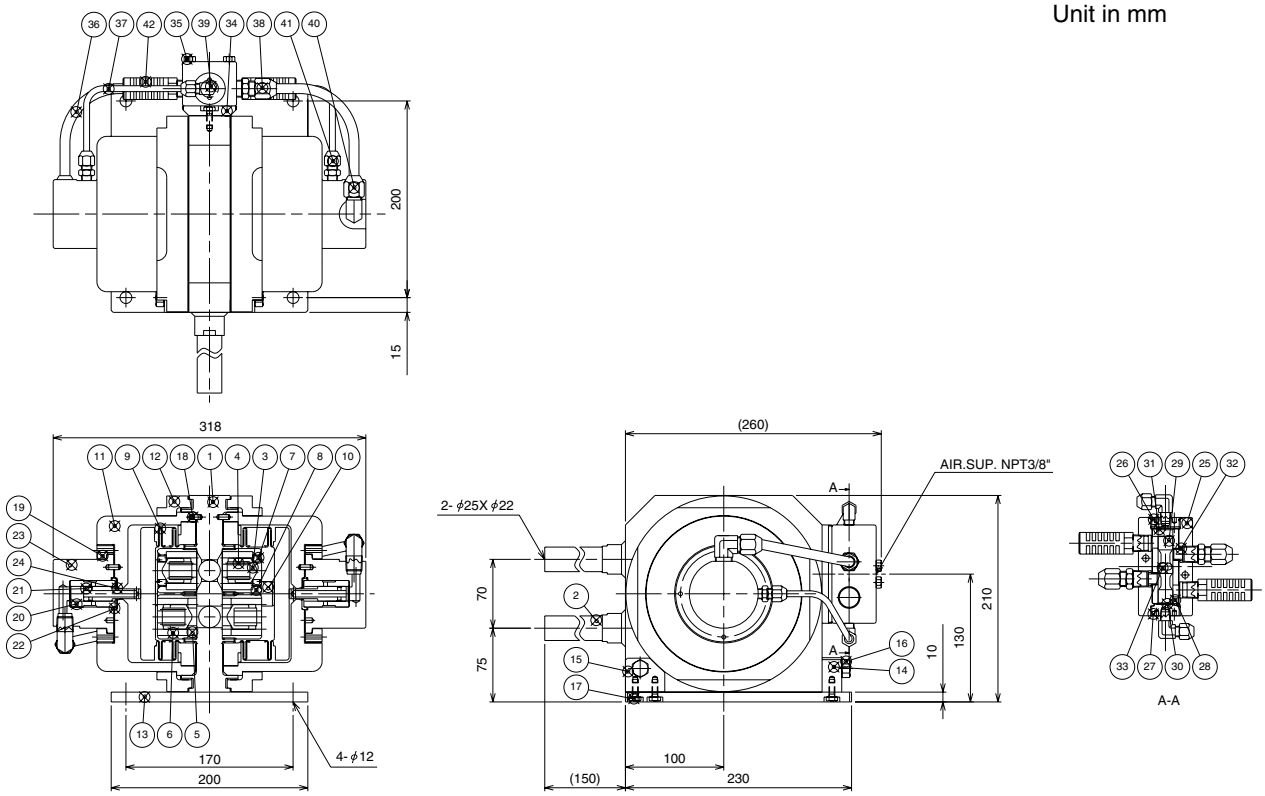
General Specification	Max. discharge capacity (Note 1)	40 L/min.
	Min. and max. number of stroke	150 spm, 480 spm
	Self-priming ability (Note 2)	2 meters
	Temperature range of handled liquid	10 ~ 100 deg. C
	Supply air pressure range	0.147 ~ 0.245 MPa
	Wet-end material	PTFE, PFA
	Pump connection bore	PFA tube (O.D.25 × I.D. 22 mm)
	Supply air connection bore	NPT3/8”
	Max. air consumption (at max. supply air pressure & max. discharge capacity)	380 NL/min.
	Permissible ambient temperature	10 ~ 40 deg. C
	Driving method	All air external switching (by built-in change-over valve)

Note 1. When pumping clear water at ambient temperature.
Note 2. When pumping clear water at ambient temperature. (Within supply air pressure range)

5. Dimension/Construction Drawing & Mass

FN-40 Mass : 9kg

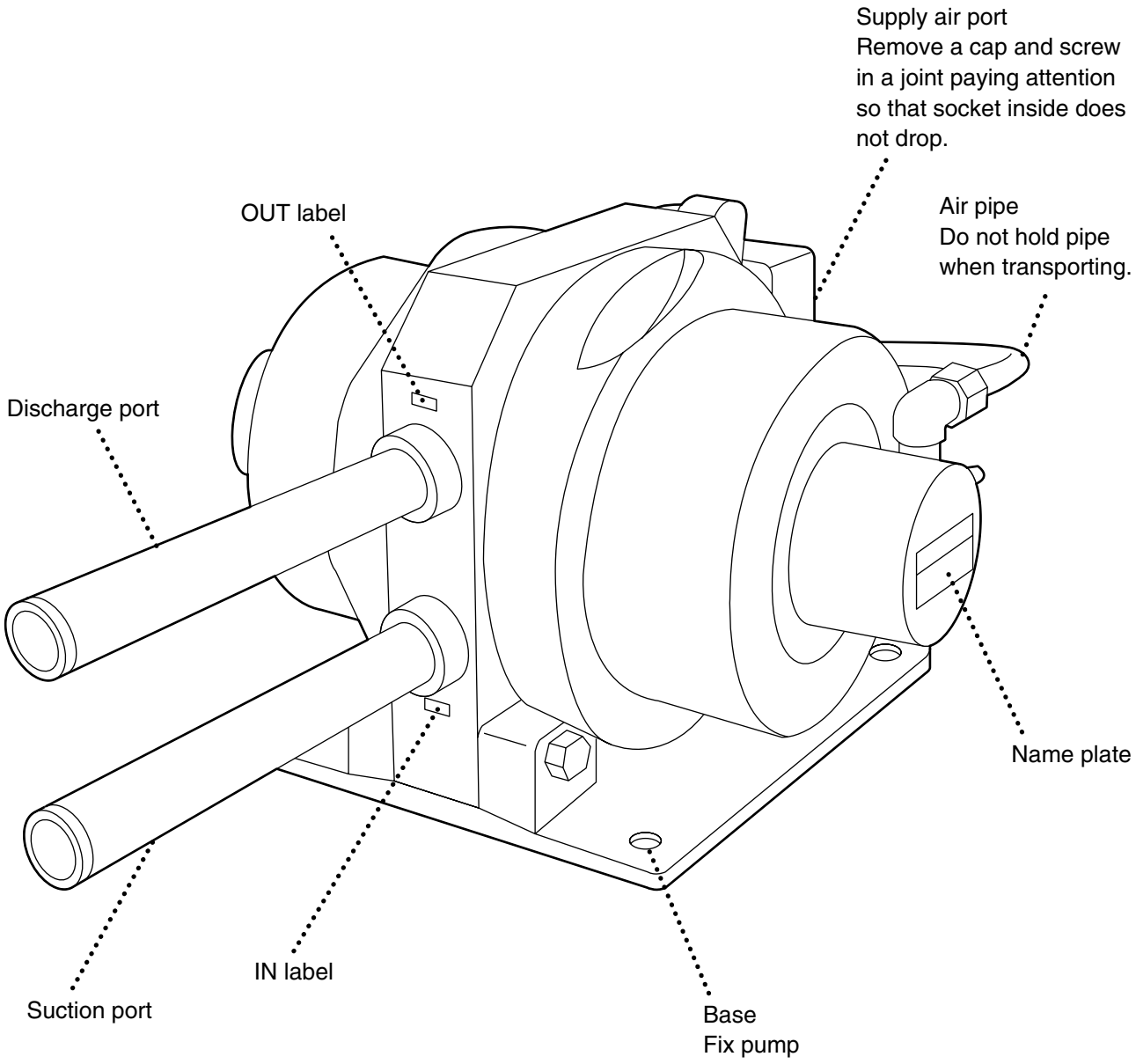
Unit in mm



No.	Parts Name	Q'ty	Material	Remarks	No.	Parts Name	Q'ty	Material	Remarks
1	PUMP HEAD	1	PTFE		22	SPACER	2	PP	
2	TUBE	2	PFA		23	SWITCH CASE	2	PP	
3	VALVE	4	PTFE		24	LIP SEAL	2	FILLED PTFE	
4	VALVE SPRING	4	PTFE		25	BODY	1	PP	
5	SUC. SIDE VALVE SEAT	2	PTFE		26	CAP A	1	PP	
6	SUC. SIDE VALVE CASE	2	PTFE		27	CAP B	1	PP	
7	DISCH. SIDE VALVE SEAT	2	PTFE		28	CYLINDER B	1	PEEK	
8	DISCH. SIDE VALVE CASE	2	PTFE		29	SPOOL	1	PEEK	
9	BELLOWS	2	PTFE		30	SPACER A	1	PEEK	
10	SHAFT	2	PFA		31	SPACER B	1	PEEK	
11	CASE	2	PP		32	SOCKET A	2	PEEK	
12	CASE FIXING RING	2	PP		33	SOCKET B	1	PEEK	
13	BASE	1	PP		34	SPOOL VALVE MOUNTING PLATE	1	PP	
14	HOLDER A	1	PP		35	HEX. BOLT	2	RENY	M60 × 50
15	HOLDER B	2	PP		36	TUBE A	2	POLYOLEFIN	
16	HEX. BOLT	3	RENY	M10 × 35	37	TUBE B	2	POLYOLEFIN	
17	HEX. BOLT	8	RENY	M6 × 15	38	OUT JOINT	2	————	CP-C10-R3/8
18	PIN	4	PP		39	PILOT JOINT A	2	————	CP-L6-R1/8
19	SWITCH CASE FIXING RING	2	PP		40	MAIN JOINT	2	————	CP-L10-R3/8
20	CYLINDER A	2	PEEK		41	PILOT JOINT B	2	————	CP-C6-R1/8
21	ROD	2	PEEK		42	SILENCER	2	————	AN303-03

6. Description on Body and Label

⚠ Caution When cleaning pump, do not to wipe labels or pump body with solvent.



INSTALLATION SECTION

This “Installation Section“ must be thoroughly understood by the user before actually installing the pump. Do not start your installation work unless you confirm your understanding of the entire set of descriptions in this section.

1. Before Use

For reliable pump performance to suit your application purposes, full safety measures should be taken for the pump unit and the entire system. The following information, including the points to be observed in the handling of the pump, deals with the measures to ensure the safe operation of the system. Please read the description carefully.

<table>
<tr><th>No.</th><th>Points to be Observed</th><th>Description</th></tr>
<tr><td>1</td><td>○ Pump stroke speed:
Do not run pump exceeding the max. stroke speed which is shown on the item 4. Specifications on page 9.</td><td>● If many air bubbles are sucked through pump suction port, pump is put into dry running condition (air locked operation) and stroke rate will rise to abnormal levels. Safety measure should be taken so that pump does not run at speeds above max. stroke speed.</td></tr>
<tr><td>2</td><td>○ Supply air pressure must be maintained within specified pressure range.</td><td>● In view of pressure resistance of filter at medium liquid temperature, protection of bellows and safety when bellows is broken, provide air as low pressure as possible.
● Any fluctuation in pressure of supplied air causes change in discharged capacity of liquid. Install a reducing valve to stabilize pressure.
<table><tr><th>Liquid temperature range</th><th>Supply air pressure range</th></tr><tr><td>10 ~ 100 deg.C</td><td>0.147 ~ 0.245 (MPa)</td></tr></table></td></tr>
<tr><td>3</td><td>○ Liquid temp. range</td><td>● Temp. of pumped liquid must be within the range of 10 ~ 100 deg.C.</td></tr>
<tr><td>4</td><td>○ Prohibited liquids
⚠ Caution
Following liquids must not be handled.
• Liquids that are easily crystallized
• Liquids containing slurry
• Low conductivity carbon hydrate liquid</td><td>● Service life of valve & bellows is shortened with use of liquid that is easily crystallized or contains slurry. Use of such liquids is not recommended.
● If solvent naphtha is used, electrostatic destruction may be generated between fluororesin and liquid, finally producing pinholes.</td></tr>
<tr><td>5</td><td>○ Difficult liquids to be handled
· Stripper
· Hydrazine
· Fuming sulfuric acid
· Solvent type liquids</td><td>● Some types of strippers may cause cracks in bellows or piping (PFA) at an early stage. (Warranty period is different if these liquids are handled. Contact IWAKI.)
● Explosion-proof specifications are required to use solvent type liquid. (Leak sensor built-in pump can not be used. Contact Iwaki for details.)</td></tr>
</table>

No.	Points to be Observed	Description
6	○ When stopping pump operation, release all pressure in pump discharge side.	⚠ **Caution** Stopping pump without releasing pressure on pump discharge side may result in deformed bellows due to force of pressure remaining on pump discharge side.
7	○ Do not narrow air exhaust port. (Do not use tubing of smaller diameter than specified one.)	⚠ **Caution** In case the exhaust port (Silencer) of spool valve on pump back side is moved to other place to exhaust, if air exhaust port is choked, the discharge side pressure and supply air pressure becomes unbalanced and bellows may be deformed by supply air.
8	○ Do not close the secondary-side air valve upon stopping the pump.	⚠ **Caution** ● If the secondary-side air valve on the liquid line is closed upon stopping the pump, the resulting residual pressure in the bellows may cause a deformation of the bellows. ● Note that the secondary-side air valve is kept open except for the purpose of drainage.
9	○ Do not close suction side air valve when pump is running.	⚠ **Caution** If suction side air valve is closed when pump is running, pump continues to run at very low stroke speed, which may cause deformed bellows.

Other precautions to be taken

[1] Surface temperature of pump

⚠ **Warning**

Touching the pump or piping whose surface temperature is extremely high due to the circulation of a hot liquid is very dangerous. Always arrange adequate hand-protective measures when engaged in feeding a hot liquid into the pump. The max. pump surface temperature is shown in the table.

Liquid temp.	Case surface temp.	Room temp.
100 deg.C	59 deg.C	34 deg.C

[2] Noise from pump

Noises are generated from air exhaust or the like during pump operation. Apply sound damping measures as necessary. The reference data of sound generated by pump is shown in the table.

Supply air pressure	Stroke speed	Sound level
0.245MPa	480 spm	76 dB(A)

2. Installation and Piping

When you feel or notice any danger or abnormal condition during installation and other set-up work, stop the work and go back to the very first step.

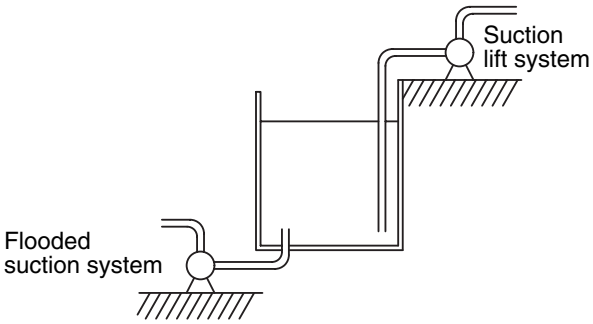
⚠ WARNING

Make sure no one turns on the power switch while work is being done on the pump. Be sure to turn off the power switch before you start any maintenance/repair work concerning the pump. If the working site is noisy or under conditions of low visibility, you should display a notice which clearly states "POWER OFF(MAINTENANCE)," near the power switch in order to inform other personnel about the situation. Power ON executed by any other person than the operator/service personnel may result in a serious accident. The operator must take special precautions to avoid accidents.

Only the operators/service staff who are adequately trained in safe handling procedures should be in charge of the related electric arrangement and control of the power source. Iwaki takes no responsibility for injury to person or damage to assets which results from a failure to observe this instruction. Consult Iwaki, an Iwaki branch office, or an Iwaki distributor as necessary.

2.1 Installation

[1] Pump installation position



- **Flooded suction system**
  Set the pump as close to the liquid supply tank as possible.

  ⚠ Caution
  Employ a flooded suction system for feeding a liquid at higher temperatures than room temperature or for a liquid circulation system.

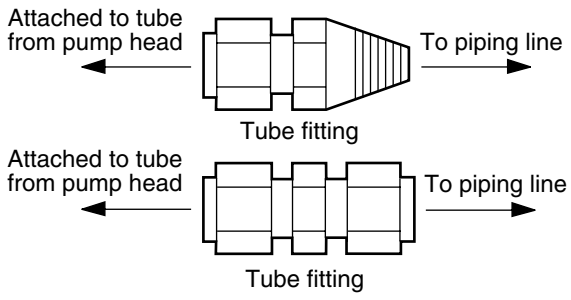
- **Suction lift system**
  Set the suction side piping in accordance with the self-priming capacity and as close to the liquid supply tank as possible.

[2] Installation foundation
Select a flat and rigid foundation (such as a chassis) for installation, to avoid twisting motion or vibration.

[3] Direction of pump
Direct the discharge port upward and the suction port horizontally. Use anchor bolts to fasten the pump firmly in position.

2.2 Liquid Tubing

The standard tubes for both the discharge and suction ports are PFA tubes. Connect the tubes as described below



[1] Pump port diameters and materials
The standard material of the pump discharge port and suction port is PFA tubing. Use tube fittings with diameters corresponding to those of the tubes. (See figures on the left.)
The diameter of the piping side tubing should be larger than those of the discharge and suction ports.

[2] Air blow or flush tubing to get rid of foreign matter, prior to connecting with the pump.

[3] Tubing connection should be done such that extra piping load is not applied to the pump. Use pipe supports as necessary to prevent vibration and heat generated along the piping from reaching the pump.

[4] Pipe joints should be assembled carefully, to prevent liquid leakage, air leakage, and air suction.

[5] Standard couplings may be used in the piping. However, they must be designed to be reliable against leakage in such operations as high-temperature feeding or heat cycle operation.

2.2.1 Points to be observed in suction pipe arrangement

[1] Basically the suction pipe should be large in diameter, short in length, and in a flooded suction condition.

[2] To block the entrance into the bellows of solid particles such as wafer fragments or the like, install a filter or strainer on the suction pipe. Select a filter or strainer which has low piping resistance.

⚠ Caution

Fragments of damaged wafer chips inside the pump may get stuck in the bellows and eventually cause damage. If solid matter clogs the pump valve, the discharge volume may be affected with the normal checking function disabled.

[3] When installing a valve on the suction pipe, select a valve with an orifice larger than the inner diameter of the said pipe. A smaller orifice may result in a larger suction piping resistance or an increased chance for the valve to be clogged with a crystallized substance. Make sure to keep the valve open during pump operation.

⚠ Caution

Operating the pump with the valve on the suction pipe increases the pressure inside the bellows to deform the bellows inwardly.

2.2.2 Points to be observed in discharge pipe arrangement

[1] The pump discharge load increases with the length of the discharge pipe or the number of bends along the pipe. In order to decrease the load install a dampener which minimizes pulsation.

[2] When installing a valve in the discharge pipe, select a valve with an orifice whose diameter is larger than that of the inner diameter of the pipe. A valve with a smaller diameter may increase the discharge piping resistance or easily be clogged with crystallized substance. Keep the valve open when the pump is in operation. Do not close the valve until the discharge pressure reaches "0" after the pump is stopped.

⚠ Caution

Do not close the valve before stopping the pump. The resulting impactive pressure may deform the bellows.

[3] A filter must be selected to meet the pump type.
Filtering area, grain-removing performance, and flow characteristics should be taken into consideration in selecting the filter. Desired flow rate may not be achieved if the selection is wrong.

⚠ Caution

The filter should be dampened well before running operation liquid. A desired flow rate may not be achieved if the filter is not dampened well.
The filter dries out if the operation liquid is not supplied for a long time. Make sure to dampen the filter prior to pump operation. Read the instruction manual of the filter for the details.

[4] The piping should be designed in a manner that no residual pressure results on the discharge side upon stopping the pump.
(For example, filter air elimination shall be set full open or a return circuit shall be employed to remove residual pressure.)

⚠ Caution

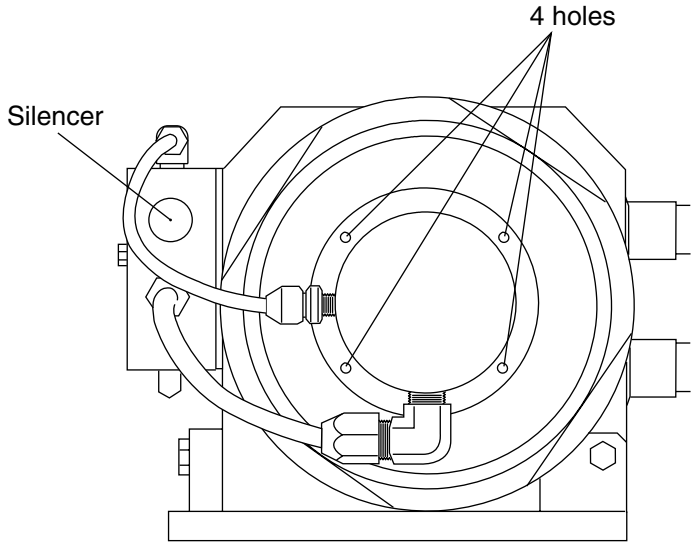
Residual pressure on the discharge side upon stopping the pump may deform the bellows.

2.2.3 Countermeasures for liquid leakage

If bellows is broken, liquid may leak through an exhaust silencer at the back of pump or through four holes at pump side. Install a leakage sensor below the silencer or below the four holes so that the electro-magnet valve can be closed to stop the supply of air to the pump. (A leak sensor to be attached to the pump is available as option. Ask us for details.)

⚠ Caution

Optional leak sensor can not be used for solvent because it may fire.



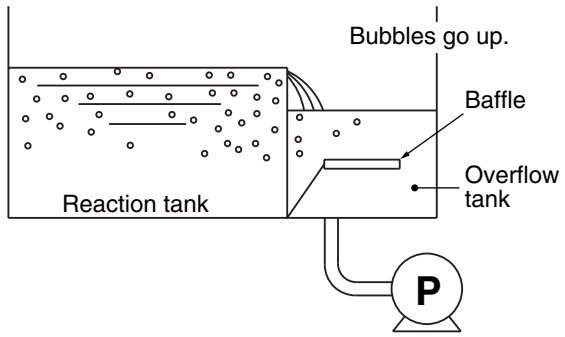
2.2.4 Air elimination measures

When strong acid liquid is fed into the reaction tank or such liquid is circulated through narrow tubing, bubbles are generated. If such bubbles are mingled in the liquid that is sent to the bellows, the system is put into a state of air locked operation. As a result, the stroke speed increases and smooth liquid feeding is impacted.

For safe and efficient circulation and feeding of liquid, it is necessary to carry out air elimination and take proper safety measures.

When air enters the bellows and the pump is air locked, the pump stroke speed increases. If the increase is excessive, that is, higher than the specified pump stroke speed, stop the pump or carry out air elimination.

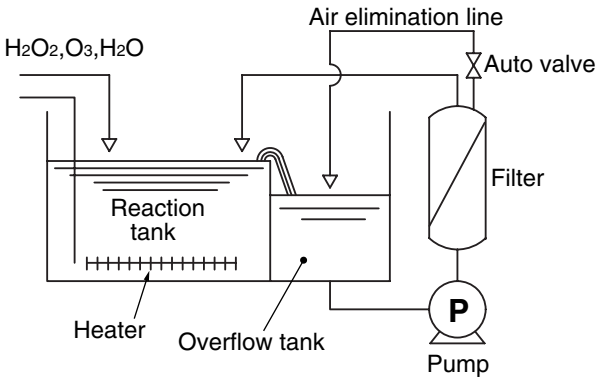
- **Plan "A"(Flooded suction system)**



[1] Plan A (Bubbles are blocked by means of baffle-board)

1 Flooded suction system:
A baffle is set in the overflow tank to separate the bubbles from the liquid, thus eliminating the air content.

- **Plan B (using auto valve)**



[2] Plan B (Automatic air elimination with auto valve installed)

1 Regardless of the occurrence of air locking, continuous automatic air elimination is executed in the entire system. For example, the air elimination process is activated every 2 minutes after the start-up of the pump by opening the auto valve for 10 seconds.

Note 1: Some filters have diameters too small for air elimination. Take the diameter into consideration when selecting a filter.

Note 2: Determine the open period of the auto valve on the basis of the system performance.

2 If the conditions under which bubbles are mingled remain the same, an air elimination technique which fits well with such conditions may be applicable. For example, if bubbles are generated only when feeding H_2O_2, open the auto valve to carry out air elimination only when H_2O_2 is fed.

3 Another technique is to install an air detection sensor in the suction port area, so that the auto valve is automatically opened by a signal sent out from the sensor and the air elimination operation is executed.

- Installing another air detection sensor on the discharge side is effective in preventing air from entering in the event of bellows damage.

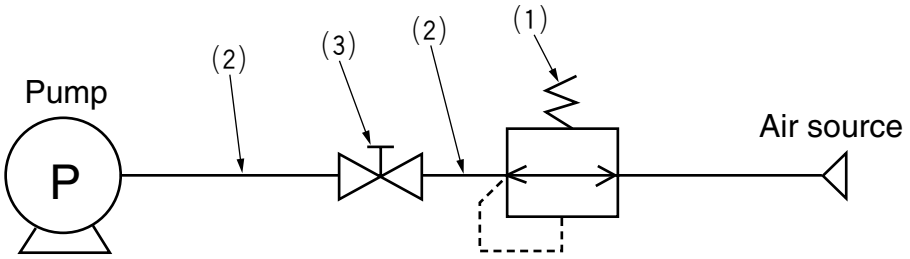
2.3 Air Piping

⚠ CAUTION

○ Any supplied air must be instrumentation air which is clean and free from moisture and dust. Water, oil, or dust in the supplied air may lower the performance of the pump.

○ The following troubles may occur with FN-40 type pump if the air supply piping is long and narrow. Discharge may be reduced because pump stroke rate can not be increased.

2.3.1 Example of air piping



Bore of air supply port to pump
: NPT 3/8

(1) Regulator
(2) Air piping
(3) Valve (for air to pump to ON/OFF pump)

1) Regulator
Select a regulator on a basis of the air consumption rate of the pump. (Pressure drop should be less than 20KPa.)

⚠ Caution

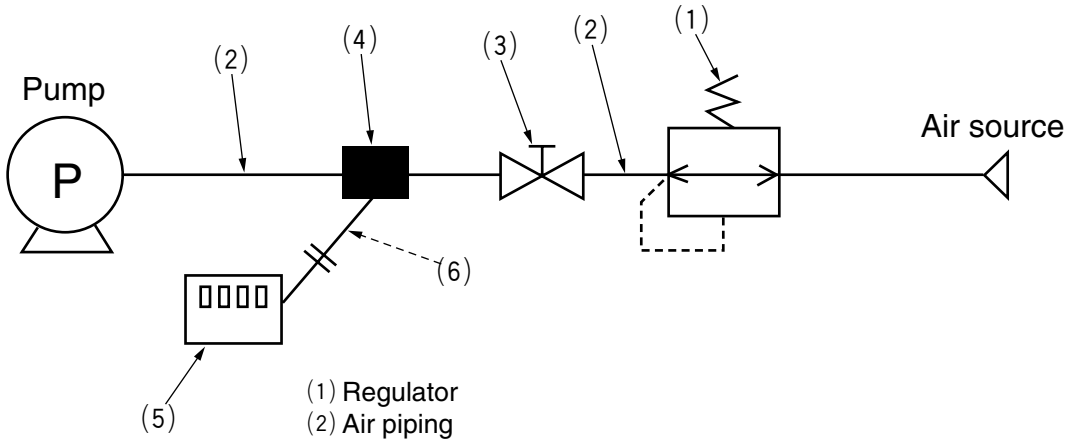
Set the supply air pressure within supply air pressure range shown below.

Liquid temperature range	Supply air pressure range
10 ~ 100 deg.C	0.147 ~ 0.245 (MPa)

2) Air piping
Use pipe of inner diameter of 8mm or more for air piping between regulator and pump.

3) Valve for pump driving air
Start and stop of pump is done by ON and OFF of the valve. Use the valve of bore 3/8" or more.

2.3.2 Example of pump stroke number indication

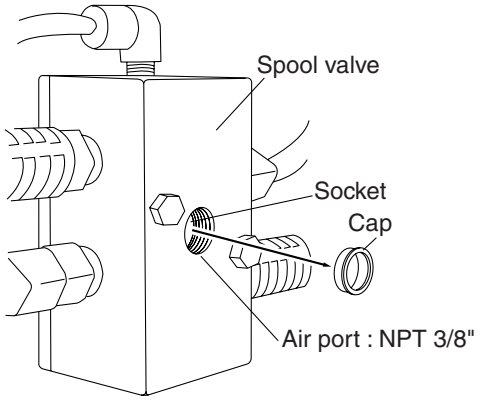


(1) Regulator
(2) Air piping
(3) Valve (for air to pump to ON/OFF pump)
(4) Pressure switch
(5) Stroke indicator, Total counter
(6) Output wire for pressure switch

Check of operating condition

If you wish to check the operating condition of pump, install a pressure switch (as shown in above illustration) in supply air piping to connect it with stroke number indicator or total counter. (Conversion from stroke number to flow rate is possible. Ask us for detailed specifications of pressure switch and stroke number indicator.)

2.3.3 Points to be observed in air piping



1) Diameter of pump connection port
   The diameter of the connection port on air is NPT 3/8".
   Remove a cap from an air port paying attention for a socket not to fall. Confirming that the socket is firmly inserted to the bottom, screw in a joint. Pay attention for the joint not to be tighten excessively. If it is tighten excessively, the spool valve may be locked. Tightening torque is 0.98 ~ 1.47N.m.

2) Install a relief type reducing valve.
   Fluctuation of supply air pressure results in fluctuation of the pump stroke rate as well as discharge volume. Install a reducing valve to maintain the air pressure at a fixed level.

3) Installation of air exhaust port
   The exhaust ports of the must be installed in correct positions so that the exhaust air is released into the open air.

   ⚠ Caution

   Narrowing the air exhaust port may block the air exhaust out of the pump. As a result the bellows may be deformed inwardly.

4) To minimize air exhaust sound
   Connect an exhaust port to a duct. In case attached silencer is removed and directly exhausted to duct by tube, an effective cross section area of discharge side must be 27mm^2 or more. Left and right length must be the same. (27mm^2 : less than 1.8m for inn.dia. 8mm)
   If bellows is broken, liquid leaks from exhaust silencer as described on "item 2.2.3. Countermeasures for liquid leakage" on page 17. To prevent exhaust duct from polution, install exaust duct at higher place than liquid level of tank or take other measures.

5) Installation of multiple pumps
   The air consumption of pumps (the total consumption by all pumps installed) increases in relation to the compressor capacity. The diameter of the pipe must be determined taking into consideration the total number of pumps.

2.3.4 Countermeasure for dew

If dew may occur at air piping of pump while pump is running, take following countermeasures.

a. Apply heater on piping.
b. Supply pump with warmed compressed air. Warming temperature must be within the permissible temperature of pipe, joint or electro-magnet valve or so.

OPERATION SECTION

Pump operation shall be limited to the range covered by and described in this instruction manual. Use of the pump in a different method or procedure that is not described in this instruction manual is prohibited. Iwaki takes no responsibility for injury to person or damage to assets which results from a failure to observe this instruction. Contact Iwaki, an Iwaki branch office, or an Iwaki distributor as necessary.

1. Preparation

Carry out the following preparatory steps when starting the pump operation for the first time after installation or after a long-time suspension of the pump operation.

1) Confirm that the air piping has been connected correctly. Check for loose couplings.
2) Confirm that the pump has been fixed firmly in place.
3) Confirm that there is no loose coupling along the liquid piping.
4) Confirm the valves on the suction and discharge piping are fully opened.
5) Confirm that the tank or bath has been filled with liquid.

   ⚠ Caution

   Never fail to conduct a trial run with pure water or actual liquid. Confirm that the trial run indicates no abnormal condition before starting the practical operation of the pump.

6) Confirm that the filter has been well dampened.

   ⚠ Caution

   Follow the description in the instruction manual of the filter.

2. Pump Operation

During the trial run of the pump, flush the unit and piping together with pump.

2.1 Starting pump

1) Set pressure of air by regulator.

   ⚠ Caution

   Air pressure must be set at 0.147 ~ 0.246 MPa.

2) Open air valve and pump starts.

   ⚠ Caution

   Adjust air pressure so that pump can not exceed the specified max. stroke speed when pump operates at no load.

2.2 Stopping pump

1) Close air valve and pump stops.

   ⚠ Caution

   Do not close liquid discharge side valve at the same time of stopping pump.
   Also while pump stops, open the liquid discharge side valve.
   Employ liquid piping system so that the residual pressure can not remain in pump discharge side.

2.3 Adjustment of discharge capacity of liquid

Discharge capacity of liquid can be changed by adjusting regulator to increase or decrease air pressure or air volume.

3. Points to Be Observed in Operation

Pay attention to the following points during operation.
Upon detecting any abnormal condition, stop the pump immediately and refer to "Causes of Trouble and Troubleshooting."

No.	Inspection Point	Remarks
1	Is pump stroke speed at specified level?	Stroke speed must be within 150 ~ 480 spm. (Note 1)
2	Is air pressure kept Normal?	Supplied air must be maintained within specified one.
3	Is air volume enough?	
4	Is there any leakage in sealed section of air piping or liquid piping?	
5	Is supply air clean?	

Note 1: If pump is operated at 150 spm or lower speed, pump movement may become unstable. Pay attention to the adjustment of discharge pressure to keep the pump speed at 150 spm or more.

MAINTENANCE SECTION

Handling, maintenance and inspection of the pump shall be limited to the range covered by and described in this instruction manual. Handling of the pump beyond the range covered by this instruction manual is prohibited. Iwaki takes no responsibility for injury to person or damage to assets caused from a failure to observe this instruction. Contact Iwaki, an Iwaki branch office, or an Iwaki distributor as necessary.

1. Causes of Trouble and Troubleshooting

Trouble	Causes	Countermeasures	Inspection and check points
Pump does not operate.	Malfunction of spool valve switching.	(1) Check, repair or replace.	a Remove spool valve and shake it slightly and confirm if spool inside moves smoothly. b Check if a spool is not locked because of too much tightened joints. Tighten joints for supply air at torque 0.98 ~1.47 N.m
	Loosened joints.	(1) Check joints and tighten them.	a Check if tube does not come off. b Check if nut of joint is not loosened. If loosened, tighten it till tube does not come off when it is pulled slightly.
	Malfunction of switching mechanism.	(1) Check and repair or replace.	If no abnormality is found on spool valve and joint, switching mechanism may be failed. In this case, repair is done by IWAKI.
	Broken bellows.	(1) Check bellows and replace. *	a Check if air pressure is less than specified one. b Check if pump stroke speed is less than specified one. c Check if liquid temperature is less than specified one. d Check if residual pressure is released when pump is stopped. e Check if suction piping is not choked.
	Increased pressure in discharge piping.	(1) Check filter and replace.	a Check if filter is not clogged or dried. b Check if filter is wet enough.
		(2) Closed discharge side valve.	a Open discharge side valve.
	Air pressure or air volume goes down.	(3) Return to initial set value. (Resetting)	a. Increase air pressure to 0.147MPa or more. b Use suitable diameter of pipe and air volume corresponding to used number of pumps.
Pump operates but no liquid is discharged.	Valve is clogged with foreign matter (such as fragments of wafer, etc.).	(1) Check, clean or replace pump. * (2) Suction-side valve is closed.	a Install pump guard filter or the like on pump suction pipe.
	Wear of valve or valve seat.	(1) Check, clean or replace pump. *	a Open suction-side valve. Check if valve route is blocked with crystallized substance

(Note) Repair works marked by * are conducted by Iwaki.

Trouble	Causes	Countermeasures	Inspection and check points
Discharge volume is reduced.	Supply air pressure or air volume is reduced.	(1) Set back to initial set value or review air flow rate.	a Secure a diameter and air flow rate in consideration of the number of pumps installed.
	Increased discharge pressure	(1) Review discharge conditions.	a Check filter for clogging or dry-up. b Check if air is removed from the filter well. c Check if discharge-side valve is open.
	Valve is clogged with foreign matter. Wear of valve or valve seat	(1) Check, clean or replace pump. *	a Install pump guard filter or the like on pump suction pipe.
	Insufficient NPSHa	(1) Check suction conditions.	a Check if suction pipe is too narrow and long.
Liquid leaks.	Bellows is broken.	(1) Check bellows and replace. *	a Check if supply air pressure is lower than the specification. b Check if pump stroke speed is lower than the specification. c Check if liquid temperature is lower than the specification. d Check if residual pressure is removed upon pump stop. e Check if suction pipe is narrowed.
Pump operation is not balanced.	Wear of valve or valve seat	(1) Check pump and clean or replace pump. *	
	Increased pressure in discharge piping.	(1) Check filter and replace.	a Check filter if it is not clogged or dried. b Check filter if it is wet.
		(2) Closed discharge valve.	a Open discharge valve.
Excessive vibration or noise	Pump is not fixed on the equipment properly.	(1) Tighten bolts	
	Pump stroke speed is excessively high.	(2) Set pump stroke speed lower than the specification.	a Lower supply air pressure or reduce air flow.

(Note) Repair works marked by * are conducted by Iwaki.

2. Maintenance and Inspection

⚠ WARNING

- Wear protectors
  Make sure to wear protective gear (protective goggles, cap, mask, etc.) when carrying out maintenance and inspection work.
- Release pressure out of piping
  Residual pressure in the piping may force the liquid and cause an unexpected accident. Release the residual pressure before starting the work.
- Power OFF
  Make sure no one turns on the power switch while work is being done on the pump. Be sure to turn off the power switch before you start any maintenance/repair work concerning the pump. If the working site is noisy or under conditions of low visibility, you should display a notice which clearly states “Power OFF (Maintenance) " near the power switch in order to inform other personnel about the situation. Power ON executed by any other person than the operator/service personnel may result in a serious accident. The operator must take special precautions to avoid accidents.

Periodic inspection

(1) Check once a month or more if the stroke speed is not increased. When the pump is operated for a long period, it may happen that the stroke speed increases because of worn shaft and bearing inside bellows. If this happens, lower the air pressure to adjust stroke speed so that stroke speed can not increase too much (not to exceed 480 spm).

(2) Check once a month or more if no liquid leaks from silencer or side of pump. If liquid leaks outside pump, bellows may be broken or liquid may leak from sealing part. When you find liquid leakage, immediately stop pump and then drain liquid from pump and ask IWAKI to replace bellows. (Bellows is replaced by IWAKI.)

(3) Inspection of bellows and other wet-end parts (Inspect more than once a year.)
Bellows and other wet-end are consumable parts. See page 28 for consumable parts. (Life of these parts are depend on liquids and/or operating conditions.)
When pump perforformance is reduced, or operating perod exceeds the time to be replaced, the consumable parts must be replaced.
(Replacement is done by IWAKI.)

(4) When pump is started after it is not used for a long period.
Supply air to the pump (approx. 0.196MPa) and confirm there is no air leakage from the pump discharge port before starting the pump.

3. Consumable Parts

The consumable parts should be replaced when the time comes for them to be replaced or when the performance goes down considerably. The replacement works are done by IWAKI.

Parts name	Quantity	Time to be replaced (Continuous operation)
Pump head unit	1	One year
Bellows	2	
Shaft	2	
Lip seal	2	
Rod	2	
Cylinder A	2	
Spool	2	
Cylinder B	2	

Note 1. Time to be replaced is a reference but not a guarantee. It depends on used conditions.
Note 2. Quantity is per unit.

IWAKI PUMPS

( )Country codes

IWAKI CO.,LTD. 6-6 Kanda-Sudacho 2-chome Chiyoda-ku Tokyo 101-8558 Japan
TEL:(81)3 3254 2935 FAX:3 3252 8892(http://www.iwakipumps.jp)

U.S.A.	: IWAKI WALCHEM Corporation	TEL : (1)508 429 1440	FAX : 508 429 1386	Germany	: IWAKI EUROPE GmbH	TEL : (49)2154 9254 0	FAX : 2154 1028
Australia	: IWAKI Pumps Australia Pty. Ltd.	TEL : (61)2 9899 2411	FAX : 2 9899 2421	Italy	: IWAKI Italia S.R.L.	TEL : (39)02 990 3931	FAX : 02 990 42888
Singapore	: IWAKI Singapore Pte. Ltd.	TEL : (65)763 2744	FAX : 763 2372	Denmark	: IWAKI Pumper A/S	TEL : (45)48 24 2345	FAX : 48 24 2346
Indonesia	: IWAKI Singapore (Indonesia Branch)	TEL : (62)21 690 6607	FAX : 21 690 6612	Sweden	: IWAKI Sverige AB	TEL : (46)8 511 72900	FAX : 8 511 72922
Malaysia	: IWAKIm Sdn. Bhd.	TEL : (60)3 7803 8807	FAX : 3 7803 4800	Finland	: IWAKI Suomi Oy	TEL : (358)9 2742714	FAX : 9 2742715
Taiwan	: IWAKI Pumps Taiwan Co., Ltd.	TEL : (886)2 8227 6900	FAX : 2 8227 6818	Norway	: IWAKI Norge AS	TEL : (47)66 81 16 60	FAX : 66 81 16 61
Thailand	: IWAKI (Thailand) Co.,Ltd.	TEL : (66)2 320 1303	FAX : 2 322 2477	France	: IWAKI France S.A.	TEL : (33)1 69 63 33 70	FAX : 1 64 49 92 73
Hong Kong	: IWAKI Pumps Co., Ltd.	TEL : (852)2 607 1168	FAX : 2 607 1000	U.K.	: IWAKI PUMPS (UK) LTD.	TEL : (44)1743 231363	FAX : 1743 366507
China	: GFTZ IWAKI Engineering & Trading Co., Ltd.	TEL : (86)20 8435 0603	FAX : 20 8435 9181	Switzerland	: IWAKI (Schweiz) AG	TEL : (41)32 3235024	FAX : 32 3226084
China	: IWAKI Pumps Co., Ltd. (Beijing office)	TEL : (86)10 6442 7713	FAX : 10 6442 7712	Austria	: IWAKI (Austria) GmbH	TEL : (43)2236 33469	FAX : 2236 33469
China	: IWAKI Pumps (Shanghai) Co., Ltd.	TEL : (86)21 6272 7502	FAX : 21 6272 6929	Holland	: IWAKI Holland B.V.	TEL : (31)297 241121	FAX : 297 273902
Philippines	: IWAKI Chemical Pumps Philippines, Inc.	TEL : (63)2 888 0245	FAX : 2 843 3096	Spain	: IWAKI Iberica Pumps, S.A.	TEL : (34)943 630030	FAX : 943 628799
Korea	: IWAKI Korea Co.,Ltd.	TEL : (82)2 3474 0523	FAX : 2 3474 0221	Belgium	: IWAKI Belgium n.v.	TEL : (32)1430 7007	FAX : 1430 7008

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