



Operation Manual

Process pump

PAF5413

SMC

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Safety instructions

This operation manual indicates the precautions for safety use of process pump with the level of potential hazard as follows. Those precautions contain the content essential to keep safety.



Warning

Operator error could result in serious injury and loss of life.



Caution

Operator error could result in injury or equipment damage.

1. Precautions for handling

Warning

1) Operating environment

- When dangerous fluid or fluid possibly harmful to human is used, take measure to isolate human from the pump. Should the external leakage of transported fluid come out, the serious damage to human could be caused.
- When flammable or highly corrosive fluid is transported, keep the fire source away from the pump. Otherwise, the fire and explosion could be caused.
- Prevent splash of corrosive fluid or other solvents to the external face of the pump.
- If attachment of unknown liquid is found on the external face of the pump, do not touch it without care.

2) External leakage of transported fluid

- When flammable or dangerous fluid is transported, keep the fire source and corrosive material away from the pump. For this purpose, prepare the vessel for possible leakage and take other measures to prevent contact with the fire source and corrosive material. Otherwise, the fire and explosion could be caused.
- During operation of pump, the transported fluid could leak due to life out of the diaphragm. In this case, take prevention for the leakage to avoid adverse effect to human or facility.
- Do not touch the leakage of fluid without care. If the fluid has high temperature or is chemical, the contact could result in burn and other injuries.

3) Disassembly

- Do not disassemble the pump.

Caution

1) Quality of supplied air

- Mount the filter with filtration of approx. 0.01 μ . For the quality of air to be used, refer to Compressed Air Cleaning Equipments Catalog No. 5*

*Typical circuit shown on No.5

Compressor → HAW(after cooler) → AT(air tank) → AFF(main line filter) → IDF(refrigerating air dryer) → AM(mist separator) → AMD(micro mist separator) → PAF

- If the amount of foreign materials generated from air supply (carbon powder etc.) is large, mount super mist separator etc. to reinforce prevention for attachment of dust. Deposit of foreign materials could increase resistance and prevent smooth operation.

2) Quality of transported fluid

- If it is known solid materials enter the transported fluid, mount the filter with filtration of 0.2mm at least on fluid in.

3) Life and replacement

- Suspend operation and replace the diaphragm before it reaches the end of life. If the diaphragm breaks, the transported fluid leaks inside the pump and exhaust port, and the internal parts of the pump are damaged and the air blows FLUID OUT port.

Calculation of life of diaphragm (depending on operating conditions)

Referential
$$\text{life date} = \frac{50 \text{ million cycles (referential life cycle)}}{\text{Frequency of solenoid valve(Hz)} \times 60(\text{sec}) \times \text{operating time per day(hour)} \times 60(\text{min.})}$$

- The discharge amount per one cycle is about 0.190 ℓ when there is no piping resistance. The pump internal capacity is about 600 m ℓ .

4) Pilot air

- Confirm the supplied pilot air is within specified range from 0.2 to 0.5MPa. The air out of this range could cause malfunction, stop of operation, damage of internal parts and external leakage.

5) Discharge amount and suction head

- Given discharge rate and suction head are for the condition with fresh water, room temperature, atmospheric pressure and no piping. Thus, they are varied by physical characteristic of transported fluid, and in some cases, enough suction head can't be obtained.

6) Max. discharge amount

- Given max. discharge rate is for the condition with supplied pressure of 0.5MPa, piping I.D. of 6mm, piping length of 0.5m, solenoid valve VQ4000 mounted, cycle of 3Hz and no load.

7) Operating temperature

- The pump is available from 0 to 90 °C, but should be cared not to freeze. (Avoid exposure to heat cycle.)

2. Precaution for installation

⚠ Caution

1) Mounting

- Only horizontal mounting is available. When the pump is not mounted horizontally with its bottom faced down, it may cause sucking failure.
- Use four M8 bolts to mount the pump. If the bolts are not tightened firmly, the pump could be exposed to the vibration and eventually damage.

2) Piping

- Perform flushing enough for piping to avoid intrusion of cutting chips and sealant debris created by screwing the piping and fitting. If the tape is used for sealing, leave two threads exposed.

3) Material of fitting

- The threaded part is made of resin. Thus, do not tighten the metal fitting to avoid collapse of the thread.

4) Tightening torque

- Insufficient tightening torque could cause external leakage and excessive one could damage threaded part and parts. Keep adequate value for tightening.

Thread size	Adequate tightening torque (N·m)
Rc1/4	0.4 to 0.5
Rc3/4	4 to 5

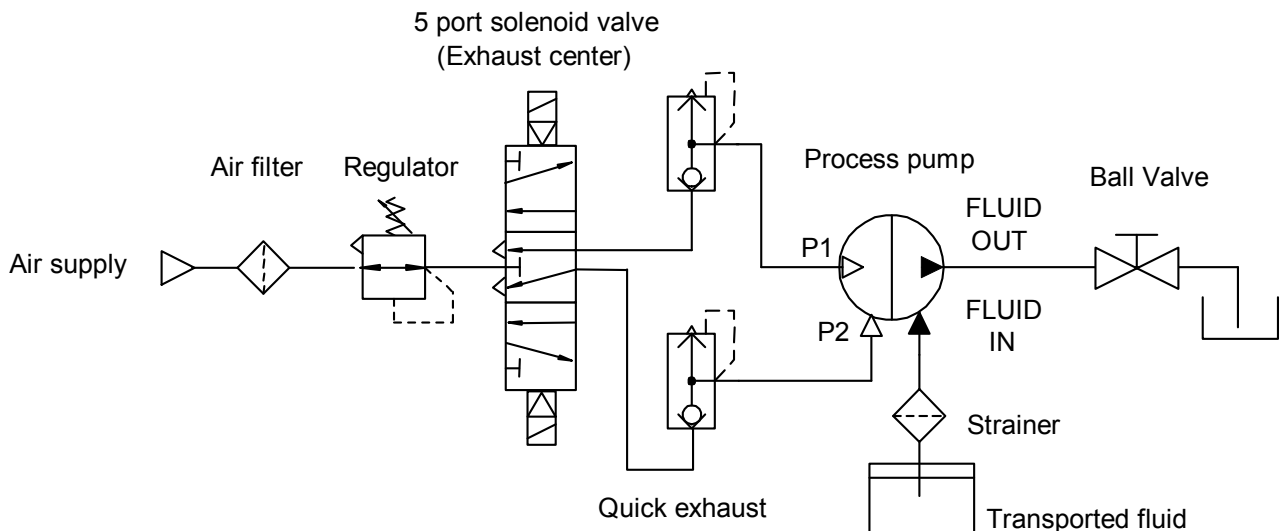
3. Description and function of individual port

Suction port (FLUID IN) --- To suck transported fluid. Connect suction piping.

Discharge port (FLUID OUT) --- To discharge fluid sucked inside the pump. Connect discharge piping.

Pilot air port (P1, P2) --- To supply and exhaust the air at set pressure. Connect air piping.

- Typical circuit



4. How to use



Caution

1) Start and stop

- Connect the supply and exhaust port "P1", "P2" with air piping and suction port "FLUID IN" and discharge port "FLUID OUT" with transported fluid piping respectively. If it is concerned molecular of transported fluid permeates PTFE diaphragm and gives adverse effect on the solenoid valve, mount compatible quick exhaust valve before the solenoid valve to prevent exposure to exhausted fluid.
- Set pilot air pressure in a range from 0.2 to 0.5MPa.
Keep the valve at discharge side open. When the solenoid valve at air supply side is energized, the air is supplied for "P1" and "P2" and the pump starts. The solenoid valve is adjusted to switch at 2 to 4Hz. Then, after a while, the fluid starts flowing from suction port "FLUID IN" to "FLUID OUT".
- To stop the pump, cut off the supply of air and exhaust the air inside the pump.

2) Adjustment of discharged flow rate

- The discharged flow rate is adjusted by opening and shutting level of the valve connected at discharge side or solenoid valve. Sudden close of these valves could cause surge and shorten the life of pump remarkably, and so must be avoided.

5. Maintenance and check

1) During operation

- During operation of pump, it is necessary to check leakage of fluid and air and operating condition periodically. If any abnormality or concern is seen, stop the pump immediately and contact local supplier or SMC.
- When touching the pump for maintenance, put the protective tool such as glove which isn't affected by transported fluid to prevent burn.

2) During stop

- If the pump is stopped for a few hours, exhaust the air at supply side.
- If the pump is left unused for extended period, clean inside of the pump to prevent adherence and sticking of transported fluid over the time which could cause abnormal operation.

3) Check and repair

- Replace the diaphragm before it reaches referential life cycles (specified cycles). If the pump is continued after the life of diaphragm, the check valves of wetted part as well as the diaphragm are deteriorated and operating failure could be caused.

6. Specifications and how to order

• Specifications

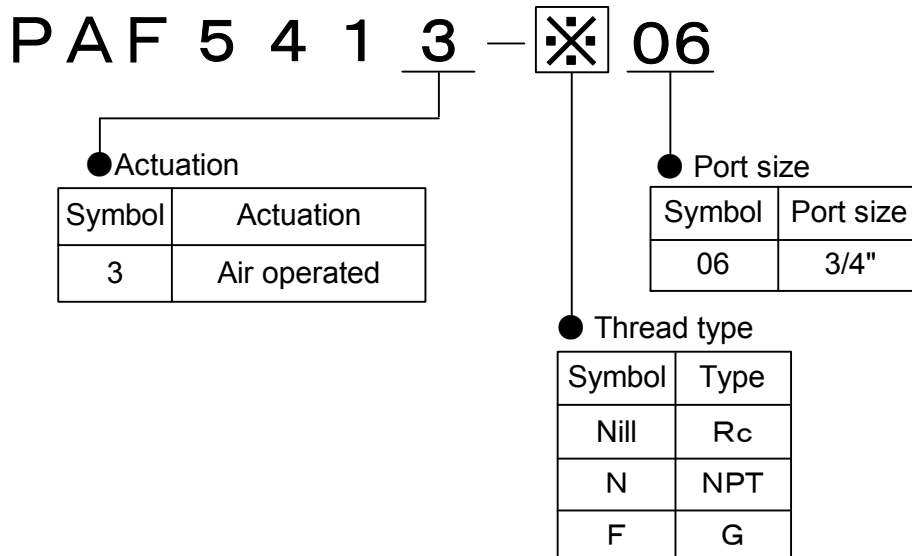
Model		PAF5413
Port size	Main fluid suction / discharge port	Rc, G, NPT 3/4, 3/4 tube piping, With nut
	P1 / P2	Rc, G, NPT 1/4
Material of wetted part	Body	New PFA
	Diaphragm / Packing	PTFE
	Check valve	New PFA, PTFE
Discharge rate		5 to 38L/min
Average discharge pressure		0 to 0.4MPa
Pilot air consumption		Max. 300L/min (ANR) ^{Note 2)}
Suction head	Dry	Max. 1m (Inside of the pump is dry.)
	Wet	Max. 4m (The pump contains the fluid.)
Transported fluid temperature		0 to 90 (No freezing)
Ambient temperature		0 to 70 (No freezing)
Recommended operation cycle		1 to 3Hz
Pilot air pressure		0.2 to 0.5MPa
Proof pressure		0.75MPa
Mounting direction		Horizontal (mounting hole at bottom)
Weight		6kg

Note 1) Above values are at ordinary temperature and with fresh water.

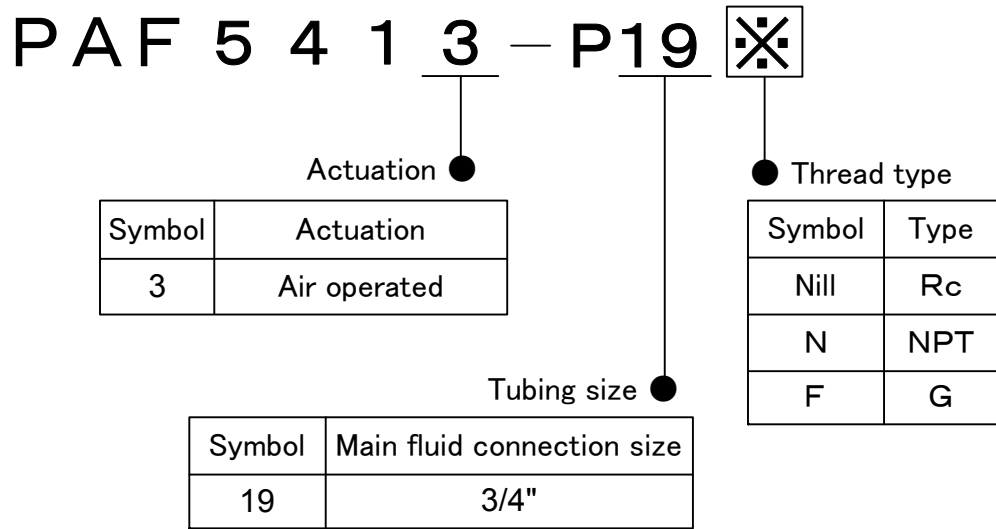
Note 2) Calculated for atmospheric condition, 20 °C (ANR)

• How to order

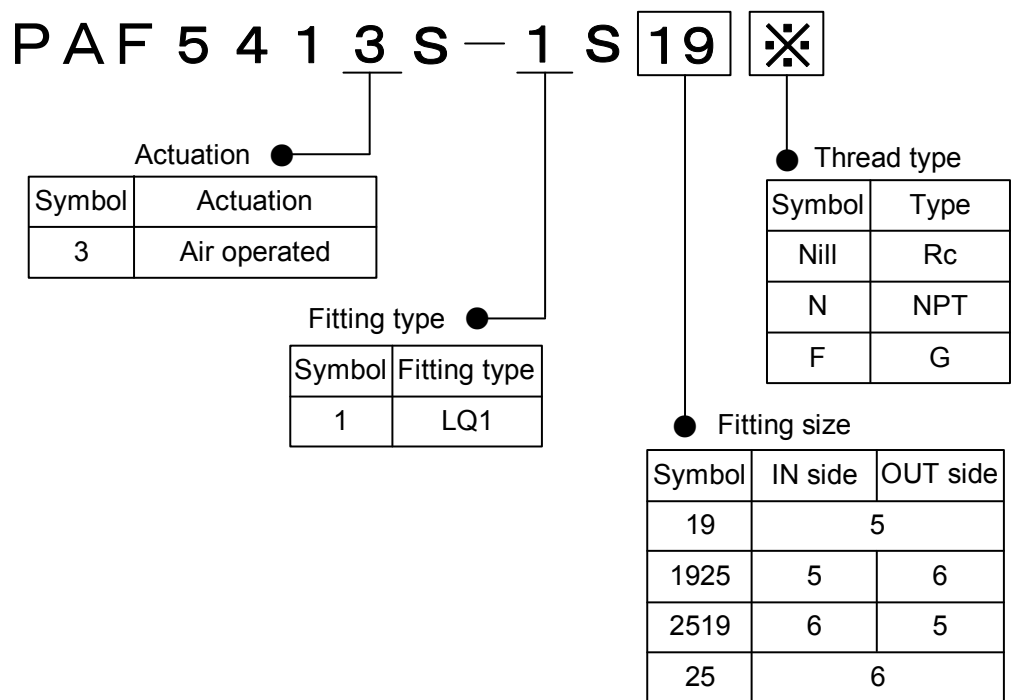
Female thread



Tube piping



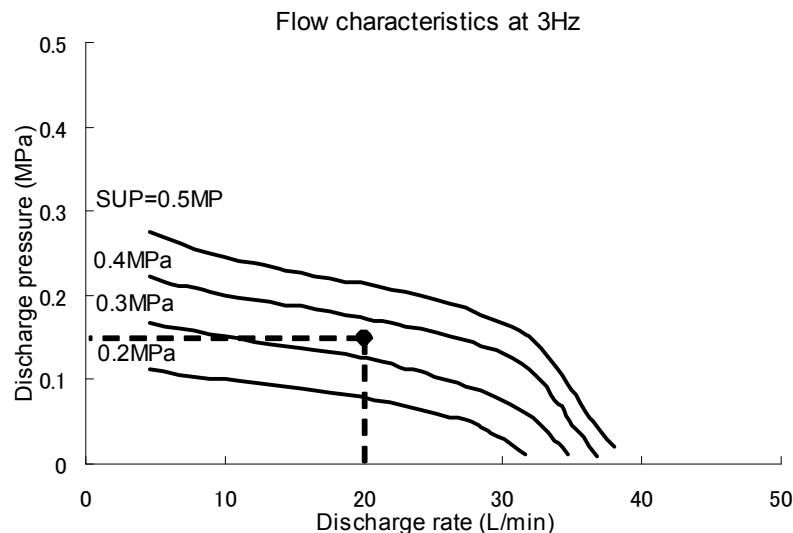
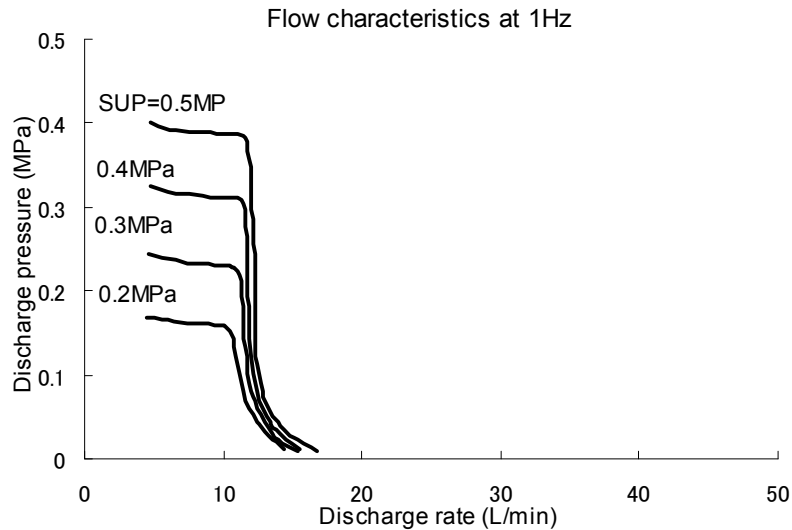
With nut



7. Discharge capability

1) Flow characteristic

With reference to flow characteristic graph (shown below), operating condition of the pump can be set.



Recommended typical condition A: Calculate air pilot pressure in case of discharge rate 20L/min and pressure 0.15MPa

<Assumption; Fresh water (viscosity 1mPa·s , specific gravity1.0) is used as transported fluid>

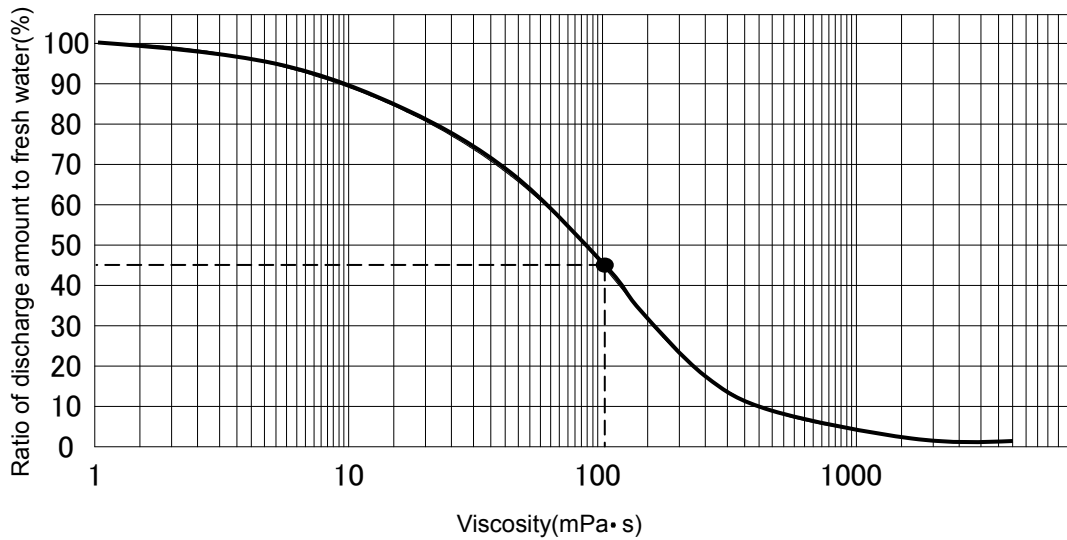
1. Plot the cross point between line with discharge rate 20L/min and line with pressure 0.15MPa.
2. Calculate pressure of transported fluid based on the point. In this example, the point is located between discharge curves (full line) with 0.3MPa and 0.4MPa and it can be found required air pressure at this point is approx. 0.36MPa in proportional relation.

⚠ Caution

- The above flow characteristic graph is for fresh water (viscosity 1mPa·s , specific gravity 1.0). Thus, if the fluid with higher viscosity such as oil is used, convert the fluid to fresh water with reference to viscosity characteristic graph.
- The discharge amount is affected by characteristic of transported fluid (viscosity, specific gravity, concentration of slurry) and operating conditions (temperature, pump head, transporting distance) etc. and should be confirmed before use.
- In the application where the back pressure is applied from discharge port “FLUID OUT”, the result of (pilot air pressure - back pressure, i.e. pressure difference) is pilot air pressure on the graph. Also, it should be noted discharge amount decreases compared with normal condition.
- If required output of compressor is calculated from air consumption, consider the output is 0.75kW per air consumption of 100L/min (ANR) for reference.

2) Viscosity characteristic

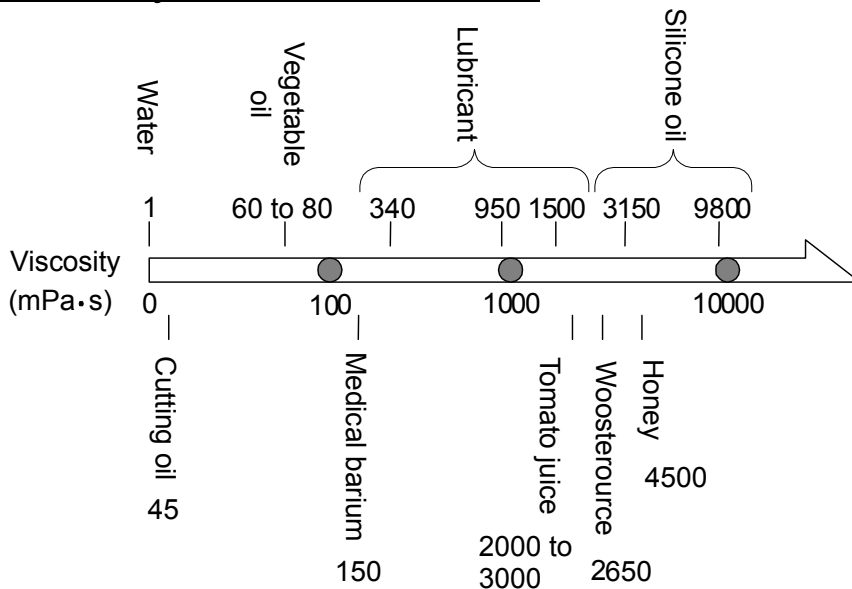
With reference to viscosity characteristic graph (shown below), discharge amount of transported fluid with higher viscosity can be calculated.



Recommended typical condition B: Calculate discharge amount of fluid with viscosity 100mPa·s in case of discharge rate 4.5L/min and discharge pressure 0.1MPa.

- Find ratio of discharge amount to fresh water for the fluid with viscosity 100mPa·s from the graph. Then, it is found to be 45%.
- After that, convert it to discharge amount of fresh water.
Since discharge rate 45% of fresh water is equal to 4.5L/min of the fluid, with the following calculation;
 $4.5\text{L/min} \div 0.45 = 10\text{L/min}$
it is found discharge rate 10L/min is necessary for fresh water.
- Then, refer to flow characteristic graph and calculated air pilot pressure.

Referential viscosity of various fluid (at 20)



Caution

- The viscosity of fluid is affected by operating conditions (temperature, transporting distance etc.) and fluctuation of ambient temperature.
- Viscosities up to 1000 mPa·s can be used.

8. Troubleshooting

If any abnormality is found, perform check along with the following list. If the abnormality can't be eliminated, return the pump to SMC.



Warning

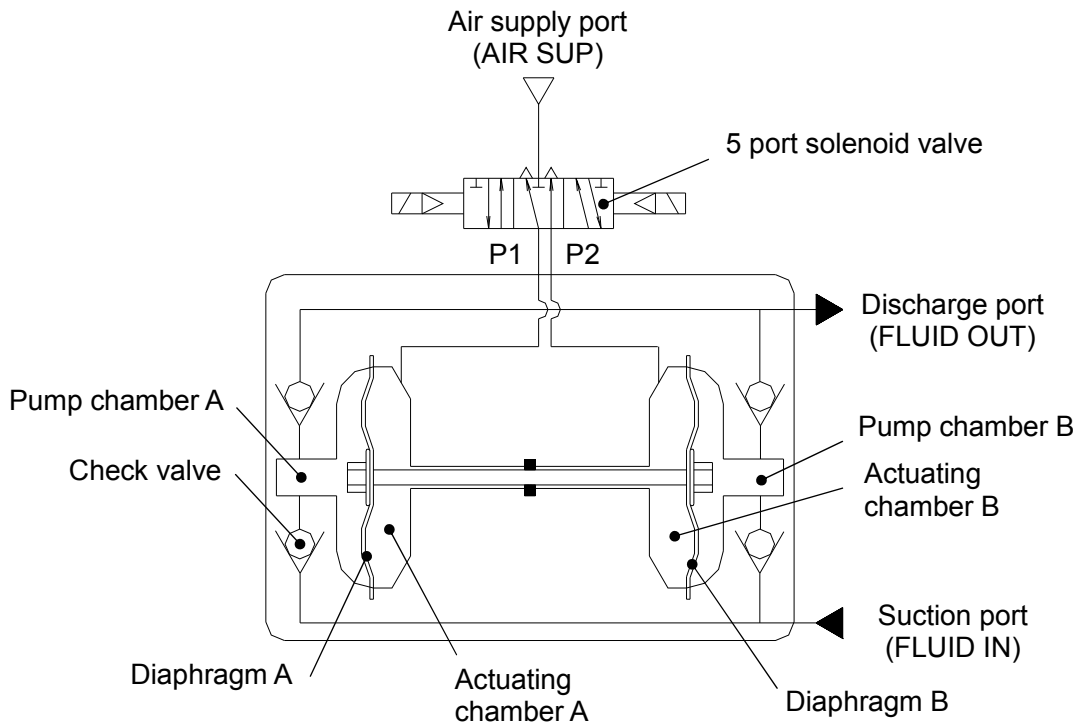
Exhaust dangerous fluid out of the pump before check.

- Do not return the pump with dangerous fluid left. Be sure to substitute it with DI water. Otherwise, the fluid could cause burn and other damages on human during transportation.

Trouble		Possible cause	Remedy
1) Supply of air can't move the pump.		<ul style="list-style-type: none"> - Internal air piping is clogged with dust. - Suction side (FLUID IN) or discharge side (FLUID OUT) is closed or has large resistance. - Defect inside the body. - Insufficient supplied air pressure. - Intrusion of foreign materials into pump chamber. - Damaged diaphragm. 	<ul style="list-style-type: none"> - Cleaning or replacement of pilot air switching part. - Review of piping at suction or discharge side and removal of restrictor. - Replacement of pump. - Supply of air at adequate pressure. - Cleaning. - Replacement of pump.
2) The pump starts, but doesn't discharge.	The pump doesn't suck.	<ul style="list-style-type: none"> - Check valve is clogged. - Check valve is damaged or worn. - The filter at suction side (FLUID IN) is clogged. - Excessive required suction head. - Incorrect mounting direction. - The diaphragm is damaged or comes off. - Sealing failure of fitting at suction side (FLUID IN). - Excessive viscosity of transported fluid. - Incorrect insertion of check valve. 	<ul style="list-style-type: none"> - Cleaning. - Replacement of pump. - Cleaning of filter. - Reduction to suction head covered by the pump. - Remounting in normal direction. - Replacement of pump. - Secure mounting of seal. - Use of fluid with lower viscosity. - Remounting in correct direction.
	The pump sucks, but doesn't discharge	<ul style="list-style-type: none"> - Check valve or fitting at discharge side (FLUID OUT) is clogged. 	<ul style="list-style-type: none"> - Cleaning.
3) The discharge amount is insufficient.		<ul style="list-style-type: none"> - Check valve at suction side (FLUID OUT) or discharge side (FLUID OUT) is clogged. - Excessive viscosity of transported fluid. - Excessive required suction or discharge pressure. - The filter of suction side (FLUID IN) is clogged. - The filter of discharge side (FLUID OUT) is clogged. - Insufficient air supply. - Too small port size of transported fluid piping. - Application of back pressure from discharge side (FLUID OUT). 	<ul style="list-style-type: none"> - Cleaning. - Non-conformance. - Reduction of required head. - Cleaning or replacement. - Cleaning or replacement. - Supply of air at adequate pressure. - Increase of air supply. - Removal of back pressure or increase of supplied air pressure.

4) A lot of air bubble come out from discharge side (FLUID OUT)	<ul style="list-style-type: none"> - Air is sucked by suction side (FLUID IN). - Sealing failure of fitting at suction side (FLUID IN). - Damaged diaphragm. 	<ul style="list-style-type: none"> - Prevention of suction. - Secure mounting of seal. - Replacement of pump.
5) Transported fluid comes out from exhaust port of solenoid valve.	<ul style="list-style-type: none"> - Damaged diaphragm. 	<ul style="list-style-type: none"> - Replacement of pump.
6) Transported fluid or air leaks from jointed part to outside.	<ul style="list-style-type: none"> - The diaphragm is damage or comes off. - Looseness of bolts which fix the parts at each port. 	<ul style="list-style-type: none"> - Replacement of pump. - Retightening.

9. Operating principle



First, the air is supplied for switching valve mounted outside the pump. Then the signal is given from timer etc. and the air starts flowing into each actuating chamber in turn and moves diaphragm up and down.

As shown on Fig.1, when the air flows into actuating chamber A, the fluid is discharged away from the pump chamber A and sucked toward the pump chamber B.

Then, the solenoid valve is switched by timer etc. and the reverse operation is performed. (Fig.2). The pump repeats these two operations in turn and performs suction and discharge of fluid continuously.

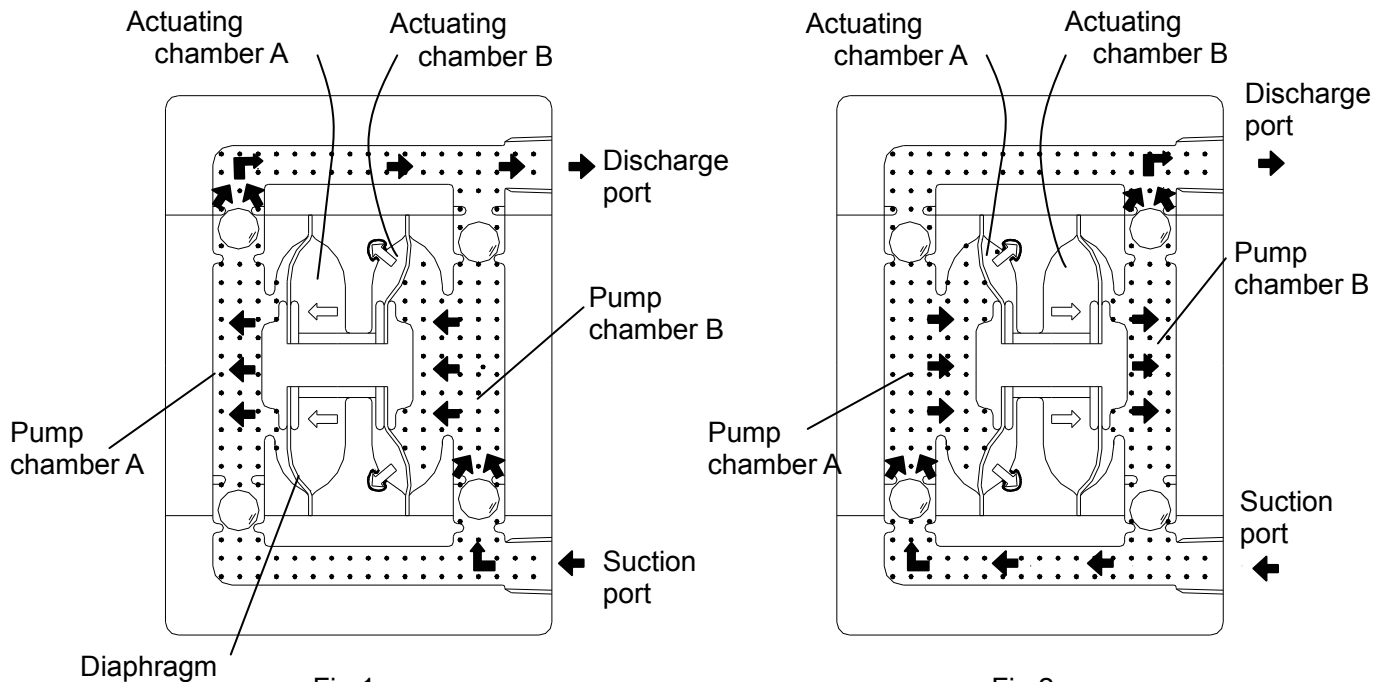


Fig.1

Fig.2

➡ Fluid flow

➡ Air flow