IWAKI PUMPS

IWAKI
Pneumatic Drive Bellows Pump
FS-100NF
Instruction Manual

⚠Read this manual before use of product

Thank you for selecting IWAKI's Pneumatic Drive Bellows Pump the FS-100NF series. This instruction manual deals with “Safety Section” “Product outline” “Installation Section” “Operation Section” and “Maintenance Section”.
Please read through this manual carefully to ensure the optimum performance, safety and service of the FS-100NF series.

Contents

This instruction manual should be kept on hand by the end user for quick reference.

If you have any questions, contact us or your nearest dealer.

Before use of the FS-100NF series pumps

Important!

- Composite effective cross section area of exhaust piping should be 43.5 mm^2 or more. Use a general quick exhaust valve which is made from aluminium with the pressure resistance of 0.7MPa or more.
- Use of the FDC-1, FD or AC-1 controller is recommended. Note that the electropneumatic regulator is not applicable for the FDC-1 and FD controllers.
- The maximum stroke speed is limited for the prevention of bellows rupture. See the table below.

Supply air pressure (MPa)	0.196 - 0.686
Max. stroke speed (spm)	100

- Differential pressure between supply air pressure and exhaust pressure is limited for the prevention of bellows rupture. See below.

Supply air pressure (MPa)	0.196 - 0.686
Differential pressure (MPa)	0.41

Important Instruction

For the Safe and Correct Handling of the pump

- "Safety Instruction" section deals with important details about handling of the product. Before the use of the pump, read this section carefully for the prevention of personnel injury or loss.
- Observe the instructions accompanied with "WARNING" or "CAUTION" in this manual. These instructions are very important for protecting pump users from dangerous situations.
- The symbols on this instruction manual have the following meanings:

⚠ **WARNING**	**Nonobservance or misapplication of the contents of "Warning" section could lead to a serious accident which may result in death.**
⚠ **CAUTION**	**Nonobservance or misapplication of the contents of "Caution" section could lead to a personal injury or 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 connecting the power cable. Any power supply switch is not provided on the pump. Connecting the power cable, the a solenoid valve starts to supply the air and the pump starts to run.


Caution

- **Do not remodel the pump**
  Never remodel the pump. We are not responsible for any injury or damage due to modification.


No Remodeling

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


Prohibited

- **Do not drain**
  Do not drain chemicals directly onto the ground or a waste channel. Disposal of chemicals should be in accordance with an applicable law.


Prohibited

- **Do not come in contact with the products**
  When the pump is sending a high temperature liquid of 50 deg.C or more, the surfaces of the pump and piping become hot. Do not touch with the bare hand. Wear protective gloves.


DO not touch

⚠CAUTION

- **Do not exceed the specified voltage**
  Do not supply any power voltage other than specified one. Otherwise, a fire or electric shock may result.


Prohibited

- **Wear protectors**
  Be sure to wear protective gear (protective goggles, cap, mask, acid-resistant gloves) when working on the pump. Rinse the pump with pure water in advance.


Wear protective gear

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


Caution

- **Power OFF**
  Be sure to turn off the power before starting a maintenance/repair work. Make sure no one turns on the power while working on the pump, otherwise it may result in a serious accident. If your work field is noisy or dark, let other people know about the situation by displaying a notice such as "POWER OFF(Maintenance)" near the power switch.


Power off

Safety section

⚠CAUTION

- **Storage limit**
  Risk of fire and/or health damage. Do not instal or store the pump in explosive atmosphere, dusty place, or corrosive gas (such as chlorine gas).

- **Keep ventilation**
  When handling a toxic liquid or odorant, keep your working site ventilation. Always wear protective gear (protective mask, goggles, gloves, etc.).

- **Pump disposal**
  Any used or damaged pump must be disposed of in accordance with local laws and regulations. Consult a licensed industrial waste products disposing company.

- **Return**
  Before return drain a chemical from the pump and clean the inside with water for safe transportation.

- **Stroke speed/Supply air pressure/Liquid temperature**
  The maximum stroke speed is 100spm at an air pressure between 0.196 - 0.686 MPa. Do not continuously run the pump beyond the operating range, otherwise the pump may be deformed or damaged. The permissible liquid temperature is between 5-60deg.C. Any operation beyond the permissible liquid temperature can lead to the deformation of the bellows.

Supply air pressure range	0.196 - 0.686 MPa
Max. stroke speed	100 spm

- **Permissible differential pressure in the bellows**
  Do not operate the pump continuously beyond 0.41 MPa. The life of bellows may shorten.

Supply air pressure range	0.196 - 0.686 MPa
Differential pressure on bellows	0.41 MPa

- **Prohibited liquids**
  Do not operate the pump with the following liquid.
  • Liquid easily crystallizes
  • Liquid containing slurry
  • Solvent naphtha

- **Liquids to be handled with care**
  • Stripper
  • Solvent-type liquid
  • Fuming sulfuric acid
  • Fuming nitric acid

⚠CAUTION

- **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 generate in the pump and may cause static discharge. Take countermeasures to remove the static electricity.

- **Ambient temperature**
  Use this product between 0 - 40 deg.C. of surrounding temperature.

- **When stopping the pump**
  - Before stopping the pump, first release discharge side pressure. Otherwise, the bellows may be deformed due to discharge side pressure.
  - Do not close any valves right after stopping the pump. The resulting impact pressure may deform the bellows or the connecting plate.

- **Pump at halt**
  - Do not supply air to both the right and left air-supply ports at the same time to prevent the bellows from becoming deformed.
  - Do not have the pump unused with any chemical in the bellows for a long period. Some chemical can penetrate the bellows and corrode metal material.

- **Composite effective cross section area**
  Composite effective cross section area should be 43.5 mm^2 or more.

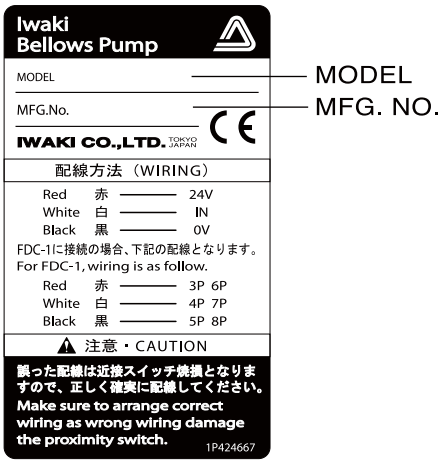
- **Air exhaust port**
  Do not narrow the air exhaust port (for example by reducing the tube bore). The residual pressure in the pump may deform the bellows.

- **During pump operation**
  - Make sure all the valves on both suction and discharge side piping are open.

- **Note for the electrode**
  The electrode occasionally fails to detect leakage depending on operating condition. Contact IWAKI for detail.

PRODUCT OUTLINE

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.

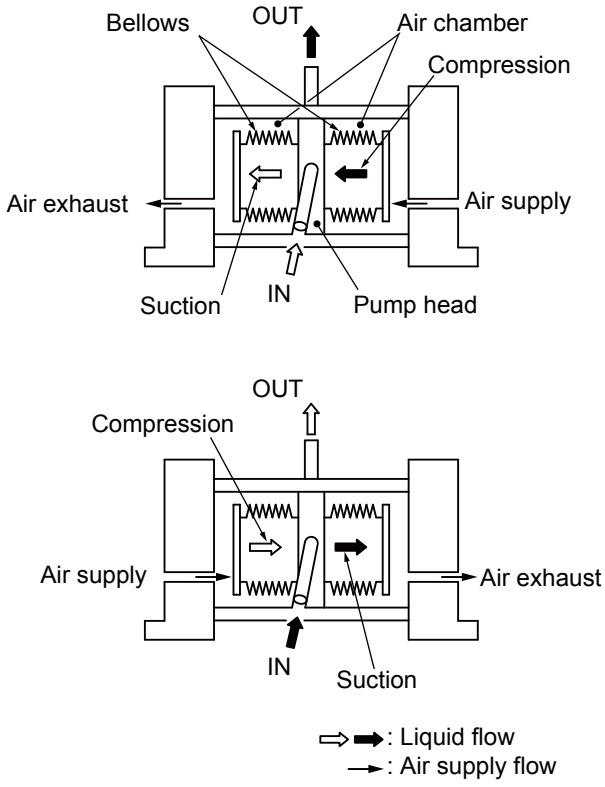
[1] Does the model indicated on the nameplate represent what you ordered?

[2] Are there any transit damage?

[3] Are all optional items such as controller delivered with the pump?

[4] Regarding the quick exhaust valve, use aluminium one with the pressure resistance of 0.7MPa or more.

2. Operation Principle



Suction/compression: Created by bellows stroke

Our pneumatic drive pumps are designed for semiconductor manufacturing and chemical dosing processes. And wet-ends are all fluororesin.

The pump unit consists of two air chambers and a pair of bellows. The bellows are reciprocated by supply air and make pumping action continuously.

[1] A liquid is sucked into the pump head through an inlet when the bellows expand (suction motion).

[2] The liquid is then pumped through an outlet when the bellows contract (discharge motion).

3. Identification Codes

FS - 100 N F - 01
① ② ③ ④ ⑤

① Series code

② Maximum discharge volume
100: 100 ℓ/min

③ Operating temperature
N: 5 - 60 deg.C

④ Pump connection port (discharge port/suction port)
F: Flange type connection (Standard)

⑤ Special specifications
No symbol: Standard
01 : Special specifications (01, 02……)

4. Specifications

	Item	Specifications
General Specification	Max. discharge volume (Note 1)	100 ℓ/min
	Supply air pressure range	0.196-0.686 MPa
	Max. stroke speed	100 spm
	Permissible differential pressure	0.41 MPa
	Self-priming ability (Note 2)	1 m
	Pump connection port	JIS 20K 25A flange
	Supply air connection port	Rc 1/2"
	Max. air consumption (at max. discharge volume, max. supply air pressure)	1495 Nℓ/min
	Liquid temp. range (deg.C)	5~60 deg.C
	Ambient temp.	0~40 deg.C
	Driving method	External forced switching of driving air
Proximity switch arrangement	Type	High-frequency type proximity switch
	Output	NPN DC open/close output
	Source voltage	DC10V~DC30V

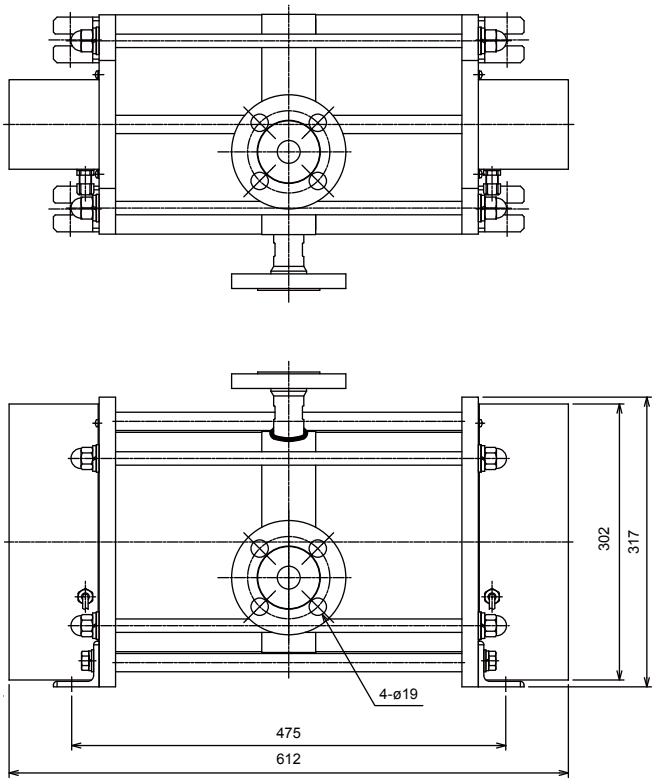
Note 1. The maximum discharge volume is on pumping clean water at room temperature.

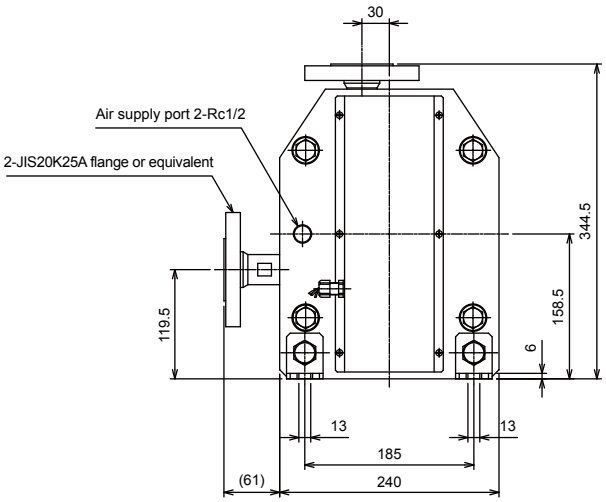
Note 2. The self-priming height is on pumping clean water at the maximum stroke speed at room temperature.

5. Outer Dimensions/Mass

FS-100NF Mass : 55.5kg

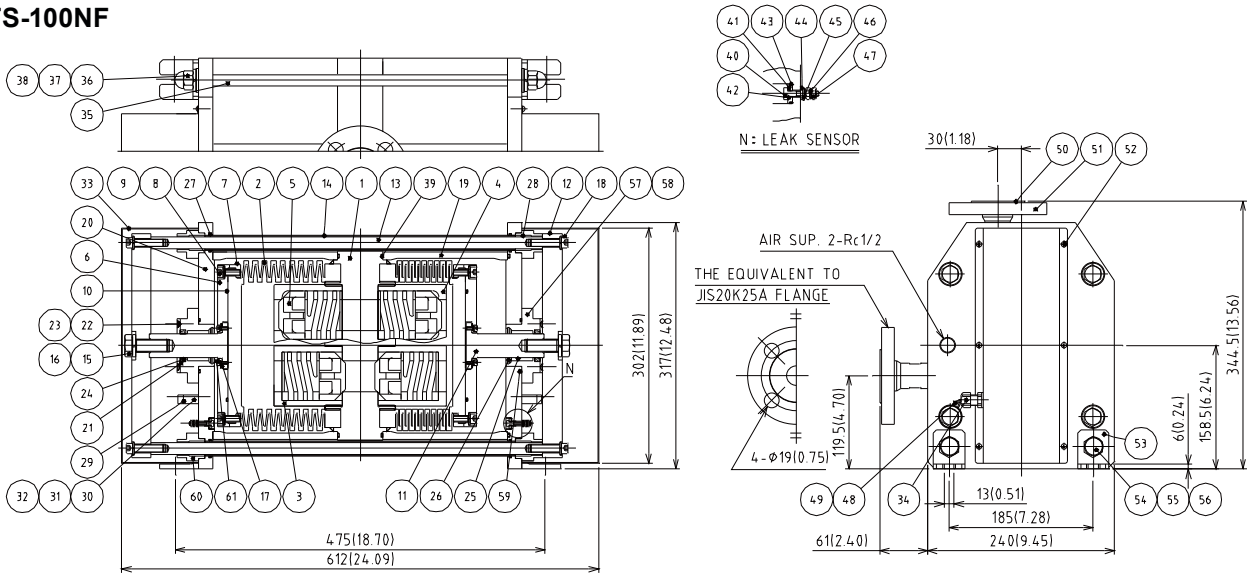
Unit : mm





6. Names of Parts and Structure of Pump

FS-100NF

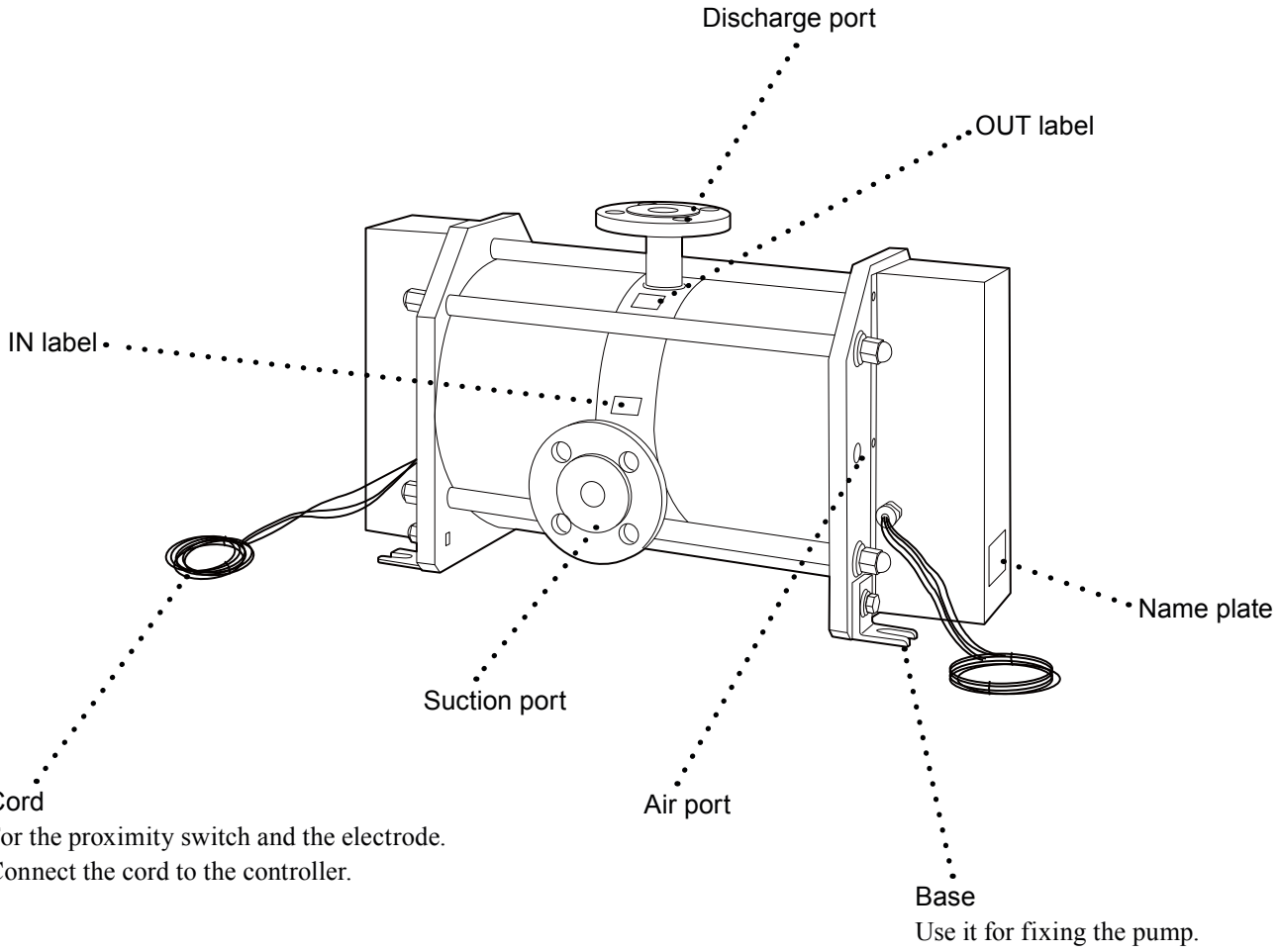


No.	Parts Name	Q'ty	Material	Remarks	No.	Parts Name	Q'ty	Material	Remarks
1	Pump head	1	PTFE		32	Spring washer	4	Stainless steel	M3
2	Bellows	2	PTFE		33	Cylinder head cover	2	SUS304	PTFE coated
3	Suction valve case	2	PTFE		34	Cord ground	2	PP	SCL-6A
4	Discharge valve case	2	PTFE		35	Stud bolt	4	SUS304	PTFE coated
5	Valve	4	PTFE		36	Domed cap nut	8	Stainless steel	M16 PTFE coated
6	Bellows plate	2	SUS304		37	Spring washer	8	Stainless steel	M16 PTFE coated
7	Bellows flange	4	SUS304		38	Plate washer	8	Stainless steel	M16 PTFE coated
8	Hex. soch cap bolt	16	Stainless steel	M8×22	39	O ring	4	FKM	AS568-270
9	Spring washer	20	Stainless steel	M8	40	Leak sensor	4	SUS304	
10	O ring	2	FKM	G-135	41	Gasket	4	PTFE	
11	Pump shaft	2	SUS304	Hard chrome plating	42	O ring	4	FKM	S-4
12	Connecting plate	2	SUS304		43	O ring	4	FKM	S-12
13	Connecting shaft	2	SUS304		44	Gasket C	4	PTFE	
14	Shaft cover	2	SUS304	PTFE coated	45	Plate washer	4	Stainless steel	M4
15	Hex. bolt	2	Stainless steel	M16×45	46	Spring washer	32	Stainless steel	M4
16	Spring washer	2	Stainless steel	M16	47	Hex. nut	8	Stainless steel	M4
17	O ring	2	FKM	S-53	48	Cord (Black)	2	——	
18	Hex. soch cap bolt	4	Stainless steel	M8×40	49	Cord (White)	2	——	
19	Cylinder	2	A6063	PTFE coated	50	Flange tube	2	PTFE	
20	Cylinder head	2	A5083P	PTFE coated	51	Flange	2	SUS304	JIS20K25A
21	O ring	2	FKM	S-44	52	Screw	12	Stainless steel	M4×8 PTFE coated
22	Packing stopper	2	SUS304		53	Base	4	A6063	PTFE coated
23	Screw	8	Stainless steel	M4×8	54	Hex. bolt	4	A6063	M12×25 PTFE coated
24	Shaft packing	2	FKM		55	Spring washer	4	Stainless steel	M12 PTFE coated
25	Bearing	2	Filled PTFE		56	Plate washer	4	Stainless steel	M12 PTFE coated
26	Stop ring	2	Stainless steel	Nominal 45	57	Bush A	2	A5056B	PTFE coated
27	O ring	4	FKM	P-20	58	Hex. soch cap bolt	24	Stainless steel	M4×22
28	Guide bush	4	POM		59	O ring	2	FKM	G-65
29	Proximity detector	2	——		60	Bush B	4	A5056B	PTFE coated
30	Installed base	2	PP		61	Hex. soch cap bolt	12	Stainless steel	M4×10 with spring washer
31	Screw	4	Stainless steel	M3×25					

7. Description of Body and Label

⚠ **CAUTION**

When cleaning the pump be careful not to wipe the labels or the pump body with solvent.



INSTALLATION SECTION

1. Before Use

Through understanding of the safety precautions described below are essential. Read them thoroughly before operation to ensure the safe operation of the pump and system.

To operate this pump, a solenoid valve and a controller (FDC-1, FD, or AC-1 controller) are required. In addition, a quick exhaust valve needs to be installed in order to enhance system safety. Purchase separately.

<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 the pump over 100spm.</td><td>● If many bubbles are sucked into the pump head, air lock may occur. In this state the pump runs dry and stroke rate increases to an abnormal level. Do not allow many bubbles to enter the pump.</td></tr>
<tr><td>2</td><td>○ Do not run the pump beyond the permissible supply air pressure range of 0.196-0.686MPa.</td><td>● For reduce the possibility that the supply air pressure may exceed the pressure resistance of the filter or bellows, keep supply air pressure low as much as possible to ensure safety.
● If supply air is not stable, discharge capacity changes. In this case attach the pressure reducing valve.
<table>
<tr><th>Pump type</th><th>Liquid temperature range</th><th>Supply air pressure range</th></tr>
<tr><td>FS-100NF</td><td>5-60 deg.C</td><td>0.196-0.686 (MPa)</td></tr>
</table></td></tr>
<tr><td>3</td><td>○ Liquid temperature range</td><td>● Liquid temperature must be 5-60 deg.C.</td></tr>
<tr><td>4</td><td>○ Prohibited liquids
⚠CAUTION
Do not use the following.
• Liquids that easily crystallize
• Liquids containing slurry
• Low conductivity carbon hydrate liquid</td><td>● Service life of valve & bellows will shorten when handling a liquid which easily crystallizes or contains slurry. Do not handle such liquids with this pump.
● If solvent naphtha is used, electrostatic destruction may be generated between fluororesin & liquid, finally producing pinholes.</td></tr>
<tr><td>5</td><td>○ Liquids to be handled with care
· Stripper
· Solvent type liquids
· Fuming sulfuric acid
· Fuming nitric acid</td><td>● Some types of strippers may cause cracks in the bellows or piping (PFA) at an early stage (Contact Iwaki for a different warranty period applied for such liquids.).
● An explosion-proof construction are required to use solvent type liquid (Contact Iwaki for details.).
● Ventilate your working area. Corrosive gas can generate if fuming sulfuric acid or fuming nitric acid is used.</td></tr>
<tr><td>6</td><td>○ Always stop the pump with discharge valves open.</td><td>⚠CAUTION
Stopping the pump without releasing discharge pressure may deform the bellows.</td></tr>
</table>

No.	Points to be Observed	Description
7	○ Do not have the pump unused for a long period with a liquid in the pump.	⚠**CAUTION** Suspending operation for a long period with a liquid in it may corrode the electrode or other parts. Some chemicals can penetrate component parts. (The pump needs to be operated for 10 minutes every day for replacing air.)
8	○ Do not narrow air exhaust port or tubing bore.	⚠**CAUTION** If the bore of an air exhaust port is narrowed, the air can not be sent smoothly and the bellows may be deformed.
9	○ Do not supply air to both right & left air supply ports at once when pump is stop.	⚠**CAUTION** ● If the air is supplied to both right and left air chambers when pump has stopped, the bellows may be deformed.
10	○ Do not close the secondary-side air valve as stopping the pump.	⚠**CAUTION** ● If the secondary-side air valve on the liquid line is closed as the pump stops, impact pressure may deform the bellows or connecting plate. ● The secondary-side air valve should be kept open except for drainage.

■ Other precautions

[1] Surface temperature of pump

⚠**WARNING**

Wear protective gloves. The temperature of the pump body and the piping surface is almost equal to the liquid temperature.

Model	Liquid temp.	Max. cylinder surface temp.	Room temp.
FS-100NF	60 deg.C	38 deg.C	23 deg.C

[2] Noise from pump

Exhaust noise accompany pump operation. Apply a protective measure as necessary.

Model	Supply air pressure	Stroke speed	Sound level
FS-100NF	0.686 MPa	100 spm	79.0 dB(A)

Note: Noise includes machine noise of the pump, solenoid valve, and mufflers.

2. Installation, Piping, and Wiring

When perceiving any danger or abnormal condition during installation or set-up, stop the work.

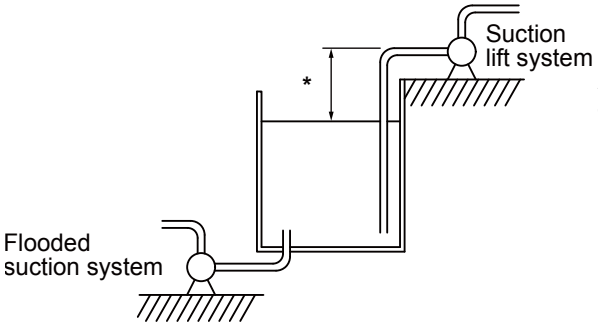
⚠WARNING

Be sure to turn off the power before starting any maintenance/repair work. Make sure no one turns on the power while working on the pump, otherwise it may result in a serious accident. If your work field is noisy or dark, let other people know about the situation by displaying a notice such as "POWER OFF(Maintenance)" near the power switch.

Electrical wiring works must be done by well-trained operator(s). We are not responsible for any injury or damage due to improper works.

2.1 Installation

[1] Pump installation position



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

⚠CAUTION

Arrange piping in a flooded suction system for feeding a liquid at higher temperatures than room temperature or for circulating a liquid in system.

- **Suction lift system**
  Have the suction side piping short and thick as much as possible within self-priming height and install the pump as close to the tank as possible.
  * Self-priming height
  (When pumping clean water at normal temperature at the max. stroke speed)
  FS-100NF : 1m

⚠CAUTION

The self-priming height is on pumping clean water at the max. stroke speed at room temperature. The suction height differs with liquid, temperature, or suction pipe length. For detailed information, contact us.

[2] Installation foundation

Select a flat and solid foundation (such as a chassis) a installation location where free form vibration.

[3] Horizontal installation

Position the pump with its discharge port upward and suction port sideward. Secure the pump with anchor bolts.

[4] Re-tightening of stud bolts (for securing air seal)

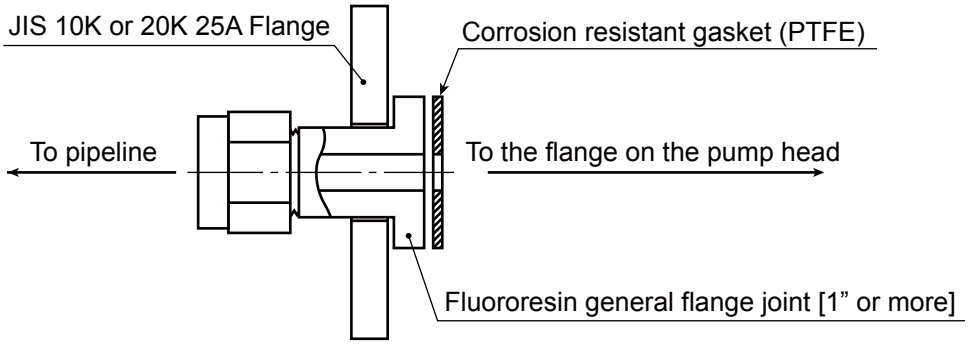
Retighten the stud bolts on the cylinder head by 30.0N•m.

⚠CAUTION

Make sure that the cylinder head is secured by tightening stud bolts at 30.0N•m before operation. If the pump runs with the cylinder head loose, liquid/air may leak.

2.2 Liquid Tubing

Take the following steps to connect JIS20K25A flanges.



[1] Inlet & outlet bore and materials

JIS20K25A flange is normally fitted to inlet & outlet of the pump. Pipe (tube) bore and fitting bore should be equal to or more than 1".

[2] Air blow or flush piping (tubing) to get rid of foreign matters prior to connecting it with the pump.

[3] Do not force the pump into piping (tubing). Use pipe (tubing) supports to reduce vibration and thermal stress.

[4] Be sure to secure each connection to prevent leakage and air suction.

[5] General joints can be used, however, they should not allow any leakage for the liquid temperature between 5 and 60 deg.C.

2.2.1 Points to be observed in suction pipe arrangement

[1] Suction piping should be short with a wide bore in flooded suction. A suction height should be adjusted depending on the self-priming height of the pump.

* The suction height differs with the liquid's characteristics, temperature, and suction pipe length. For detailed information, contact Iwaki.

[2] Install a filter or strainer at the end of suction pipe to prevent particles from entering the bellows. The filter or strainer should not increase piping resistance too much.

⚠CAUTION

If fragments enter the pump, they may get stuck in the bellows and eventually cause failure. If it clogs the valves, the discharge volume may reduce and the pumping operation is unbalanced.

[3] When installing a valve on the suction pipe, its orifice should be larger than pipe bore. If orifice is too small, inertial resistance may increase and crystallized substances may get stuck in the valve. During pump operation always keep the valve open.

⚠CAUTION

Operating the pump with the suction side valve close, negative pressure increase in the bellows and deform the bellows inwardly.

2.2.2 Points to be observed in discharge pipe arrangement

[1] The pipe resistance increases as discharge piping becomes long or pipe has many bends on it. In order to decrease pipe resistance, install a dampener which minimizes pulsation. When sending a liquid up via a riser pipe, install a check valve.

[2] When installing a valve in discharge pipe, select a valve with an orifice whose diameter is larger than pipe bore. A valve with a small orifice may increase the pipe resistance or easily be clogged with crystals. Always open valves 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 a discharge-side valve right after stopping the pump. Impact pressure may deform the bellows.

[3] Take account of filtering area, grain-removing performance, and effect on flow for using the filter. Desired flow may not be obtained if selection is wrong.

⚠CAUTION

Dampen the filter before use. A desired flow may not be obtained if the filter is not dampened. Filter becomes dry if it is unused for a long period. Read the instruction manual of the filter for details.

[4] Be sure to release discharge pressure when stopping the pump by the filter and the air vent valve, or a return circuit.

⚠CAUTION

Discharge-side pressure may deform the bellows when stopping the pump.

2.3 Air Piping

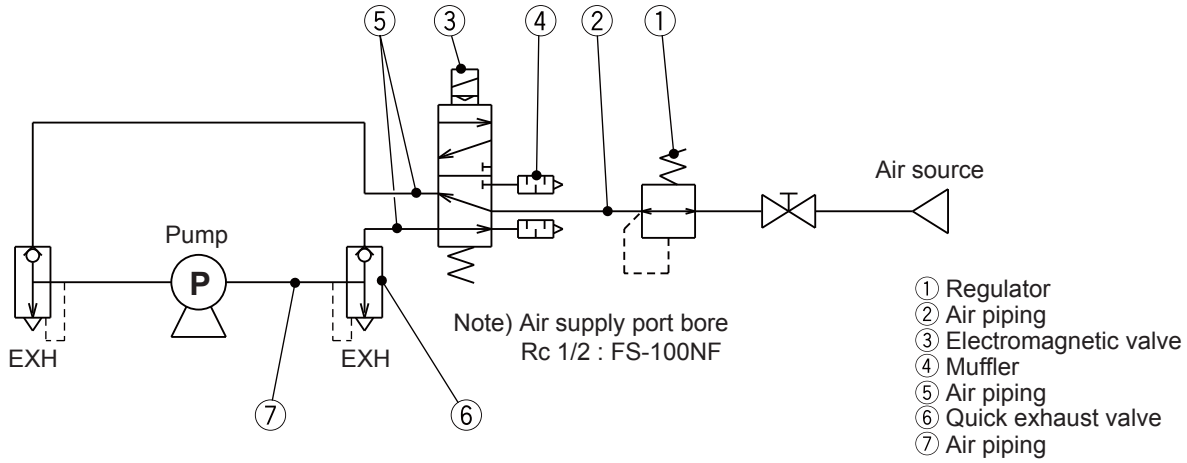
⚠CAUTION

○ Supply air should be free from moisture and dust. If the supply air is contaminated with water, oil, or dust, the pump may fail in starting. If water enter the air chambers, the electrode may detect it and sounds an alarm.

○ The following troubles may occur with the FS-100NF if the air supply tubing is long/ narrow.
Long/narrow air supply tubing prevents....
a. The compressed air from coming out from the air chamber. This may deform the bellows inwardly.
b. Acceleration. This may reduce flow.

2.3.1 Air piping diagram

Complete air piping in accordance with the diagram below.



[1] Regulator

Select one regulator per pump in accordance with the air consumption of the pump (Pressure drop should be at or below 20KPa.)

⚠CAUTION

Set the supply air pressure within the allowable supply air pressure below.

Pump type	Liquid temperature range	Allowable supply air pressure
FS-100NF	5-60 deg.C	0.196-0.686 (MPa)

⚠CAUTION

Just one regulator can not cover two or more solenoid valves, the valve located farthest from the regulator may malfunction due to a low pressure.

[2] Air piping

• The air pipe bore between the regulator and the electromagnetic valve should be 12mm or more.

[3] Solenoid valve

Select a 5 port solenoid valve which satisfies the necessary effective cross-sectional area and the port bore. See the table below.

Model	Necessary effective cross-sectional area	Connection port bore
FS-100NF	100mm^2 or larger	Rc 1/2" or larger

⚠CAUTION

Use a 2-position double-solenoid valve. Using a 3-position type, the bellows may be deformed because some 3-position solenoid valves pressurize/depressurize both the air chambers when the pump has stopped.

[4] Muffler

Mufflers should be installed on the exhaust ports of the solenoid valve and quick exhaust valves.
FS-100NF: Effective cross-section area of the mufflers should be 90mm^2 or more.

[5] Air piping

Air piping between the solenoid valve, the pump, and the quick exhaust valves should satisfy the specified requirement below.

	FS-100NF
Pipe length is within 1m	Inner diameter should be 11mm or more
Pipe length is between 1 - 3m	Inner diameter should be 12mm or more, otherwise use quick exhaust valves.
Pipe length is 3m or more	Contact Iwaki

⚠CAUTION

Right and left air pipe length should be equal. Extremely different length can make pulsation big and can affect flow.

[6] Quick exhaust valve

The air from the pump is exhausted via the exhaust ports of the solenoid valve (Fig. 1).
Some chemical generates permeable gas. The gas may mix with the exhaust air and may corrode the solenoid valve. In this case install quick exhaust valves between the pump and the solenoid valve so that the air will be exhausted through the quick exhaust valves (A slight amount of the air will be exhausted through the electromagnetic valve.). Quick exhaust valves are recommended to be directly installed to the air port on the pump, otherwise install them within 0.5m from the pump (Fig. 2).

• Air flow

Fig.1 Air flow without quick exhaust valves

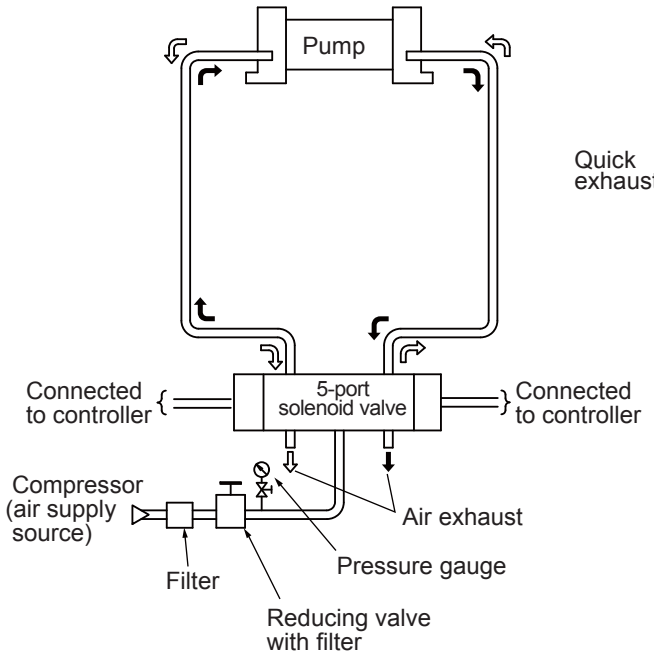
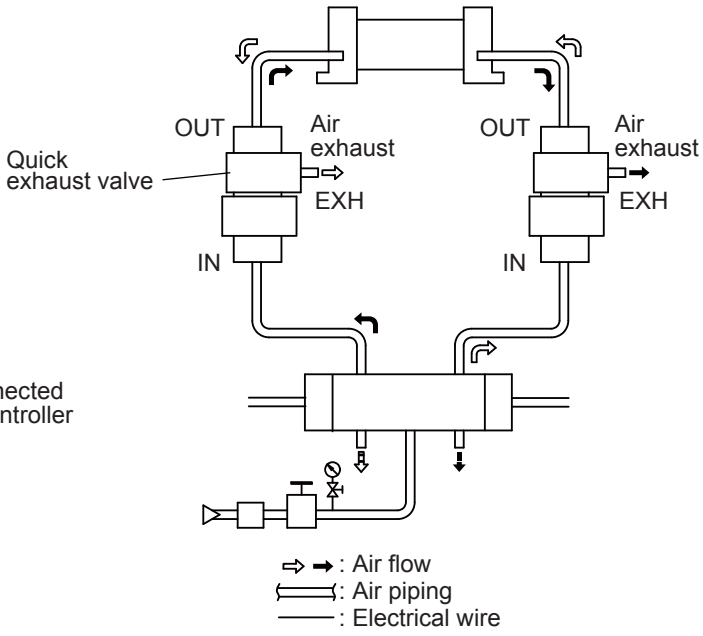


Fig. 2 Air flow with quick exhaust valves



2-position 5 port single solenoid valve

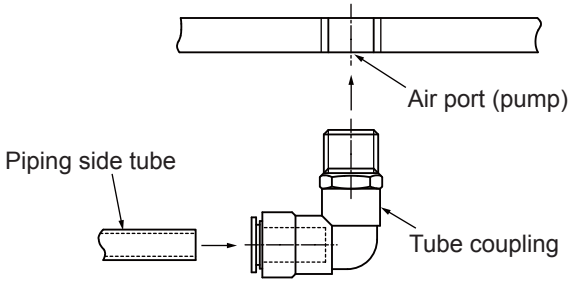
Note1: The quick exhaust valve has IN, OUT, and EXH ports (stamped on the valve.). See Fig.2.
Note2: Regarding the quick exhaust valve, use aluminium one with the pressure resistance of 0.7MPa or more.

[7] Air piping

The air piping between the quick exhaust valves and the pump should satisfy the requirement below.

	FS-100NF
Piping length	0.5m or less
Pipe inner diameter	11mm or more

2.3.2 Points to be observed in air piping



[1] Air port bore

The air port connection bore

FS-100NF: Rc 1/2"

[2] Pressure reducing and relieving valve

Fluctuation of supply air pressure affects stroke rate and discharge volume. Install a pressure reducing and relieving valve to maintain the supply air pressure constant.

[3] Safety valve

Install a safety valve to keep the supply air pressure within allowable supply air pressure below.

Pump type	Liquid temperature range	Allowable supply air pressure
FS-100NF	5-60 deg.C	0.196-0.686 (MPa)

[4] The exhaust air from the mufflers and solenoid valve

The exhaust air from the mufflers and the solenoid valve should be released into the open air.

⚠CAUTION

Narrowing the air exhaust port makes the air less likely to come out of the pump. As a result the bellows may be deformed inwardly. Select necessary air devices with reference to the air piping diagram on page 17.

[5] Reduction of exhaust noise

To reduce exhaust noise, release the exhaust air through the duct of the plant facility to the air, or attach silencers to exhaust ports.

[6] When Installing 2 or more pumps

The air consumption for total pumps increases in relation to the compressor capacity. Optimize pipe bore taking account of the total number of pumps.

2.3.3 Effective cross-sectional area

[1] Effective cross-sectional area

In the field of pneumatic devices, the term “Effective cross-sectional area” is used to indicate actual air flow. When the air is sent through a pipe, the air cannot run totally for the actual cross-sectional area due to piping resistance. The larger the effective cross-sectional area is, the more air flows.

• For detail effective cross-sectional area at each pneumatic device, see the catalogue issued by manufacturers.

[2] Composite effective cross-sectional area

Air devices are connected in series with the pump. It is necessary to determine the composite effective cross-sectional area of the entire system by calculating the exhaust-side effective cross-sectional area at each device.

Composite effective cross-sectional area is calculated from the following formula.

$$\frac{1}{S^2} = \frac{1}{S1^2} + \frac{1}{S2^2} + \text{---------} + \frac{1}{Sn^2}$$

S : Composite effective cross-section area

Si: Effective cross-sectional area of each part

Effective cross-sectional area of air device/air pipe: See the catalogue issued by each manufacturer.

Required composite effective cross-sectional area
FS-100NF type S=43.5mm^2 or larger

Confirm that the composite effective cross-sectional area of the actual air piping is 43.5mm^2 or larger.

2.3.4 Preventive measures against condensation

If condensation is likely to occur in the pipe between the pump and solenoid valve, take the following preventive measures.

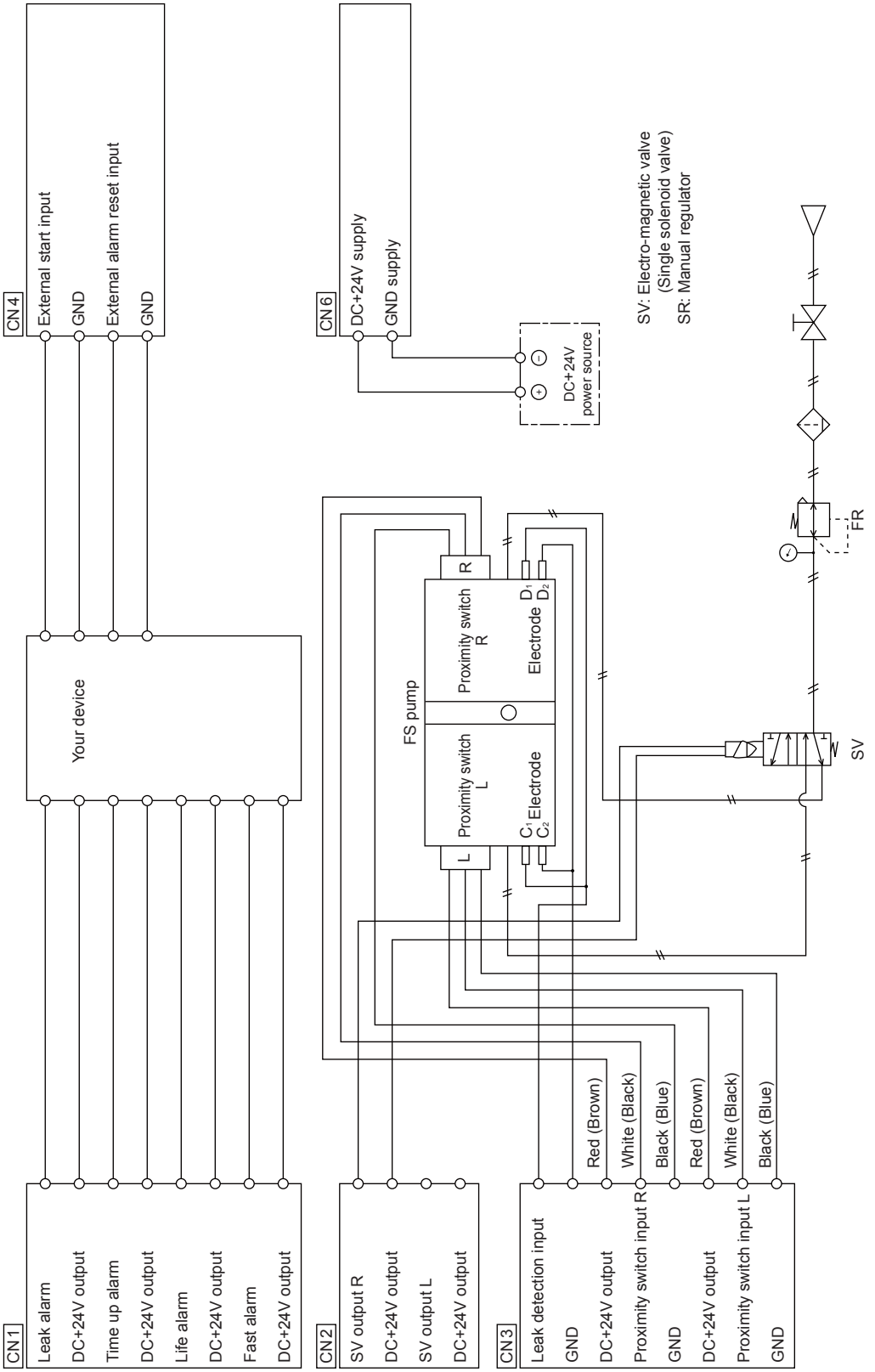
- Reduce supply air pressure as much as possible. (Reduce pump speed)
- Arrange a heater (or heat insulator) system over the piping.
- Feed the heated and compressed air to the pump. Observe the temperature limits of the pipe joints, solenoid valve, and other component parts when heating the pipe or compressed air.

2.4 Wiring

The FDC-1, FD, or AC-1 controller are required together with a 5 port solenoid valve for operating this pump. For wiring, refer to the instruction manual of each controller.

2.4.1 Wiring diagram (with the FDC-1 controller)

The following shows a wiring diagram for the FDC-1 controller. Refer to instruction manual of each controller for further information.



Note: Electro-pneumatic regulator can not be used.

[1] Wiring for proximity switch

⚠CAUTION

The proximity switches of the FS-100NF has three wires: black, white, and red. Improper wiring may cause a fire. Carry out wiring work properly.

►Proximity switch R: Connect the wires (black, white, and red) with terminals CN3 of the controller.

►Proximity switch L: Connect the wires (black, white, and red) with terminals CN3 of the controller.

Wire colour	Specification
Black	0 V
White	Output
Red	Power voltage (DC10V - DC30V)

⚠WARNING

Standard proximity switches cannot be used when a flammable liquid such as solvent is used. The proximity switch should be in explosion-proof specifications for pumping of a flammable liquid. Ask Iwaki or your dealer.

[2] Wiring for electrode

Connect white and black wires (approximately 1.8m), which are extended from both the right and left sides of the pump with controller terminals CN3.

►Join right and left white wires and connect it with controller terminal CN3.

►Join right and left black wires and connect it with controller terminal CN3.

• Never connect the white and black wires. This will result in electrical conduction between the two lines.

⚠WARNING

The use of an electrode is prohibited when a flammable liquid such as solvent is pumped. A spark in a solvent may cause a fire.

[3] Wiring for solenoid valve

Connect the cord of the solenoid valve with the controller terminal CL2. Refer to instruction manual of solenoid valve for detail information.

⚠CAUTION

Be careful about the +/– polarity in wiring. Improper polarity may result in breakage.

Note:

The 'normal-open' should be connected to the proximity switch R and 'normal-closed' should be connected to the proximity switch L. The pump does not run with wrong connection. To run the pump, interchange the air piping of the solenoid valve or interchange the wires between proximity switches R and L.

2.4.2 Wiring instructions

[1] Extension of electrode wire

Keep the resistance of the electrode + the attached lead wire (about 1.8m in length) at or below 5k Ω. When the resistance is beyond the detection range, the auto-stop alarm for the bellows failure can not be detected.

[2] Wiring of proximity switch

Do not band the wires of the proximity switch with the power line or other high-voltage cable. Do not install them in the same duct or in the same cable tube, otherwise the switch may malfunction. The cross-section of the switch wire should be 0.3mm^2 or more when wire length is within 30m. The resistance should be 100 Ω/km or less when wire length is more than 30m.

OPERATION SECTION

1. Preparation

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

[1] Confirm that the electric wiring is correct (Wiring for the proximity switch and solenoid valve).

⚠CAUTION

Improper wiring may cause burned proximity switch.

[2] Confirm that the air piping are correct. Check for loose couplings.

[3] Confirm that the pump is fixed in place.

[4] Confirm that piping connections are secured.

[5] Confirm the valves on the suction and discharge piping are fully opened.

[6] Confirm that the tank is filled with liquid.

⚠CAUTION

Conduct a trial run with pure water to confirm there is no abnormality before operation.

[7] Confirm that the filter is well dampened.

⚠CAUTION

Follow the instruction manual of the filter.

2. Pump Operation

During the trial run of the pump, flush the unit and piping at the same time.
(Refer to the instruction manual of each controller before operation.)

2.1 Starting pump

[1] Supply air to the pump

• Set the regulator to a specified supply air pressure (when pump has stopped).

⚠CAUTION

Set the supply air pressure within supply allowable pressure range.

Pump type	Liquid temperature range	Allowable air pressure range
FS-100NF	5-60 deg.C	0.196-0.686 (MPa)

⚠CAUTION

Adjust the speed controller on the discharge-side air pipe from the regulator so that the pump can not run over a specified stroke rate even if the pump is in no-load running. Refer to "Product outline" 4. Specification.

[2] Use the controller to start the pump

Refer to the instruction manual of each controller for detail.

2.2 Stopping the pump

[1] Use the controller to stop the pump. Refer to the instruction manual of each controller for detail.
[2] Make sure the discharge-side valves are open when stopping the pump.

⚠CAUTION

Do not close any discharge-side valve right after stopping the pump.

[3] Be sure to release discharge-side pressure when the pump has stopped.

2.3 Adjustment of discharge capacity (Output)

[1] Flow can be changed by adjusting air flow and supply air pressure.

3. Points to Be Observed in Operation

Pay attention to the following points during operation.
Upon detecting any abnormal condition, stop the pump 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 specified one.
2	Is air pressure at normal?	Supplied air must be within specified one.
3	Is supply air volume enough?	
4	Is there any leakage in sealed section of air or liquid piping?	
5	Is supply air clean?	

MAINTENANCE SECTION

1. Causes of Trouble and Troubleshooting

Trouble	Causes	Countermeasures	Inspection and check points
Pump does not operate.	Switchover failure of solenoid valve.	① Inspect/repair/replace.	a Use a quick exhaust valve if corrosive gas influences.
	Improper wiring or disconnection in proximity switch	① Inspect, correct wiring. ② Replace if it is burned.*	a Check if wires are arranged as described in the manual. b Check air piping and wiring.
	Bellows are damaged. (Alarm output)	① Replace the bellows.*	a Check if supply air pressure is within specification. b Check if stroke speed is within specification. c Check if liquid temperature is within specification. d Check if discharge-side pressure is released when the pump has stopped. e Check if air pipe is too narrow/long. f Check if suction pipe is narrowed.
	Discharge pressure in pipe increases.	① Inspect the filter and replace it as necessary.	a Check filter for clogging, dry-up, or air elimination. b Check if filter is well dampened.
	Discharge side valve is closed.	① Open discharge-side valves.	
	Supply air pressure or air volume is too low.	① Reset the system.	a Set pressure higher than minimum operation pressure of solenoid valve. b Secure proper air pipe bore and air flow taking account of the number of pumps installed.
	Malfunction of electrode	① Remove moisture from the air chamber and supply air.	a. Check the cause of moisture generation in the pump and the supply air.
Pump operates but not discharge any liquid.	Valve is clogged with foreign matters.	① Install a filter (with less pressure drop) on suction piping.	a Check if operation is unbalanced or not.
	Wear of valve and valve seat	① Replace the pump head and bellows unit*	
	A suction side valve is closed.	① Open the suction-side valve.	a Check if the valve is blocked with crystal.

Note: Repair works marked by * should be conducted by Iwaki.

Trouble	Causes	Countermeasures	Inspection and check points
Discharge volume is reduced.	Supply air pressure or air volume is reduced.	① Reset system or review air flow.	a Secure a air pipe bore and air flow taking account of the number of pumps installed.
	Discharge pressure increases	① Review discharge conditions.	a Check filter for clogging or dry-up. b Check if the air is removed from the filter well. c Check if discharge-side valves are open.
	Wear of valve or valve seat due to clogging with foreign matter.	① Inspect/clean/replace the pump head.*	a Install pump guard filter on the pump suction pipe.
	Insufficient NPSHa (Net positive suction head available)	① Check suction conditions.	a Check if suction pipe is too narrow or too long.
Liquid leaks.	Bellows are damaged.	① Replace the pump head and bellows unit.*	a Check if supply air pressure is within specification. b Check if stroke speed is within specification. c Check if liquid temperature is within specification. d Check if discharge-side pressure is relieved when the pump has stopped. e Check if air pipe is too narrow/long. f Check if suction pipe is narrowed.
Excessive air consumption	Wear of shaft packing	① Replace shaft packing.*	
	Stud bolt is not secured.	① Retight stud bolts	a. Retighten stud bolts on specified torque. See 2.1 Installation [4].
Pump operation is not balanced.	Wear of valve or valve seat	① Replace the pump head and bellows unit.*	
	Faulty switchover of solenoid valve	① Inspect/repair/replace.	a Set supply air pressure higher than minimum operation pressure of solenoid valve.
High vibration or noise level	Pump fixation is loose.	① Secure the pump by tightening anchor bolts.	
	Pump stroke speed is excessively high.	② Set stroke speed within the specification.	a Lower supply air pressure or reduce air flow.

Note: Repair works marked by * should be conducted by Iwaki.

2. Maintenance and Inspection

⚠ WARNING

- **Wear protectors**
  Always wear protective clothing (protective goggles, cap, mask, etc.) during maintenance and inspection work.
- **Release pressure out of piping**
  Residual pressure in the piping may splash liquid and cause an unexpected accident. Release the residual pressure before work.
- **Power OFF**
  Be sure to turn off the power before starting a maintenance/repair work. Make sure no one turns on the power while working on the pump, otherwise it may result in a serious accident. Let other people know about the situation by displaying a notice such as "POWER OFF(Maintenance)" by the power switch.

2.1 Periodic inspection

[1] Check stroke speed has not reduced (At least once a month)

Stroke speed reduces due to air leakage. The wear of shaft packing is possible for air leakage. Replace the shaft packing as necessary.

* This repair work shall be conducted by Iwaki.

[2] Check valve and bellows (At least once a month)

Valve and bellows are consumable parts and need to be replaced about their estimated life span or when their performance deteriorates. (Life span at each consumable part differs with a liquid handled and operating condition.)

* This repair work shall be conducted by Iwaki.

[3] Operation of the pump after a long period of suspension

Feed the air to the pump (approx. 0.196MPa) and confirm there is no air leakage from the discharge port before operation.

3. Consumable Parts

The consumable parts shown below should be replaced when it reaches the estimated life end or when performance deteriorates remarkably, whichever comes fast. Contact IWAKI.

FS-100NF

No.	Parts name	Q'ty	Estimated life span
1, 2, 3, 4, 5, 6, 50, 51	Pump head & bellows unit	1	One year (when continuous operation)
25	Shaft packing	2	

Note1: The estimated life span vary with operational condition and is not warranted.
Note2: Q'ty shows the number of parts.
Note3: Refer to page 9 "6. Names of Parts and Structure of Pump" for parts No.

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