IWAKI PUMPS

IWAKI
Electromagnetic Metering Pump
EK Series
Instruction Manual

⚠ Read this manual before use of product

Thank you for having selected IWAKI's EK Series electromagnetic metering pump.
This instruction manual deals with the correct handling and operation procedures of the pump.
You are requested to read this manual prior to installing and using the pump, to ensure safe and long life of the pump.
The contents of this manual may be changed without notice.

Contents

1. Instructions for safety

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

- **Turn off the power supply.**
  Working without disconnecting the power supply may cause an electrical shock. Before engaging upon any working procedures involving the pump, make sure to turn the power supply switch off and to stop the pump and other related devices.

- **Terminate operation**
  When you detect or become aware of a dangerous sign or abnormal condition during operation, terminate the operation immediately and start it from the beginning again.

- **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.

- **No remodeling**
  Never remodel a pump. Otherwise, a serious accident may result. Iwaki will not be responsible for any accident or damage of any kind which is caused by the user remodeling the pump without first obtaining permission or instructions from Iwaki.

- **Do not submerge**
  The pump is not a submergible pump. Do not submerge the pump in the water or liquid.

- **Wear protectors.**
  If you touch or come in contact with any type of hazardous chemical liquid, including but not limited to chemicals, you may experience a serious injury. Wear protective gear (protective mask, gloves, etc.) during the pump operation.

⚠ CAUTION

- **Qualified operators only**
  The pump operator and pump operation supervisor must not allow any operators who have little or no knowledge of the pump to run operate the pump. Pump operators must have a sound knowledge of the pump and its operation.

- **Specified power only.**
  Do not operate the pump on voltage which is not specified on the nameplate. Failure to do so may result in damage or fire. Only the specified power level is to be applied.

- **Do not run the pump dry.**
  Do not run the pump dry (without liquid inside the pump). Heat generated as a result of abrasion between elements inside the pump during operation without liquid may damage the inside of the pump.

Safety Section

⚠ CAUTION

- **Ventilate**
  Poisoning may result during an operation which involves toxic or odorous liquid. Ventilate the operating site sufficiently.


Caution

- **Damaged pump**
  Never operate a damaged pump. A damaged pump may cause leakage or electrical shock.


Prohibited

- **Do not damage power cable**
  Do not scratch, damage, process, or pull the power cable forcibly. An extra load onto the cable, such as heating the cable or placing something heavy on the cable, may damage the cable and finally cause a fire or an electrical shock.


Caution

- **Arrange grounding**
  Do not operate the pump without connecting the grounding wire. Otherwise, an electrical shock may result. Make sure the grounding wire is connected with the grounding terminal.


Grounding

- **Install an earth leakage breaker (option)**
  The operation of a pump without using an earth leakage breaker may cause an electrical shock. Please purchase an optional leakage breaker and install in the system.


Electrical Shock

- **Handling of power cable**
  Use of a defective or damaged power cable may result in a fire or electrical shock. Handle the power cable carefully.


Electrical Shock

- **Follow the instruction manual**
  Replace the consumable parts by following the descriptions in the instruction manual. Do not disassemble any part of the pump if the disassembling procedure for the part in question is not included in the instruction manual.

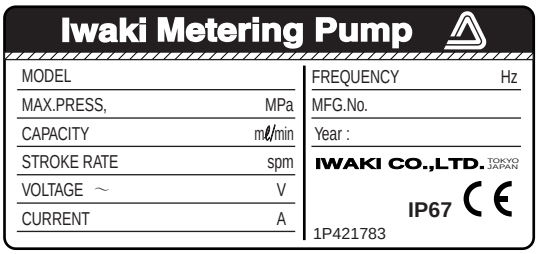
- **Limited operating site and storage**
  Do not install or store the pump in the following places:
  * Places where a flammable gas or material is used or stored.
  * Places where the ambient temperature is extremely high (40°C or higher) or extremely low (0°C or lower).


Prohibited

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

2. Before use of product

2-1. Unpacking and inspection



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

[1] Do the model, discharge pressure, voltage, etc., shown on the nameplate represent what you ordered?

[2] Has the pump been damaged in transit? Are the bolts and nuts loose?

Note : The pump is not designed for submergible use. Do not submerge the pump in the water or liquid.

2-2. Model identification

(Example)

EK - B 10 _ PC - 20E P R 2
(1) (2) (3) (4) (5) (6) (7) (8) (9)

(1) Pump Series

(2) Drive unit : B Average power consumption 20W (High viscosity type : 14W)
C Average power consumption 22W (Tubephragm type/High viscosity type : 18W)

(3) Diaphragm/tubephragm effective diameter (Nominal mm)
Diaphragm : 10, 15, 20, 30, 35
Tubephragm : 12, 14

(4) Pump head type
No symbol : Diaphragm type
T : Tubephragm type
H : High viscosity type

(5) Wet-end material : VC, VH, PC, PH, P6, SH, TC (Refer to wet-end material table on page 10)

(6) Power source
100 : AC100V/110V/115V 50/60Hz
20E : AC220V/230V/240V 50/60Hz

(7) Power cord

Symbol	Cord end
No symbol	Press-fit terminal
P	With plug

(8) Controller type R : R type

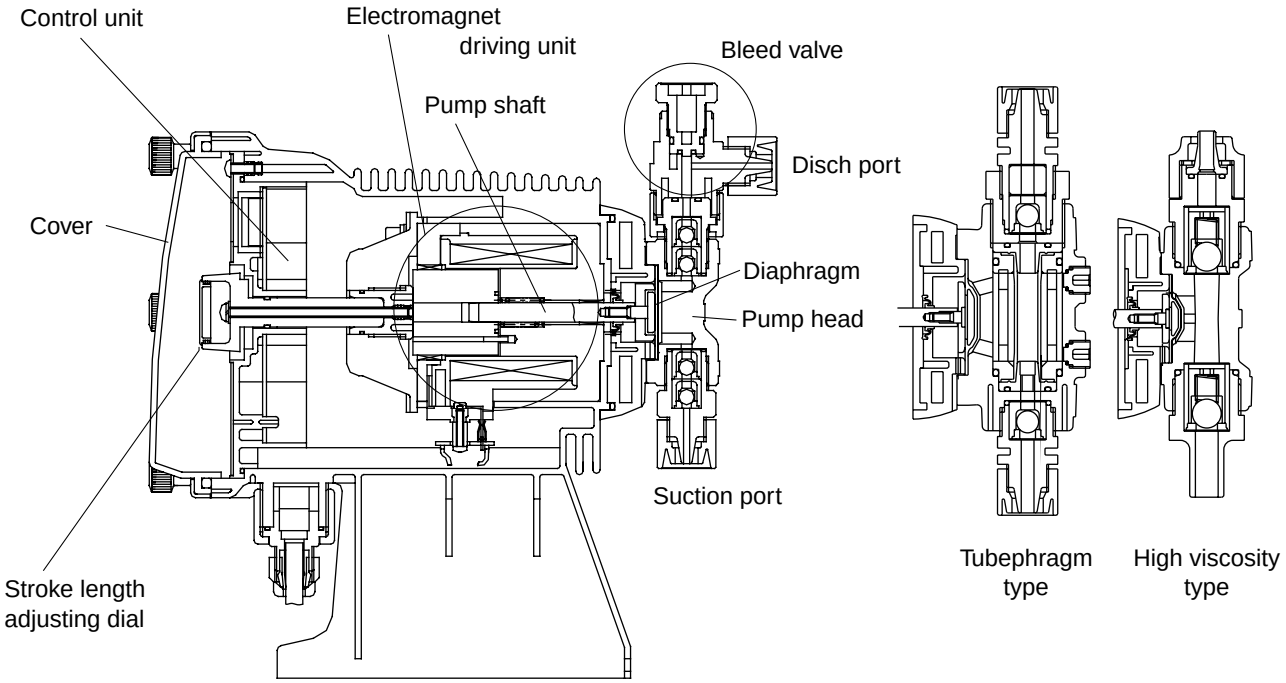
(9) Connection hose

Symbol	Hose diameter (mm)
1	4 × 9
2	4 × 6
3	6 × 8
4	8 × 13
5	9 × 12
6	10 × 12
9	Rc1/4" (Female)
20 (High viscosity type)	Discharge 8 × 13 Suction 15 × 22
21 (High viscosity type)	Discharge 9 × 12 Suction 15 × 22

3. Outline of product

EK Series pump is a totally enclosed and water-proof construction (IP67 certified) type electromagnetic metering pump. For the pump head construction, it has three types of diaphragm type, tubephragm type and high viscosity type.

3-1. Operating principle



Diaphragm type (with bleed valve)

A pump shaft put in the electromagnet driving unit makes reciprocating movement which is brought by pulse current from controller. This reciprocating movement is transferred to the diaphragm which open and close by turns the discharge and suction valves to discharge the liquid. The speed of reciprocating movement (stroke rate per minute) can be changed by changing the pulse frequency of controller. The length of reciprocating movement (stroke length) can be adjusted by stroke length adjusting dial to adjust the discharge capacity per stroke. These two adjustments of stroke length and stroke speed enable fine adjustment of flow rate.

Tubephragm type

Forward movement of diaphragm indirectly compresses the cylindrical tube via operation liquid, which enables smooth liquid flow in the tube from bottom to the top without sedimentation.

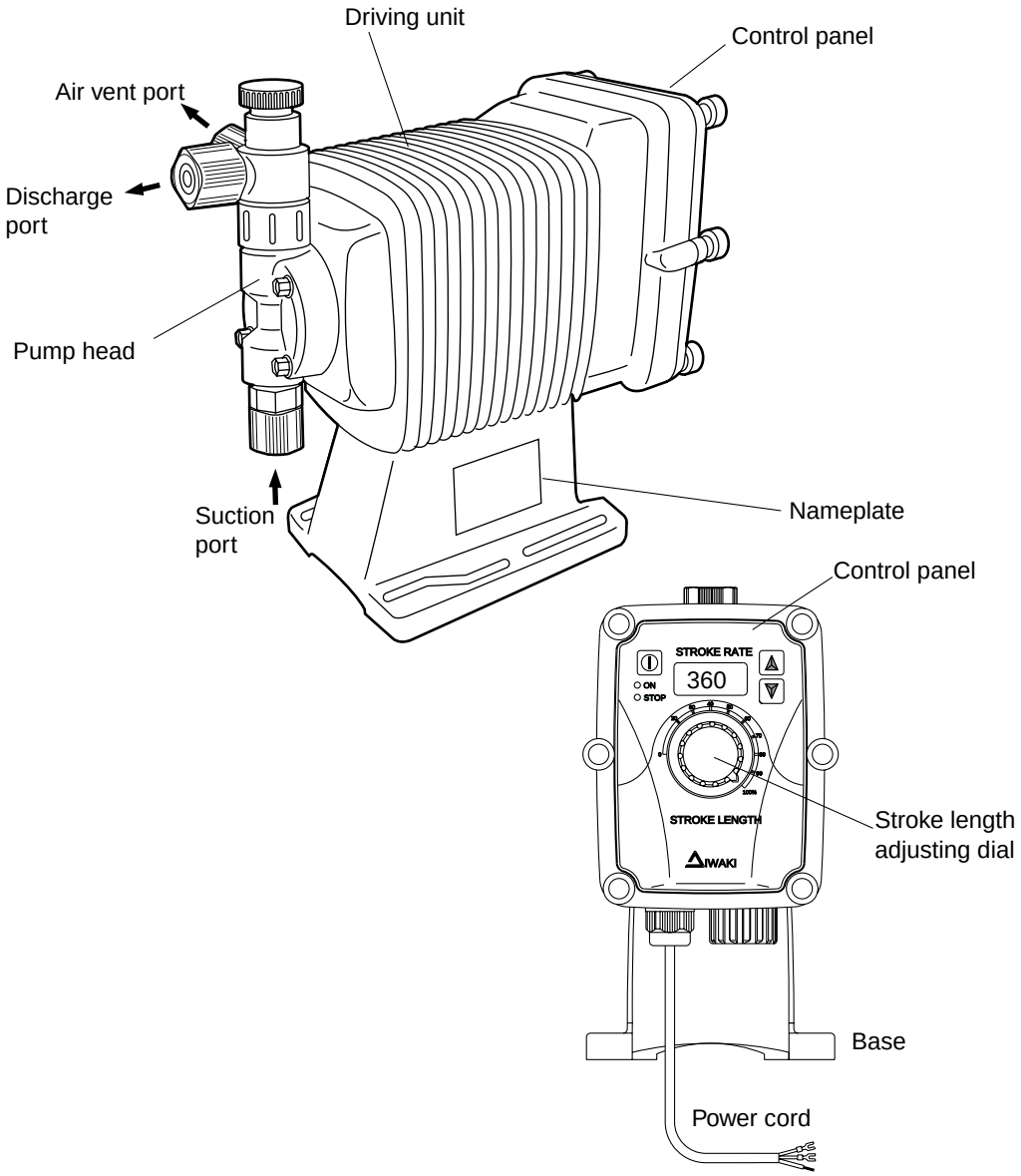
High viscosity type

This type minimizes the flow resistance in the pump chamber and it is equipped with the valve spring to certify the checking effect of the valve.

3-2. Features and functions

1) The pump is water-proof construction and can be installed outdoor. Electronics parts and print circuit board are molded by plastic resin to avoid the deterioration by humidity.
2) Many kinds of control can be done easily because of CPU built-in controller. Touch key operation enables easy setting of stroke rate.
   Automatic control by external pulse signal.
   Pump can be stopped by external contact signal.
3) Tubephragm type for slurry liquid and high viscosity type for small flow and high viscosity liquid are available.

3-3. Main parts



3-4. Specifications

■ Diaphragm type (Wet-end material codes : VC, VH, PC, PH)

Model		B10	B15	B20	B30	C15	C20	C30	C35
Max. disch. capacity	mL/min	40	65	115	210	80	145	270	420
	L/hr	2.4	3.9	6.9	12.6	4.8	8.7	16.2	25.2
Disch. capacity per shot	mL/shot	0.11	0.18	0.31	0.58	0.22	0.40	0.75	1.17
Max. disch. pressure	MPa	1.0	0.7	0.4	0.2	1.0	0.7	0.35	0.2
Stroke length	mm	1.0 (Effective adjusting range : 40~100%)				1.25 (Effective adjusting range : 30~100%)			
Stroke rate	spm	1~360							
Power source		Refer to item 2-2. “Model identification” on page 4.							
Insulation, etc.		Insulation class E, With thermal overload protector, With 2.0m long power cord							
Average input power	W	20				22			
Connection (hose dia.)	mm	4 × 6, 4 × 9, 6 × 8			8 × 13, 9 × 12	4 × 6, 4 × 9, 6 × 8		8 × 13, 9 × 12	
Mass	kg	2.8				3.7			

■ Diaphragm type (Wet-end material code : SH)

Model		B10	B20	C20	C30	C35
Max. disch. capacity	mL/min	40	115	135	270	400
	L/hr	2.4	6.9	8.1	16.2	24.0
Disch. capacity per shot	mL/shot	0.11	0.31	0.38	0.75	1.11
Max. disch. pressure	MPa	1.0	0.4	0.7	0.35	0.2
Stroke length	mm	1.0 (Effective adjusting range : 40~100%)		1.25 (Effective adjusting range : 30~100%)		
Stroke rate	spm	1~360				
Power source		Refer to item 2-2. “Model identification” on page 4.				
Insulation, etc.		Insulation class E, With thermal overload protector, With 2.0m long power cord				
Average input power	W	20		22		
Connection		Rc1/4 female threads				
Mass	kg	3.9		4.7	5.5	5.8

■ Diaphragm type (Wet-end material code : TC)

Model		B10	B20	C20	C30	C35
Max. disch. capacity	mL/min	40	115	135	270	400
	L/hr	2.4	6.9	8.1	16.2	24.0
Disch. capacity per shot	mL/shot	0.11	0.31	0.38	0.75	1.11
Max. disch. pressure	MPa	1.0	0.4	0.7	0.35	0.2
Stroke length	mm	1.0 (Effective adjusting range : 40~100%)		1.25 (Effective adjusting range : 30~100%)		
Stroke rate	spm	1~360				
Power source		Refer to item 2-2. “Model identification” on page 4.				
Insulation, etc.		Insulation class E, With thermal overload protector, With 2.0m long power cord				
Average input power	W	20		22		
Connection (hose dia.)	mm	4 × 6			10 × 12	
Mass	kg	3.1		3.9	4.0	

■ Tubephragm type/High viscosity type

Model		Tubephragm type		High viscosity type		
		C12	C14	B20	C20	C30
Max. disch. capacity	mL/min	140	260	38	62	124
	L/hr	8.4	15.6	2.28	3.72	7.44
Disch. capacity per sho	mL/shot	0.58	1.08	0.16	0.26	0.51
Max. disch. pressure	MPa	0.35	0.2	0.35	0.35	0.35
Stroke length Effective adjusting range	mm	1.25 (30~100%)		1.0 (40~100%)	1.25 (30~100%)	
Stroke rate	spm	1~240				
Power source		Refer to item 2-2. “Model identification” on page 4.				
Insulation, etc.		Insulation class E, With thermal overload protector, With 2.0m long power cord				
Average input power	W	18		14	18	
Connection (hose dia.)	mm	8 × 13, 9 × 12		Disch 8 × 13 Suc 15 × 22, Disch 9 × 12 Suc 15 × 22		
Mass	kg	3.0		3.9		

Note 1. Max. discharge capacity and discharge capacity per shot are based on pumping clear water at ambient temperature.

2. Max. discharge capacity is the value at max. discharge pressure and stroke rate. Discharge capacity increases when the discharge pressure is low.
3. Handled liquid temperature : 0 – 60 deg. C (0 – 40 deg. C for wet-end material codes VC, VH)
4. Ambient temperature : 0 – 50 deg. C (0 – 45 deg. C for wetend material codes VC, VH)
5. Ambient humidity : 35 – 95% RH (No dew drop should be inside the pump)
6. Temperature to be stored : -10 – 50 deg. C

■ Wet end material

Parts	Diaphragm type						Tubephragm type		High viscosity type
	VC	VH	PC	PH	SH	TC	PC	PH	P6
Pump head	PVC		GFRPP		SUS316	PVDF	GFRPP		GFRPP
Valve	CE	HC	CE	HC	HC	CE	CE	HC	SUS316
Valve seat	FKM	EPDM	FKM	EPDM	SUS316	FKM	PCTFE		PCTFE
Valve gasket	PTFE		PTFE		PTFE	PTFE	PTFE		PTFE
O ring	FKM	EPDM	FKM	EPDM	–	FKM	FKM	EPDM	EPDM
Diaphragm	PTFE		PTFE		PTFE	PTFE	PTFE		PTFE
Tubephragm	–		–		–	–	FKM	EPDM	–

1. PTFE is coated on EPDM for the material of diaphragm.
2. Material symbol
   - PVC : Transparent hard polyvinyl chloride
   - GFRPP : Glass fiber reinforced polypropylene
   - CE : Alumina ceramic
   - HC : Hastelloy C 276
   - EPDM : Ethylene propylene diene methylene
   - FKM : Fluoroelastomer
   - PTFE : Polytetrafluoroethylene
   - PCTFE : Polychlorotetrafluoroethylene

■ Controller specifications

1. Operation function
   - Manual operation: Stroke rate
     Diaphragm type : 1 – 360 spm
     Tubephragm type : 1 – 240 spm
     High viscosity type : 1 – 240 spm
   - External signal operation: 1) Operation by external pulse signal : Synchronous operation (one shot per pulse) with external pulse signal.
     2) Stop function : to stop pump operation by external stop signal.
2. Input signal
   - Pulse signal: Pulse frequency : 0 – 6 Hz (0 – 360 pulses/min.)
     Potential free contact or open collector (Max. charge voltage : DC5V, 1.1 mA) (Note)
   - Stop signal: Pump stops when contact is opened, or, pump stops when contact is closed.
     Potential free contact or open collector (Max. charge voltage : DC5V, 1.1 mA) (Note)
3. Operation panel
   - UP key: To set value
   - DOWN key: To set value
   - START/STOP key: To start and stop pump at manual operation mode
4. Display
   - LCD: 4 digits indication for stroke rate, operation mode etc.
   - ON lamp: Green LED : Lit synchronous with stroke
   - STOP lamp: Red LED : Lit when stop signal is input.
5. Power source
   - Power source voltage: 100 : AC100V/110V/115V 50/60Hz
     20E : AC220V/230V/240V 50/60Hz

Note : In case a contact type contact such as relay or so is used, use the one of minimum applicable load of 1mA or less.

4. Installation

4-1. Before installation

EK Series is an enclosed and water-proof construction, however use the pump observing the following conditions.

1) Do not submerge the pump. This pump is not a submergible pump.
2) Do not splash a chemical liquid. Otherwise, Pump body or wires/cords may be corroded.
3) It is not recommended the pump is installed at the place where it is exposed to sunlight.

4-2. Installation

1) Ambient conditions

   Temperature : 0 – 50 deg. C (0 – 45 deg. C for PVC type)

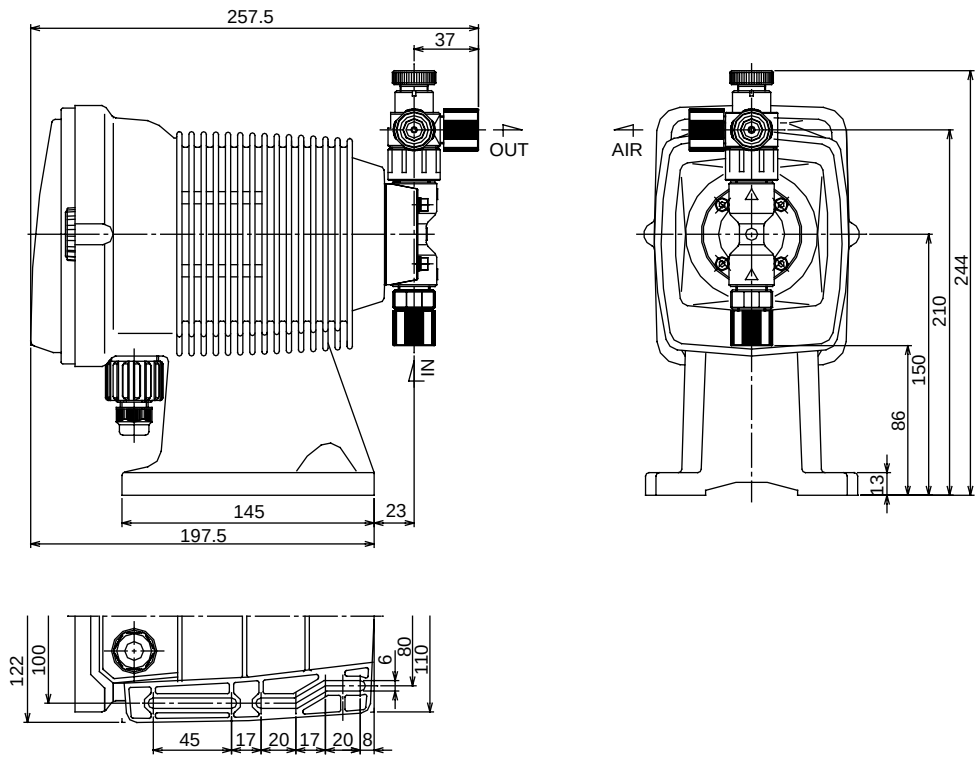
   Humidity : 35 – 95% RH (No dew drop should be inside the pump.)

   Storage temperature : -10 – 50 deg. C

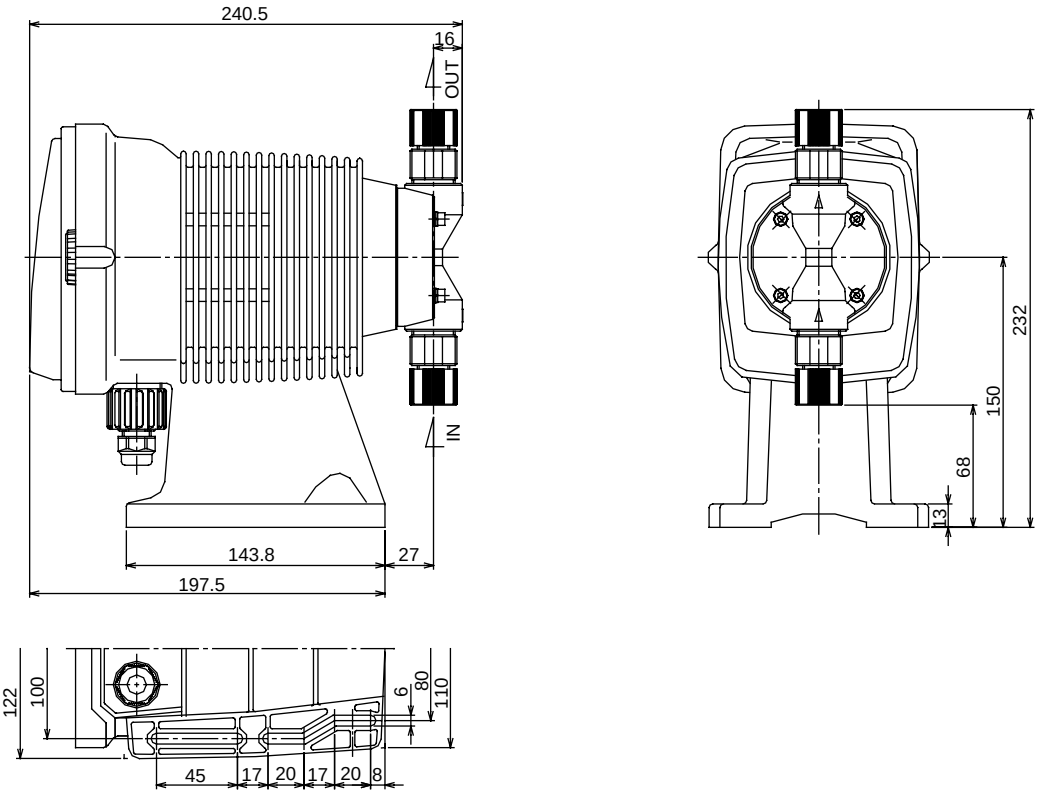
2) Install the pump at horizontal place where no vibration is generated.
3) Keep the space for maintenance works around the pump.
4) Install the pump as close to the supply tank as possible. It is recommended that the pump is installed below the liquid level of the tank.
5) Suction side piping should be as short as possible. (Less than 2 m)
6) When handling chemicals which generate bubbles such as sodium hypochlorite or hydrazine, install the pump and tank at cool and dark place. Otherwise, the pump may be air-locked due to the bubbles.

4-3. Dimensions

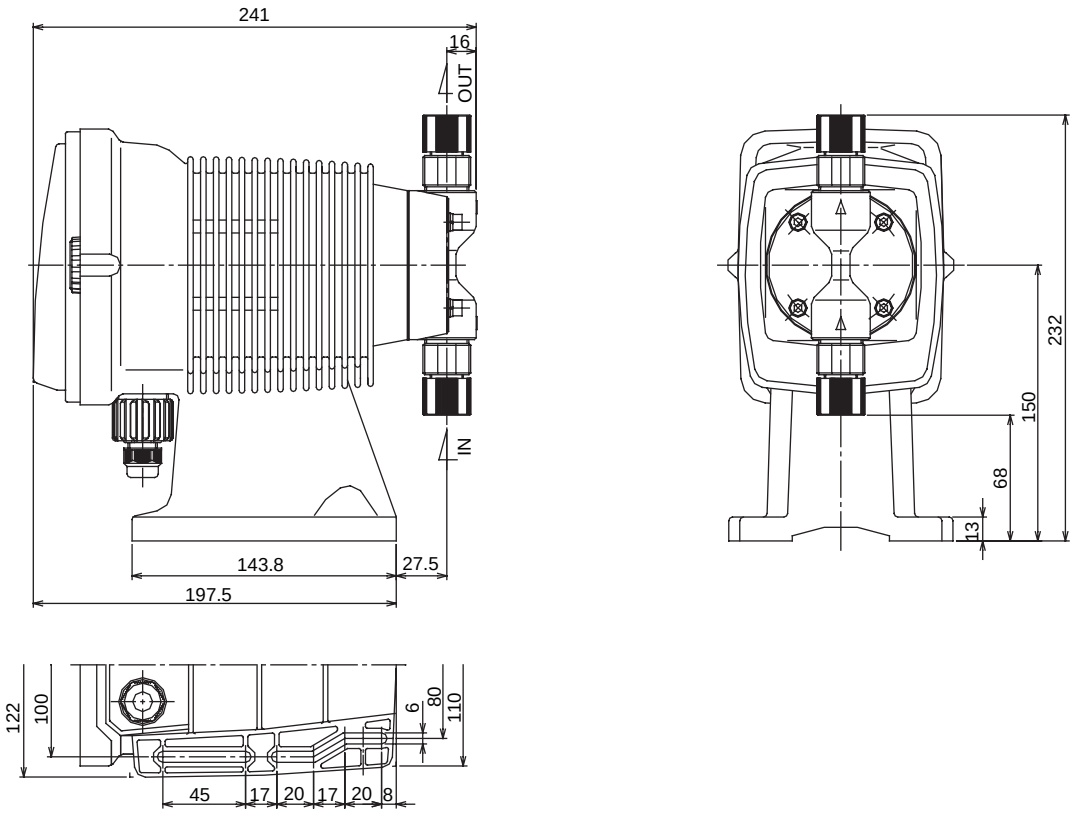
EK-B10, B15, B20, C15 and C20 Types (VC, VH, PC, PH, TC)



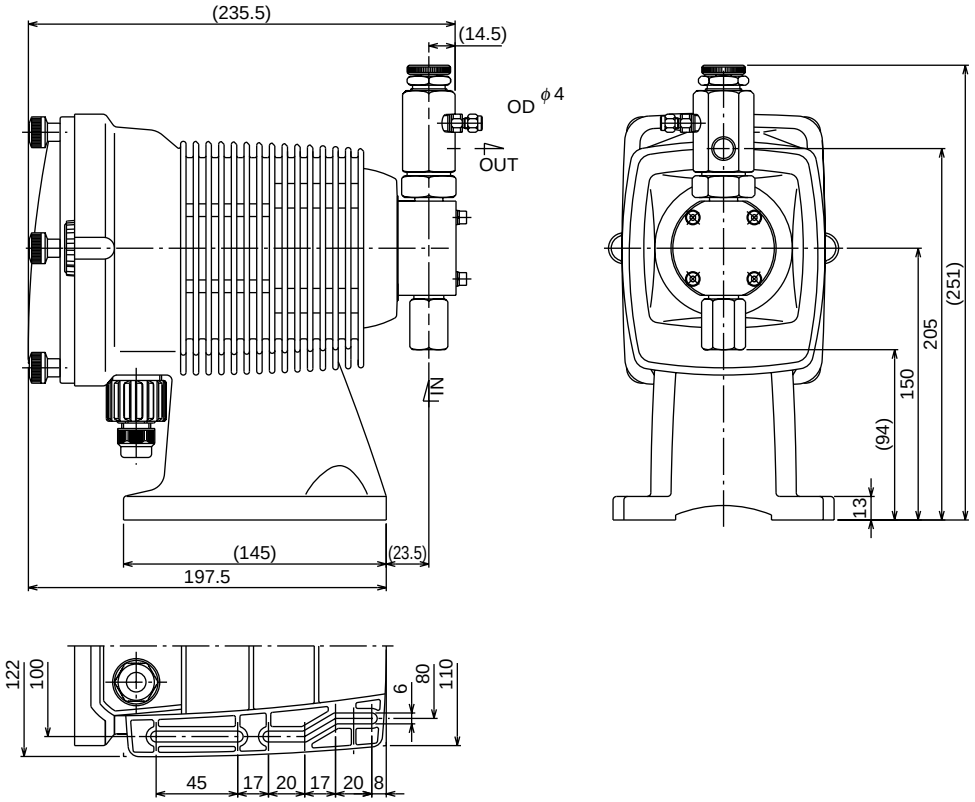
EK-B30 and C30 Types (VC, VH, PC, PH, TC)



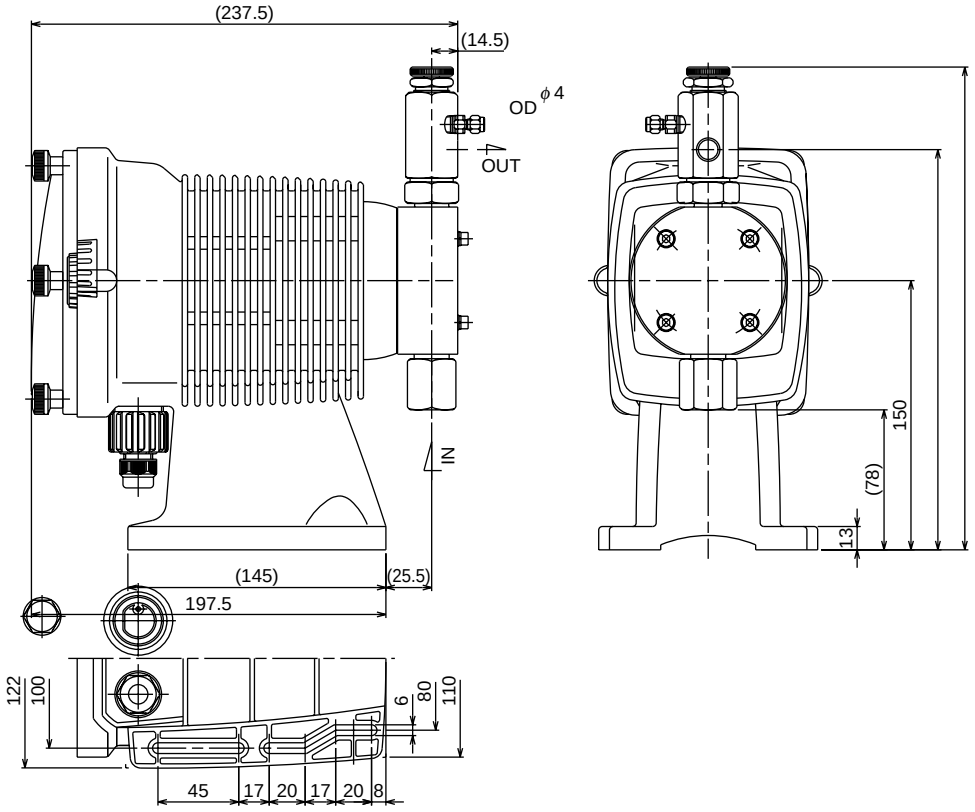
EK-C35 (VC, VH, PC, PH, TC)



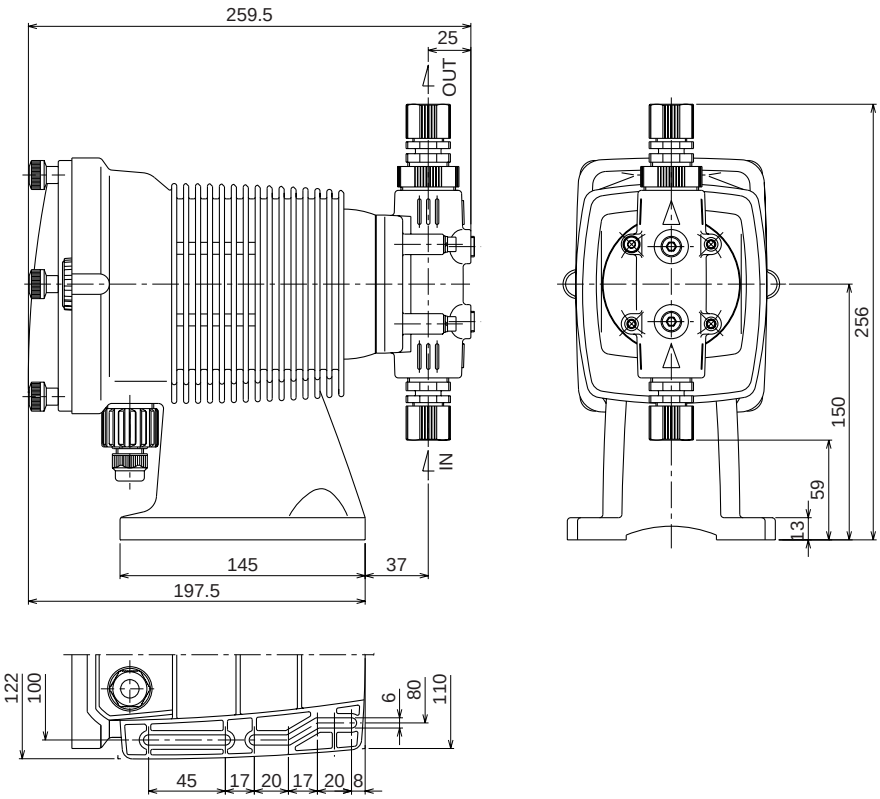
EK-B10, B20, C20 Types (SH)



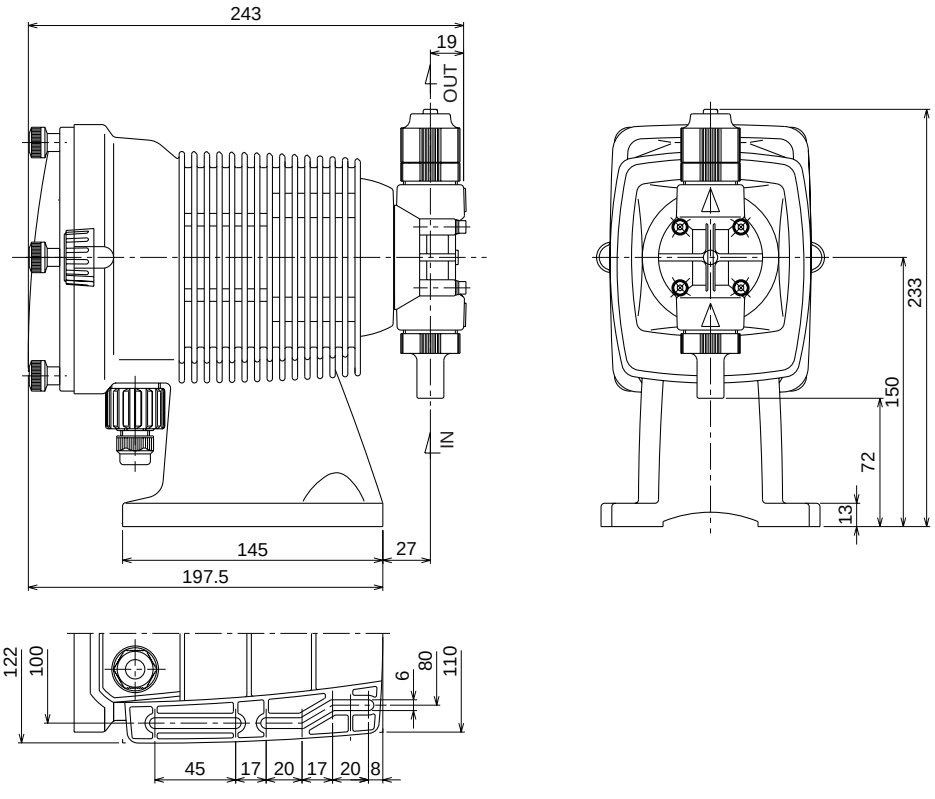
EK-C30, C35 Types (SH)



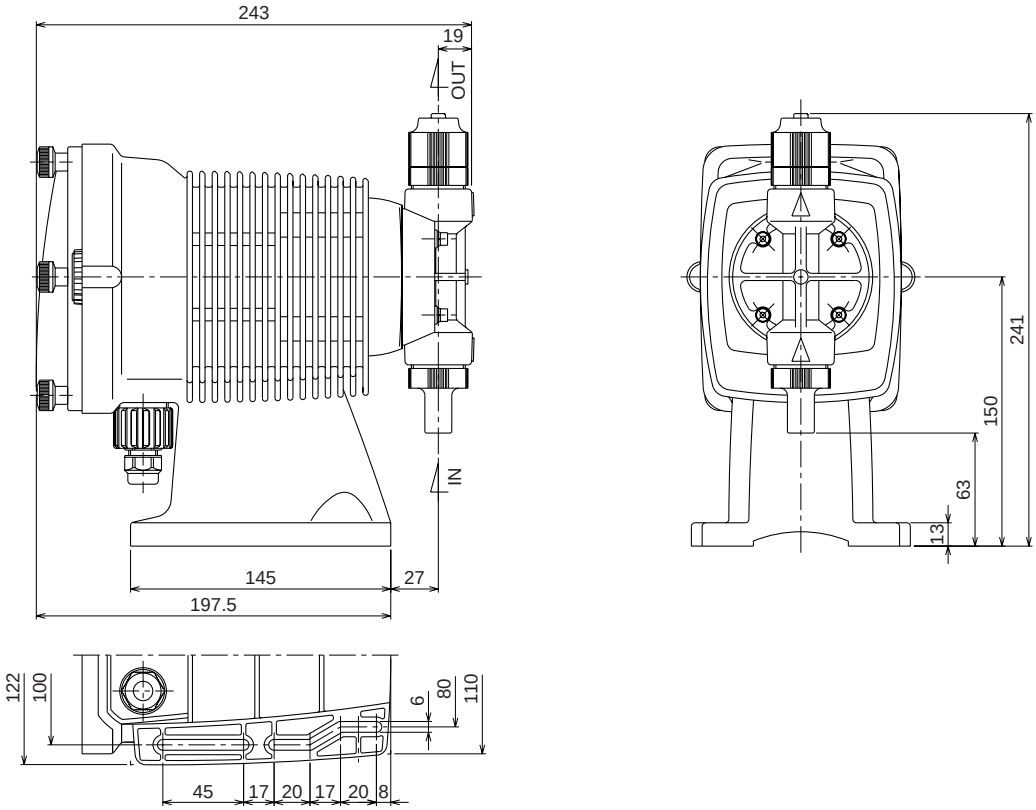
EK-C12 and C14 (Tubephragm type)



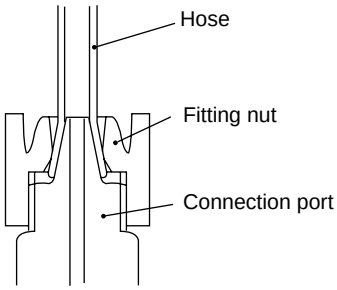
EK-B20 and C20 (High viscosity type)



EK-C30 (High viscosity type)



5. Piping



■ Connection of hose for material codes VC, VH, PC, PH, TC

1) After the hose is put on the connection port and the fitting nut is tightened by hand, tighten the nut by half turns by wrench. Securely tighten the nut so that the liquid can not leak nor suck the air.

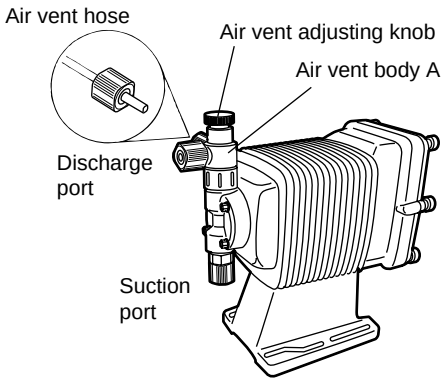
⚠ Caution

Since the fitting nut and connection port are made of plastic resin, do not fasten the nut too tightly. Otherwise, they may be broken.

2) Connect a hose to the air vent port. Return another hose end to the tank.
3) Adjust the direction of air vent port. It can be directed freely.
   a. Loosen by wrench a lock nut below the air vent body A turning it to left.
   b. Position the direction of air vent port.
   c. Tighten the lock nut holding by hand the air vent body A.
   d. Tighten further the lock nut by wrench by 1/4 turns.

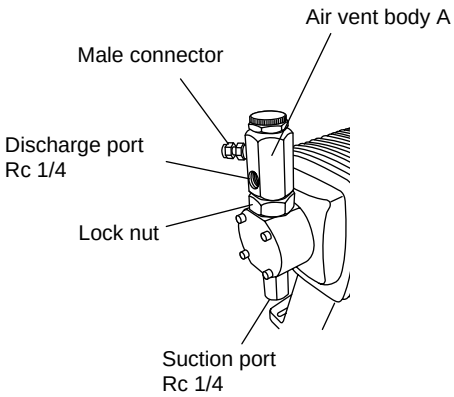
⚠ Caution

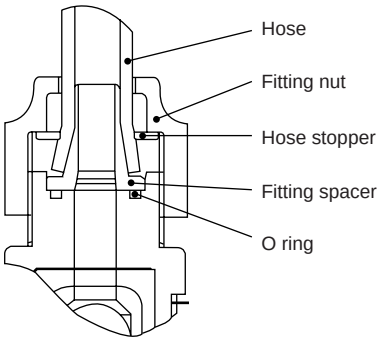
Diaphragm type of EK-30 and 35, all types of tubephragm head and all types of high viscosity head are not equipped with the air vent valve.



■ Connection of hose for material code SH

1) Connection port is Rc1/4 female threads. Use proper size of pipe and securely connect pipe so that liquid can not leak or air can not be sucked in.
2) Screw the attached male connector in the bleed port.
3) Connect hose of 4 mm dia. to the male connector. Return the hose end to the tank.
4) Adjust the direction of discharge port to any desired direction.
   a. Turn the lock nut to counter clockwise with wrench to loosen it.
   b. Adjust the direction of discharge port.
   c. Holding the air vent body A by hand, turn the lock nut to clockwise to tighten it.
   d. Turn the lock nut to clockwise by one fourth turn with wrench to retighten it.





■ Connection of hose for high viscosity type

1) Put fitting nut, hose stopper and fitting spacer in order on the hose.
2) Insert the fitting spacer into the hose as deep as possible. Otherwise, the liquid may leak or the hose may remove.

■ Check valve

Check valve is to be mounted in the discharge piping to avoid siphon phenomenon and over-feeding. Do not fail to install the check valve in case :

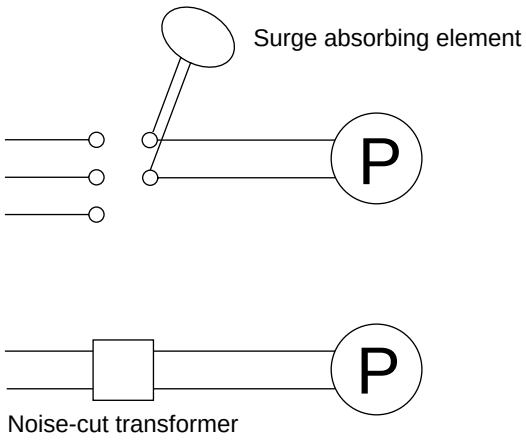
1) Discharge end is lower than liquid level of tank. (To avoid siphon phenomenon.)
2) Too low discharge pressure (To avoid over-feeding)
   In case the discharge pressure is lower than 0.13 MPa for EK-B10/B15/B20/C15/C20/C30, Tubephragm type C12, and High viscosity type B20/C20/C30, and 0.049 MPa for EK-B30/C35 and Tubephragm type C14.

Check valve must be installed at the end of discharge hose and at a distance of 1 meter or more apart from the pump.

6. Electrical wiring

⚠ Caution

- Only qualified operators/service staff should be in charge of the related electrical arrangement and control of the power source. Failure to observe this instruction may result in injury to person or damage to assets.
- Never do the wiring when the power is switched on and the pump is operating to avoid electrical shock to the person and pump damage.



- Surge voltage

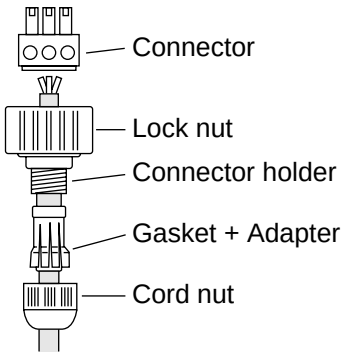
  The electronic circuit of the control unit may be affected by excessively high surge voltage. So, do not operate the pump near high-power electrical equipment that generates high surge voltage.

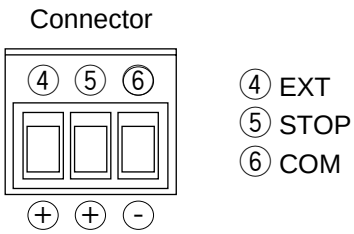
  Take either of the following measures under unavoidable circumstances.

(1) Use a surge absorbing element (such as a varistor with surge resistance of 2000A or more) at the pump power supply connection.

(2) Use a noise-cut transformer.

Connection of external signal cord





1) Remove a lock nut from the port for the external signal cord located at the bottom of the pump.
2) Insert the external signal cord through the lock nut which was removed from the pump, cord nut, adapter + gasket, connector holder which are separately attached to the pump.

   Connect the wires to the connector as shown on the figure at left.

   Use the cord of diameter ϕ 4.6 - 7.6.

   If other size of cord is used, the cord can not be connected or the perfect sealing can not be done.
3) Put the connector to the connector holder, and tighten the cord nut.

   The connector and the connector holder have the direction. Put them together mating the marks.
4) Direct the cutout side of the connector holder to the controller panel side, and insert the connector into the mated connector which is located in the pump inside.

   Tighten the lock nut securely.

   Loose tightening causes wrong sealing.

In case the pulse input is used.

The pulse input is used when the pump is operated by EXT mode.

The EXT mode means that the pump makes one shot per one external pulse signal. (Pump speed must be max. 6Hz = 360 spm or less.)

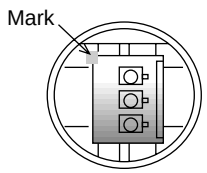
- When open collector signal is employed, pay attention to the polarity.
  ④ EXT is plus(+) and ⑥ COM is minus(-). (Max. applied voltage 5V, Current 1.1mA)
- When the relay or like is used, employ the one of the minimum applicable load is 1mA or less designed for electronic circuit.

In case the stop function or the level sensor is connected.

The stop function means that the pump operation is stopped by the external potential free contact signal. Connect wires to STOP and COM for both stop function and level sensor.

- In case the level sensor is open collector output, pay attention to the polarity. Pay attention to the polarity. ⑤ STOP is plus(+) and ⑥ COM is minus(-). (Max. applied Voltage 5V, Current 1.1mA)
- In case the level sensor is contact output, use the one of which the minimum applied load is 1mA or less designed for electronic circuit.

5) Insert the connector into the connector holder



The connector and the holder have a mark to decide the direction. Insert the connector into the holder mating the marks.

The figure on the left shows the connector which is inserted into the holder.

6) Mount the connector holder to the pump body.

Turn a notch cut of holder to the operation panel direction of controller and insert the holder from the pump bottom, then securely tighten the lock nut.

Insufficient tightening will cause lowered waterproof ability.

7. Operation

After the installation, piping, and wiring works are completed, operate the pump in accordance with the following steps.

⚠ Caution

- **Do not operate the pump with a completely closed discharge-side valve.**
  Operating the pump with the discharge-side valve fully closed may lead to liquid leakage or pipe rupture. Make sure not to operate the pump with the discharge-side valve closed.
- **Do not run the pump dry.**
  A pump which has been run dry may experience liquid leakage during its liquid feeding operation. Make it sure to run the pump after supplying liquid inside the pump.
  * Dry operation of the pump for a long time (30 minutes or more) may cause the pump to overheat and the pump unit (pump head, valve case, etc.) to become deformed or the pump head attachment to become loose, which may result in liquid leakage trouble.
- **Do not adjust stroke length when pump stops.**
  Adjust the stroke length adjusting dial while pump is running.
- **Keep the pump head firmly assembled.**
  If the installation bolts on the pump head are loosened, liquid leakage may result.
  * Fasten the 4 hex, socket bolts tightly before starting the initial pump operation. (The bolts may be loosened during storage or transportation of the pump, depending upon the condition of each.)
  * Fastening torque: 2.2N·m for B10, 15, 20, C15, 20
    2.6N·m for B30, C30 (and Tubephragm type.)
    3.0N·m for C35
    Tighten all the bolts fully by applying an equal amount of torque in a diagonal order among the bolts.

7-1. Preparation for operation

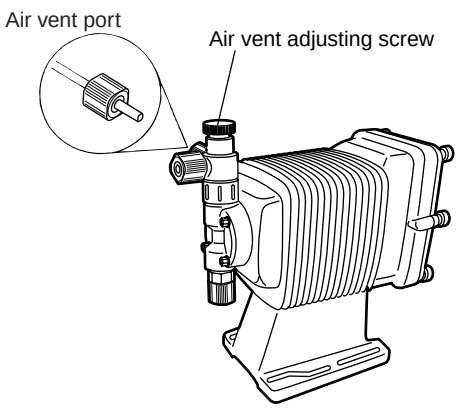
Bleeding

Bleeding is a process undertaken to eliminate air inside the suction-side tube and the pump head. Make sure to carry out air elimination prior to the initial operation of the pump and/or after replacing the liquid in the tank. For safe bleeding, first set a hose to the air-vent port of the air vent unit.

⚠ Warning

Some liquids used in pump feeding may cause skin trouble or affect the quality of a mechanical part. Wipe off the liquid immediately when it wets your hand or a mechanical part.

VC, VH, PC, PH, TC types



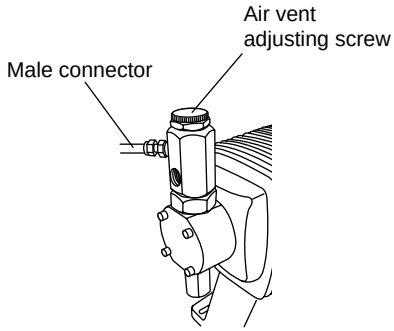
<Bleeding for EK-B10, 15, 20 and EK-C15, 20 models>

[1] Start the pump. See the clause "Operation" to operate the pump.

[2] Rotate the air vent adjusting screw counterclockwise (almost half a turn) to open the air vent port.

[3] Operate the pump under this condition for longer than 10 minutes for a complete removal of air.

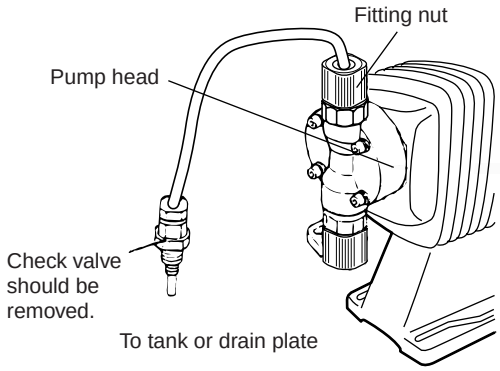
SH type



[4] Rotate the air vent adjusting screw clockwise to close the air vent valve.

[5] Check if liquid does not leak from any part.

<Bleeding for EK-B30·C30·C35, Tubephragm type, High viscosity type>



[1] Extend the tube connected with the discharge-side fitting nut of the pump to the liquid tank or something like a drain plate. Then, start pump operation.
· Remove the check valve if it is installed on the discharge-side.

[2] Adjust the stroke rate to 360 spm, and continue operating the pump for about 10 minutes to eliminate the air completely.

[3] When the air in the pump head is completely eliminated and replaced with liquid, return the discharge-side tube to the regular piping position.

[4] Finally, make sure there is no leakage in any section.

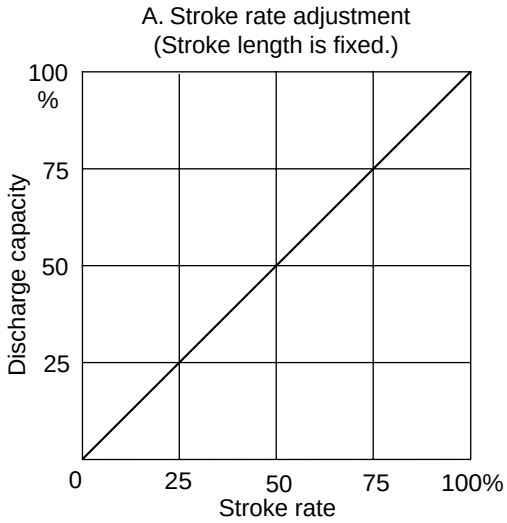
7-2. Adjustment of discharge capacity

There are two ways to adjust the discharge capacity.

A) Adjustment of stroke rate : Stroke speed (stroke per minute) is changed by the controller.

B) Adjustment of stroke length : Stroke length is changed by stroke length adjusting dial to adjust the discharged capacity per stroke.

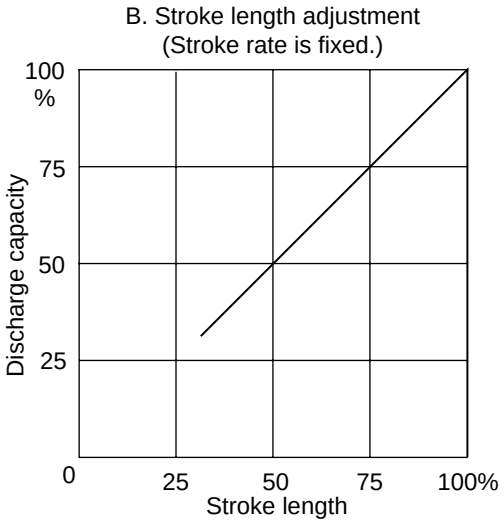
Basically the discharge capacity is adjusted by changing stroke rate with the stroke length fixed at 100% or so. Stroke length adjustment is used as auxiliary method to the fine adjustment which can not be done by the stroke rate adjustment. The compression ratio of the pump gets lower as the stroke length gets shorter, which causes the volumetric loss due to the bubbles and influence of pressure resulting in decreased discharged capacity.



A. Adjustment of stroke rate

1) Max. stroke rate depends on pump type. See item 3-4. “Specifications”

2) Refer to item 7-3. “Operation” for stroke rate adjusting method.



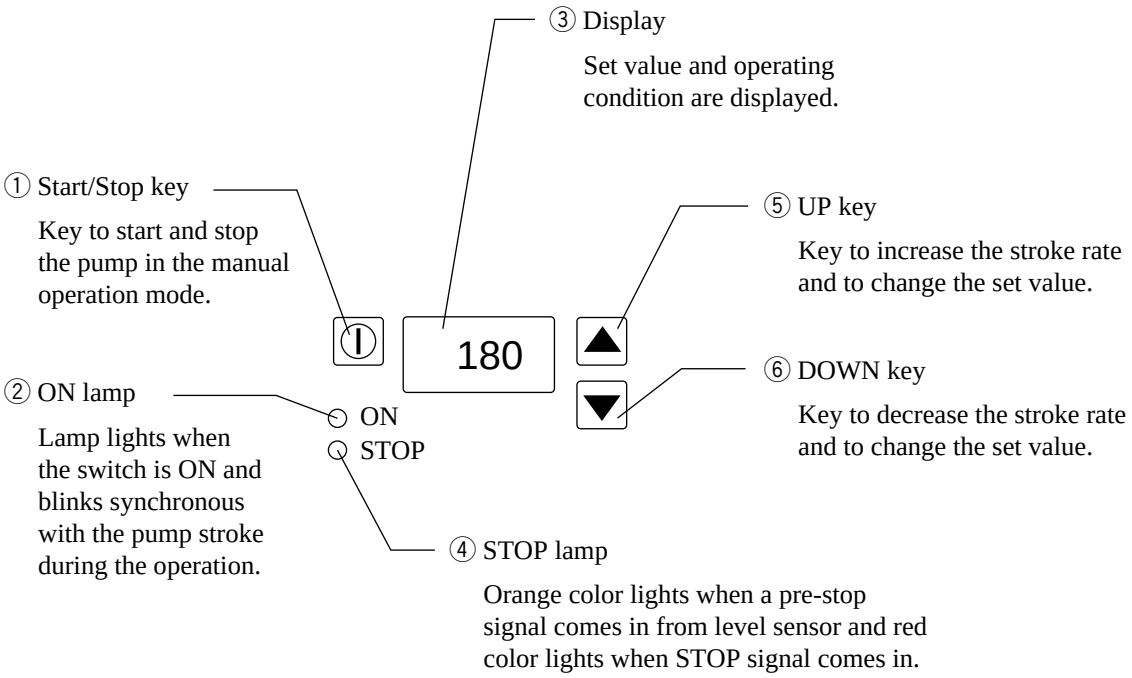
B. Adjustment of stroke length

1) Effective adjustment range of stroke length depends on pump model and type.

2) Stroke length adjustment should be done while pump is running.

7-3. Operation

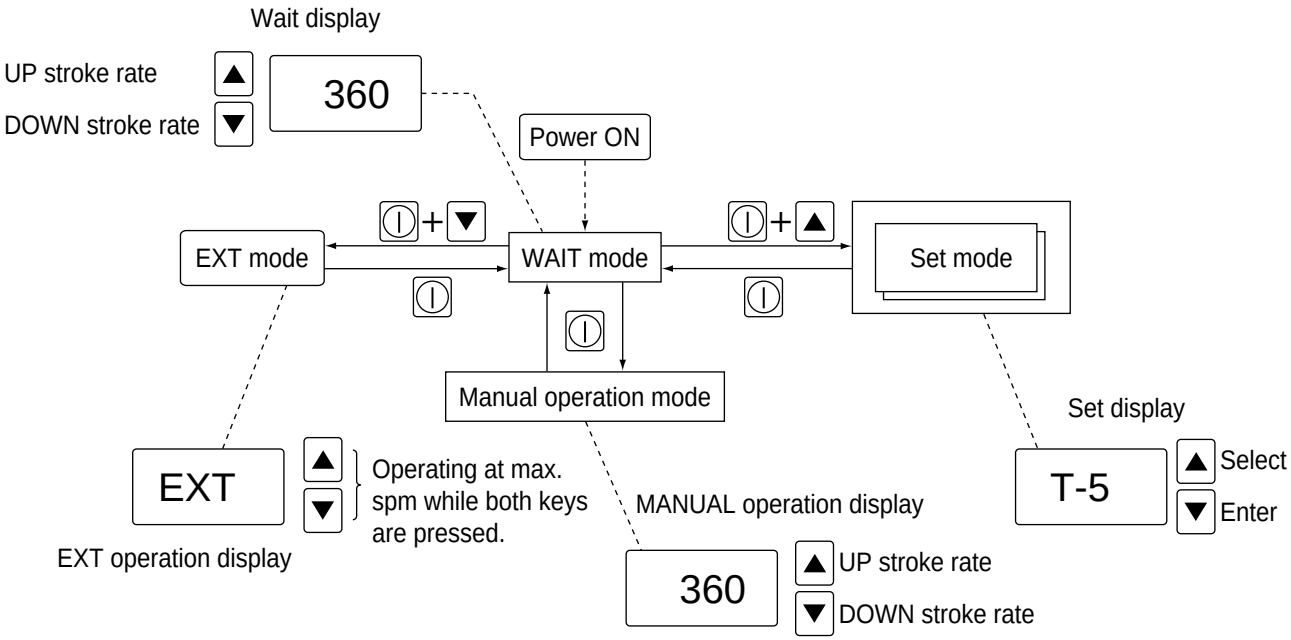
Control panel



Basic display

180	Stroke rate is displayed.
EXT	EXT operation is displayed.
T-5	Display for chattering absorption function

Overview operating chart

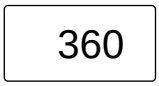


1. ------► means automatic move. After the program version is momentarily displayed, it automatically moves to the status at which the power is switched off last time. (When the power is ON for the first time, it comes to WAIT mode.)
2. For the manual operation, the pump starts when ⏻ START/STOP key is pressed at WAIT mode. To stop the pump, it returns to WAIT mode when ⏻ START/STOP key is pressed again.
3. For EXT operation, press ⏻ START/STOP + ▼ keys at the same time to start the operation. For the stop of EXT operation, press ⏻ key to come back to WAIT mode.
4. For the SET mode, press ⏻ + ▲ keys at the same time. Setting is done by ▲ key, and press ▼ key to enter and to move to next setting.

Refer to following pages for details.

Operation

Power ON

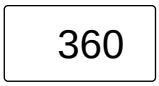


When the power is ON, the display comes to WAIT mode after program version is momentarily displayed. (When the power is switched on initially.)

Once the initial power is switched on, it comes to the mode at which the power was off last time. (In case the power was off at SET mode, WAIT mode comes first.)

· At the WAIT mode, stroke rate is displayed. ON lamp lights.

Manual operation



① Start and stop

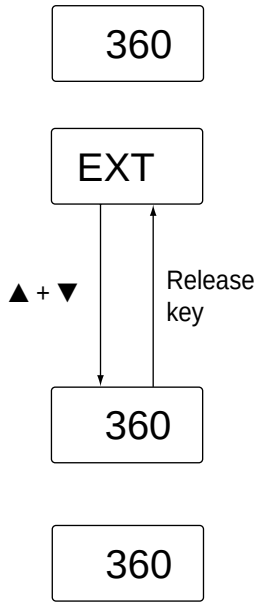
To start manual operation at WAIT mode, press ⏻ START/STOP key once. ON lamp blinks.

If ⏻ START/STOP key is pressed again, ON lamp lights and it comes to WAIT mode.

② Change of stroke rate

Stroke rate is set by ▲ and ▼ keys. Press ▲ key to increase and ▼ key to decrease the figure. If the keys are pressed for more than 3 seconds, the figures change quickly. The change of stroke rate can be done while the pump is running or stopped (WAIT mode)

EXT operation



① Moving to WAIT mode

If it is in Manual operation mode or SET mode, make it WAIT mode once. If it is in WAIT mode, go to next.

② Moving to EXT mode

To move to EXT mode, press ⏻ START/STOP and ▼ keys at the same time. In this EXT mode, the pump is operated automatically corresponding to external pulse signal.

③ Manual operation during EXT operation

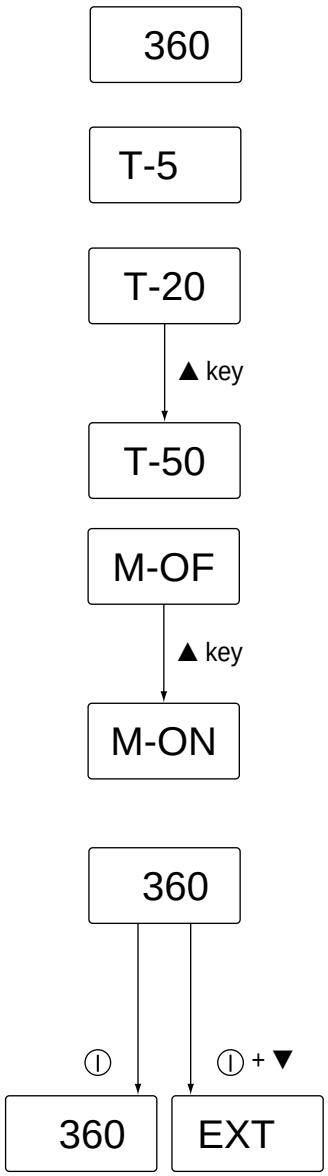
Although EXT mode is automatic operation, the pump operates at 360 spm while ▲ and ▼ keys are pressed at the same time. If either one of keys is released, then it returns to EXT mode.

Use this way when you wish to do bleeding during EXT operation or when you wish to run pump while the pulse signal dose not come.

④ Moving to WAIT mode

Push ⏻ START/STOP key to move to WAIT mode from EXT operation. When it comes to WAIT mode, the display shows the spm at which the MANUAL operation is done and the pump stops.

Setting of function



① Moving to WAIT mode

If it is in MANUAL operation or in SET mode, set to WAIT mode. If it is in WAIT mode, go to next step.

② Moving to SET mode

Push Ⓘ START/STOP and ▲ keys at the same time and it displays anti-chattering function.

③ Setting of anti-chattering function (Note)

Push ▲ key to change input pulse signal. Every time the key is pushed, the display changes to "T-5", "T-20" and to "T-50". Select the appropriate figure corresponding to the chattering condition of the signal. When no problem is found, select "T-5" (factory shipment status) and set the large figure for the noisy signal. Push ▼ key to move to next setting.

④ Setting of STOP function

"M - OF" and "M - ON" is displayed alternatively every time when ▲ key is pressed. To stop the pump by closing the contact when the signal enters, select "M - OF" and select "M - ON to stop the pump by opening the contact when the signal enters.

If ▼ key is pushed here, it comes to the mode of anti-chattering function setting and if Ⓘ START/STOP key is pushed, it comes to WAIT mode.

⑤ Moving to WAIT

Push Ⓘ START/STOP key once to come back toWAIT mode. When WAIT mode comes, the display shows the spm of MANUAL operation and the pump stops.

⑥ Operation

Start the pump operation when the function setting is completed. Push Ⓘ START/STOP key once for MANUAL operation. Push Ⓘ START/STOP and ▼ keys at the same time for EXT operation.

(Note) The chattering means that one pulse is recognized as several pulses due to the disordered wave caused by the noise. When the chattering happens, the timing should be adjusted to recognize the pulse so that the correct counting can be done in spite of the disordered pulse.

Parameters

Following table shows the parameters and setting range for each mode.

Model	Parameter	Initial value	Setting range
MANUAL	SPM	(240 spm) 360 spm	(1 ~ 240) 1 - 360 spm (by one spm)
SET	Chattering	T - 5	T-5, T-20, T-50
	STOP	M - OF	M - OF, M - ON

Note : Figures in ( ) are for tubephragm type and high viscosity type.

8. Maintenance

8-1. Maintenance and inspection

Daily inspection

Check the pump daily for the points below.

Check items	Method
If the pump normally injects the liquid	by flow meter or visual
If the pressure is normal	by pressure gauge or abnormality in piping
If the liquid maintains the same condition and does not crystallize.	by visual
Noise, vibration and heat	Touch the pump
If no liquid leaks from the pump and piping.	by visual

Pump head mounting bolts

Check periodically the pump head mounting bolts to see if no bolts are loosened, and tighten them if loosened.
It may happen the bolts are loosened during the operation.

Tightening torque

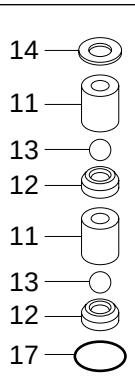
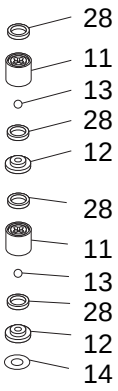
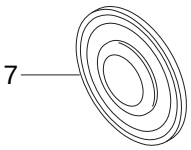
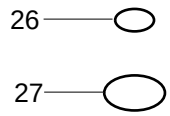
Pump model	Tightening torque
B10, B15, B20 C15, C20	2.2 N·m
B30, C30 C12, C14 (Tubephragm type)	2.6 N·m
C35	3.0 N·m

8-2. Expendable parts (Refer to pages 40 to 42)

If the pump is operated for a long period, it is necessary to replace the expendable parts.

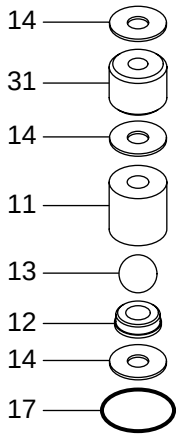
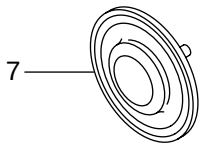
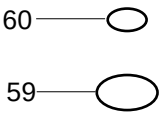
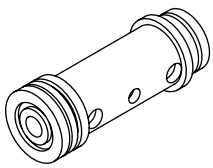
It is recommended you always stock the following expendable parts.

Diaphragm type

<table>
<tr><th colspan="3">Parts</th><th>Quantity/unit</th><th>Time to be replaced</th></tr>
<tr><td rowspan="2">Valve unit</td><td>VC, VH, PC, PH, TC</td><td>SH</td><td rowspan="2">2 units</td><td rowspan="3">8,000 hours</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>Diaphragm</td><td colspan="2"> 
</td><td>1</td></tr>
<tr><td>O ring</td><td> 
</td><td>—</td><td>1</td></tr>
</table>

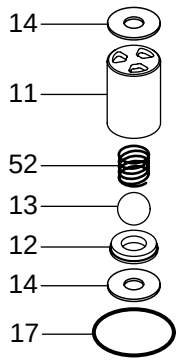
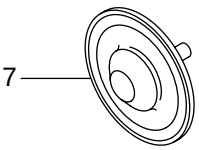
Time to be replaced is a reference and it depends on the liquid handled and operating condition.

Tubephargm type

Parts		Quantity/unit	Time to be replaced
Valve unit		2 units	8,000 hours
Diaphragm		1	
O ring		Refer to “Exploded view”	
Tubephragm ass’y		1 unit	

Time to be replaced is a reference and it depends on the liquid handled and operating condition.

High viscosity type

Parts		Quantity/unit	Time to be replaced
Valve unit		2 units	8,000 hours
Diaphragm		1	
O ring		1	

Time to be replaced is a reference and it depends on the liquid handled and operating condition.

8-3. Troubleshooting

Trouble	Cause	Troubleshooting
Pump does not start.	● Faulty wiring or disconnection in wiring	· Correct wiring.
	● Lowered voltage	· Trace cause and raise voltage to specified level.
	● Electronic circuit of control unit is damaged.	· Replace the whole unit. (Substrate part cannot be repaired.)
Liquid cannot be sucked in.	● Air suction in suction piping	· Set piping normally.
	● Valve gasket is not installed.	· Install valve gasket.
	● Valve set assembling direction is wrong.	· Reassemble valve set.
	● Pump is air-locked.	· Carry out air elimination.
	● Pump stroke length is too short.	· Drive pump with stroke length set at 100%. Then, reset stroke length.
	● Suction-side/discharge-side valve is clogged with foreign matter.	· Disassemble, inspect, and clean.
	● Adhesion of valve onto valve seat	· Disassemble, inspect, and clean.
	○ Reduced hydraulic liquid	· Replenish hydraulic liquid
	□ Broken valve spring	· Replace
Discharge amount fluctuates.	● Suction-side/discharge-side valve is clogged with foreign matter.	· Disassemble, inspect, and clean.
	● Air is trapped in pump.	· Carry out air elimination.
	● Overfeeding	· Install check valve.
	● Diaphragm is damaged.	· Replace diaphragm.
	○ Ruptured tubephargm	· Replace tubephragm unit
	○ Reduced hydraulic liquid	· Replenish hydraulic liquid
	□ Broken valve spring	· Replace
Liquid leaks.	● Valve or connecting port is not tightly closed.	· Tighten section.
	● Pump head is not tightly closed.	· Tighten pump head.
	● Diaphragm is damaged.	· Replace diaphragm.
	● O ring and valve gasket are not installed.	· Install O ring and valve gasket.
	○ Ruptured tubephargm	· Replace tubephragm unit
	○ Insufficiently tightened joints	· Tighten
	○ Insufficiently tightened cap	· Tighten

● : Common to diaphragm type, tubephragm type and high viscosity type.

○ : For tubephragm type only

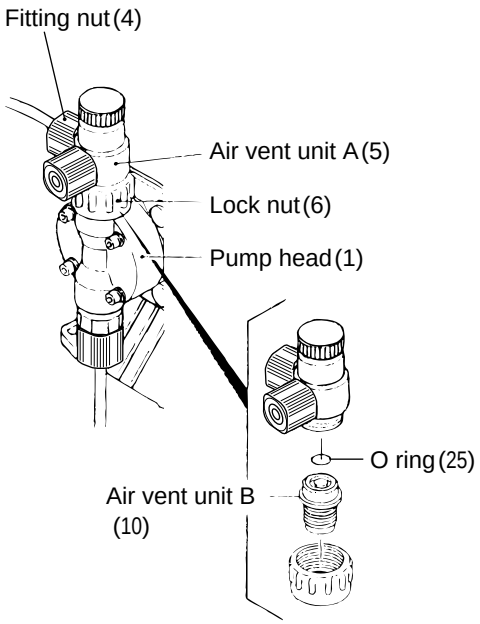
□ : For high viscosity type only

8-4. Disassembling and assembling

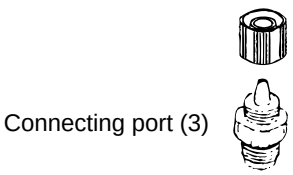
⚠ Warning

- Pay special attention to the presence of residual liquid inside the pump when disassembling the pump.
- Wash the wet-end parts in the pump head with water.

8-4-1. Diaphragm and high viscosity types



· EK-B30, C30, C35
and high viscosity types



■ **Replacement of valve set for wet-end material symbols VC, VH, PC, PH, TC** (Refer to pump unit disassembled view on Page 40)

<Disassembly>

[1] Removal of the valve set on the discharge side

(1) Loosen the fitting nut(4) and detach the tube to the pump. Pay attention to any residual liquid which may flow out of the end of the disconnected tube.

(2) Use a pair of pliers or similar tool to turn the lock nut(6) counterclockwise (seen from top) to remove the air vent unit A(5).

(3) Use a wrench to loosen and remove the air vent unit B(10). Then, take the valve set out of the pump head.

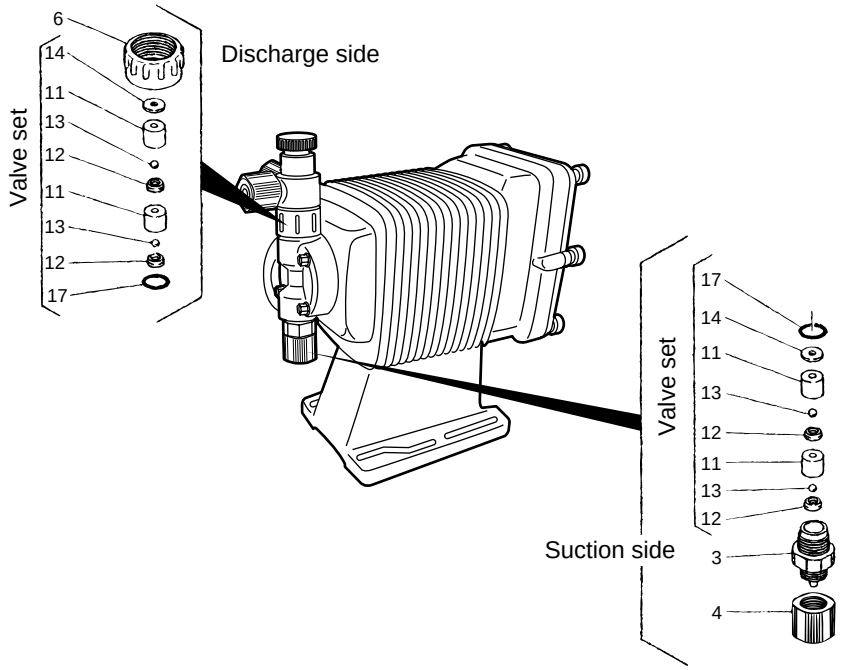
· In the case of EK-B30, C30, C35 type and high viscosity type, use a wrench to loosen and remove the connecting port(3). Then, take the valve set out of the pump head.

[2] Removal of the valve set on the suction side.

(1) Loosen the fitting nut(4) and detach the tube from the pump.

· Pay attention to the residual liquid which may flow out of the end of the disconnected tube. Use a wrench to loosen and remove the connecting port(3).

· If any element of the valve set thus removed is scratched or worn, replace it with a new one.



<Assembly>

Assemble the pump by following the disassembly sequence in reverse. Carefully monitor the following points to achieve a perfect assembly.

· Be careful to the assembly positions and directions of the parts.
If the elements of the valve set are inserted in incorrect positions and/or directions, an abnormal liquid flow may result, for example liquid leaks or a reduction in discharge amount.

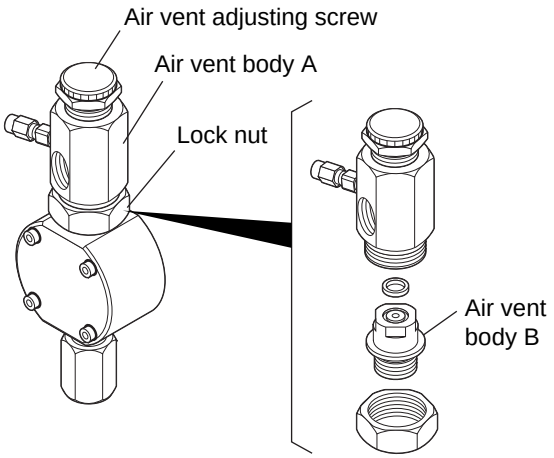
· Do not forget to insert the O ring(17) or valve gasket(14).

[3] Assembly of the valve set on the discharge side

Position the valve set on the pump head. Then, insert the lock nut(6) into air vent unit B(10) and fasten the lock nut.

[4] Assembly of the valve set on the suction side

Position the valve set on the connecting port(3) and fasten the connecting port by hand. Next, use a wrench to rotate the connecting port about 1/4 turn for further tightening.



■ Replacement of valve set for wet-end material code SH (Refer to pump unit disassembled view on page 41.)

<Disassembly of discharge valve>

1) Remove every hose and pipe.
2) Turn the lock nut to left with wrench to remove air vent body.
3) Loosen the air vent body B with wrench to remove it.
4) Remove the valve set with tweezers from pump head.

<Disassembly of suction valve>

Loosen the connection port with wrench to remove it and remove the valve set with tweezers.

⚠ Caution

Pay attention not to drop the valve set.

<Assembly of discharge valve set>

Put the valve set into pump head and screw in the air vent body B after lock nut is put on it.

<Assemble of suction valve set>

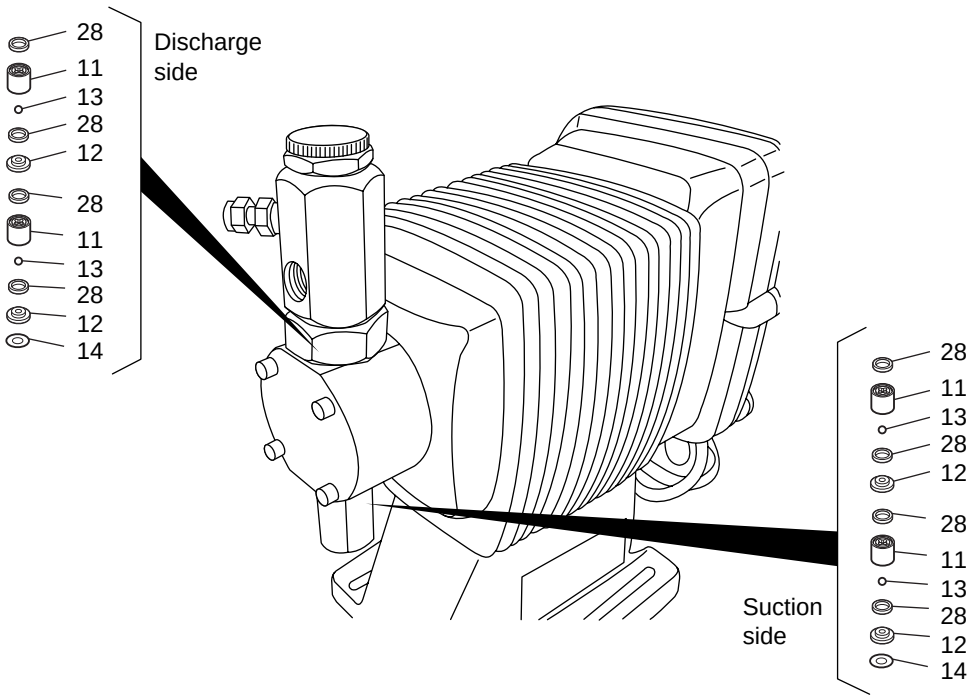
Put the valve set in the connection port, screw it into pump head by hand and tighten it by wrench by turning it by one fourth turns.

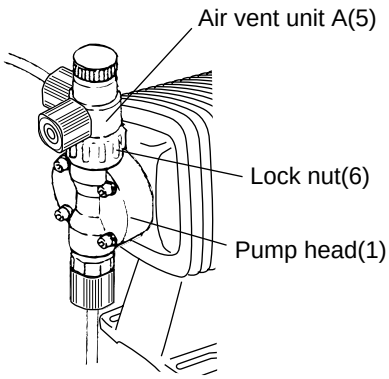
⚠ Caution

Pay attention not to put the parts in wrong order and upside down. Wrong mounting of parts will cause failed pumping or abnormal pressure increase.

⚠ Caution

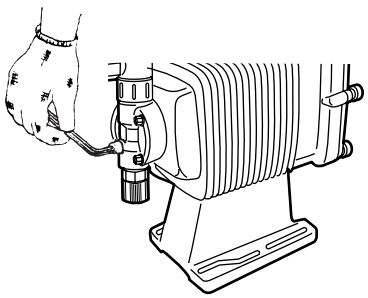
Do not forget to put O ring and gasket.





■ Air vent assembly

Use a wrench to loosen the lock nut(6). Since the air vent unit(A) can be rotated 360 degrees, the tube connection position can be selected freely to satisfy your requirements. The lock nut shall be loosened to make sure that the tube is not positioned over the pump head. Then, fix the position by fastening the lock nut. When fastening the lock nut, hold the air vent valve A with your hand and rotate the lock nut by hand clockwise when viewed from the top of pump unit. Then, use a wrench to rotate the lock nut about 1/4 turn for further tightening.



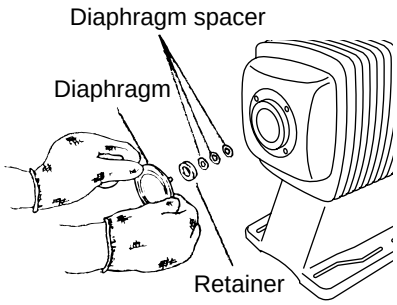
■ Replacement of diaphragm

<Disassembly>

[1] Loosen the four hex socket bolts with a hexagon L-shaped wrench to detach the pump head from the pump body.

[2] Operate the pump to adjust the stroke length to 0%.

[3] Hold the periphery of the diaphragm and rotate the diaphragm counterclockwise to detach it from the plunger pin.
- In some cases, some diaphragm spacers are inserted behind the diaphragm and retainer for positioning purpose. (In some cases the pumps are equipped with no spacers). Be careful not to misplace them when replacing the diaphragm.



<Assembly>

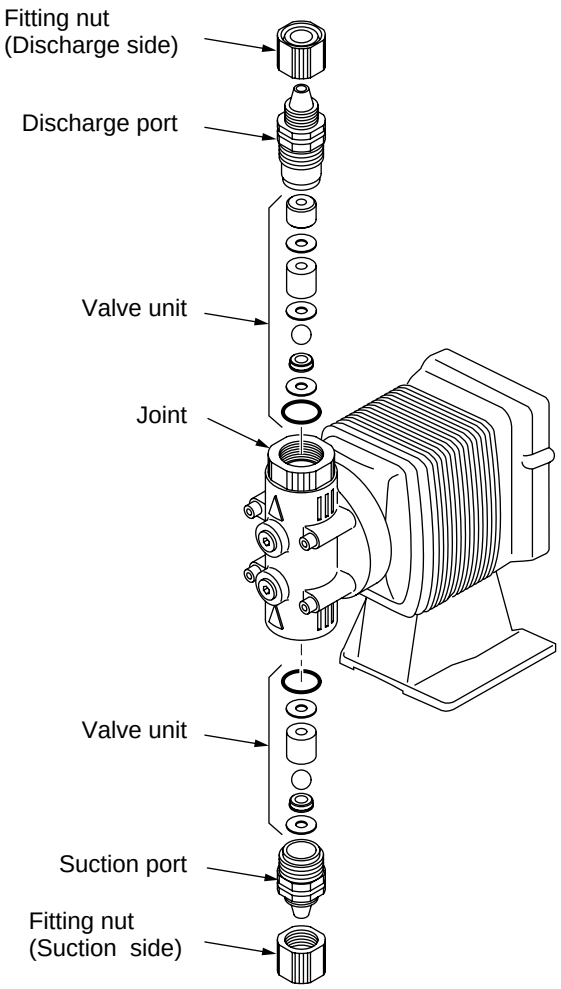
To assemble the diaphragm, follow the disassembly sequence in reverse, paying attention to the following points.

[1] Prior to reassembly, set the pump stroke length at 0%.
- First, start the pump for stroke length setup. Then, stop the pump and disconnect the power supply.

[2] Insert the retainer and diaphragm spacers into the screwed section of a new diaphragm and screw the diaphragm onto the plunger pin.
- Face the concave side of the retainer to the diaphragm so that it will not come off.

[3] Attach the pump head onto the pump body. Tighten the four hex socket bolts by applying an equal amount of torque to them.
- Refer to “8-1. Maintenance and inspection” on page 24 for the tightening torque.

8-4-2. Tubephragm type



<Disassembly of valve unit>

[Discharge side]

(1) Loosen the fitting nut and remove a hose.

(2) Holding the joint with a wrench, remove the discharge port turning it with another wrench.

⚠ Caution

Fix the joint to turn the discharge port. If the joint is not fixed when the discharge port is turned, the joint may be loosened and hydraulic liquid may leak out.
Also, if loosened joint is tightened again, the tubephragm may be distorted or broken.

(3) Remove the valve unit from the joint.

[Suction side]

(1) Loosen the fitting nut of suction side and remove a hose.

(2) Turn the suction port counterclockwise with a wrench and remove it.

(3) Remove the valve unit.

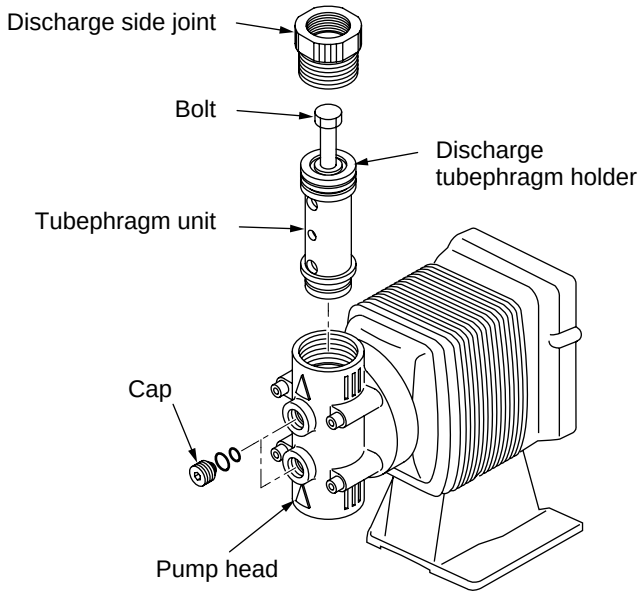
<Assembly of valve unit>

To assemble the valve unit, follow the disassembly sequence in reverse, paying attention to the following points.

(1) Put the parts in correct order and do not put them upside down. Wrongly mounted parts will cause malfunction and abnormal pressure increase resulting in accident.

(2) Do not forget to mount O ring and gasket.

(3) Joint must be fixed when the discharge port is tightened.



<Disassembly of tubephragm>

(1) Loosen two caps with hex. wrench and remove them.

⚠ Caution

Clear boiled water is employed as sealed (hydraulic) liquid but transferred chemicals are mixed up when the tubephragm is broken.

(2) Loosen the discharge side joint with wrench and remove it.

(3) Insert a bolt into the hole of discharge tube holder.

Bolt sizes are:

12 tubephragm : M6 length 100 mm or more

14 tubephragm : M8 length 110 mm or more

(4) Screw the bolt to the bottom of suction tube holder.

(5) Fixing the pump head by hand pull out the bolt to take out the tubephragm unit.

⚠ Caution

Screw the bolt into the suction tube holder by 5 mm or more. Threads may be deformed if the bolt is screwed in insufficiently.

(6) Do not forget to remove a O ring if it stays at the pump head.

<Assembly of tubephragm>

(1) Silicone grease is applied to O ring.

(2) Mount the O ring on the pump head to the stepped part.

O ring size : G25

⚠ Caution

Do not scratch the O ring when it is mounted. Scratched O ring may leaks liquid.

(3) Push the tubephragm unit in the pump head by hand till you can see three or more of the threads.

Push by hand the tubephragm unit into the pump head. Push it till the depth you see three threads of pump head. Adjust the holes of suction tube cylinder to the cap holes of pump head.

⚠ Caution

If the holes do not coincide each other, the air can not be vented easily.

(4) Run the pump and adjust the stroke length as follows.
12 tubephargm : 80%
14 tubephragm : 90%
(5) Put the pump so that the caps come upward
(6) Put the sealed liquid through the cap holes and tighten the caps by hex. wrench at tightening torque of 1.0 N·m.

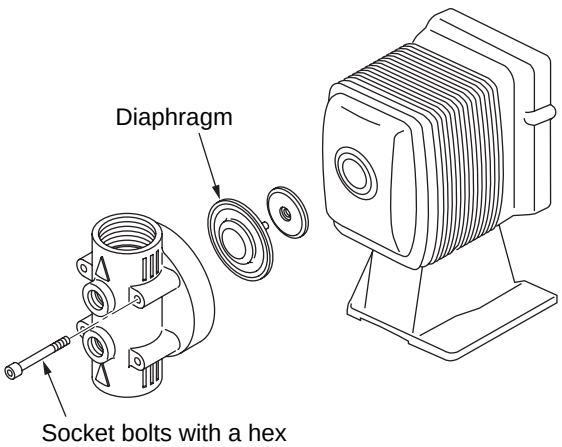
⚠ Caution

Use clean water (boiled water) as sealed liquid.

(7) Run the pump to adjust the stroke length at 100%.
(8) Run the pump a minute without liquid.
(9) Again put the pump so that the caps come upward and remove the discharge side cap with wrench.
(10) Replenish the sealed liquid through the discharge side cap and tighten the cap.
(11) Repeat the air venting procedure of (5) to (11) three times.

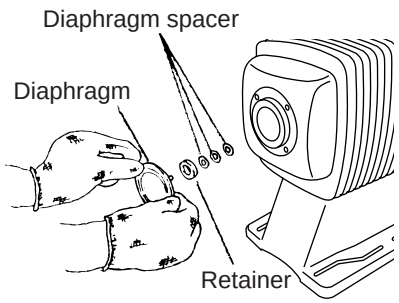
⚠ Caution

Air venting must be done three times.
Otherwise discharge capacity may go down.



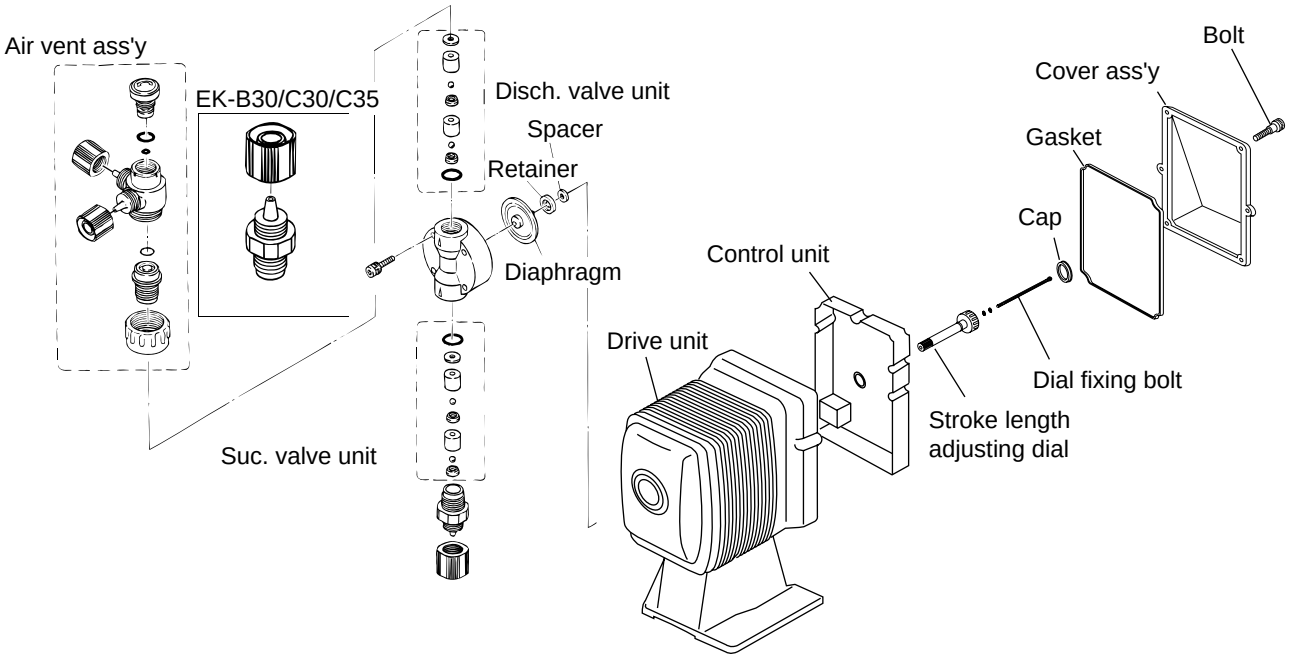
<Disassemble of diaphragm>
(1) Loosen the four hex. socket bolts with a hex. L-shaped wrench to detach the pump head from the pump body.
(2) Hold the periphery of the diaphragm and rotate the diaphragm counterclockwise to detach it from the plunger pin.

Note: You will find several pieces of diaphragm spacers put at the back of retainer. The spacers are put for the purpose of positioning the diaphragm. Pay attention not to lose them. (No spacers are put on some pumps.)



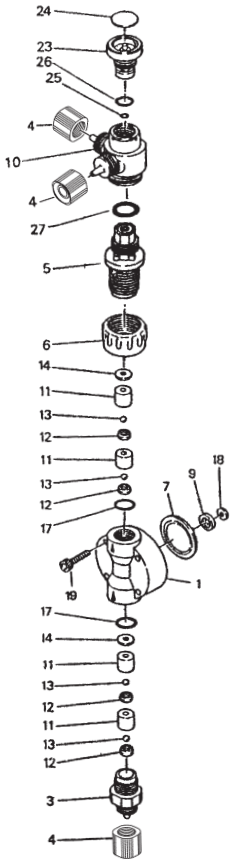
<Assemble of diaphragm>
(1) Start the pump and adjust the stroke length at 100%.
(2) Stop the pump and take the plug out.
(3) Put the retainer and diaphragm spacer on the threaded part of new diaphragm and screw it into the plunger pin. Face the concave side of the retainer to the diaphragm so that it does not come off.
(4) Mount the pump head on the pump body. Tighten four hex. socket bolts by applying an equal amount of torque to them.
Tightening torque : 2.6 N·m

8-5. Disassembled views (Diaphragm type)



■ Pump Unit (Diaphragm type)

● EK-B10, B15, B20, C15, C20 (VC, VH, PC, PH, TC)

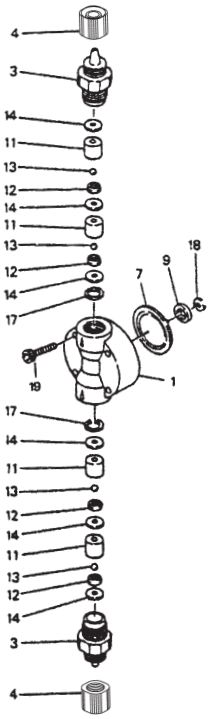


No.	Name	Quantity
1	Pump head	1
3	Fitting	1 (2)
4	Fitting nut	3 (2)
5	Air vent body B	1(0)
6	Lock nut	1(0)
7	Diaphragm	1
9	Retainer	1
10	Air vent body A	1(0)
11	Valve guide	4
12	Valve seat	4
13	Valve	4
14	Valve gasket	2
17	O ring	2
18	Diaphragm spacer	(Note 1)
19	Hex. socket cap bolt (with SW, PW)	4
23	Adjusting screw	1(0)
24	Name plate	1(0)
25	O ring	1(0)
26	O ring	1(0)
27	O ring	1(0)

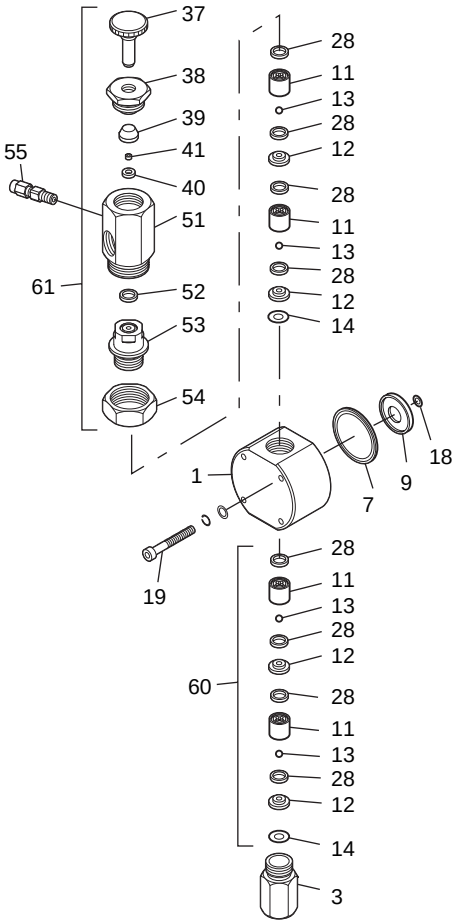
Note 1:The number of the diaphragm spacers, which are for dimensional adjustment, depend on the type of pump.

2:Quantity in parentheses is for EK-B30, C30, C35.

● EK-B30, C30, C35 (VC, VH, PC, PH, TC)



● EK-B10, B20, C20, C30, C35 (SH)

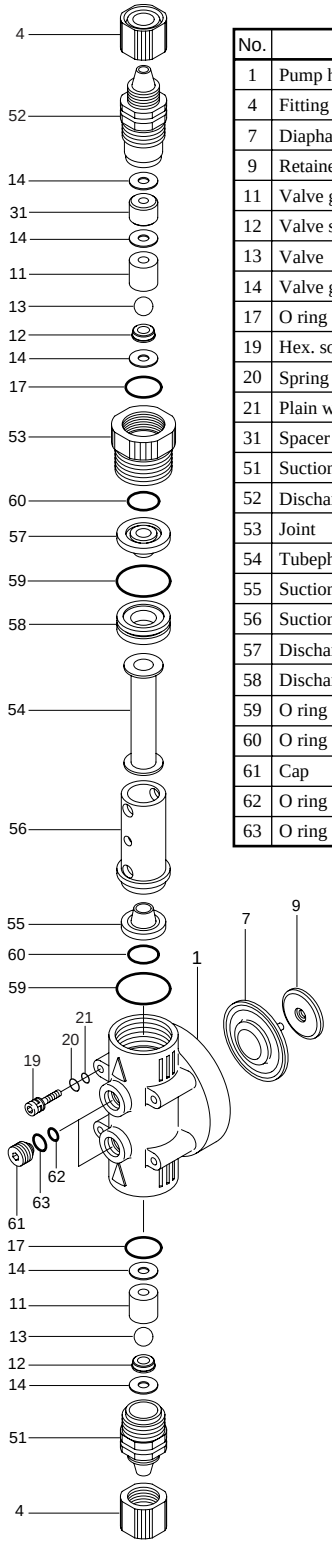


No.	Parts name	Q'ty
1	Pump head	1
3	Fitting	1
7	Diaphragm	1
9	Retainer	1
11	Valve guide	4
12	Valve seat	4
13	Valve	4
14	Valve gasket B	2
18	Diaphragm spacer	(Note)
19	Hex. socket cap bolt (with SW, PW)	4
28	Valve gasket A	8
37	Adjusting screw	1
38	Seal nut	1
39	Seal ring	1
40	Seat	1
41	Seat ring	1
51	Air vent body A	1
52	Gasket	1
53	Air vent body B	1
54	Nut	1
55	Male connector	1

Note : The number of the diaphragm spacers, which are for dimensional adjustment, depend on the type of pump.

Tubepragm type

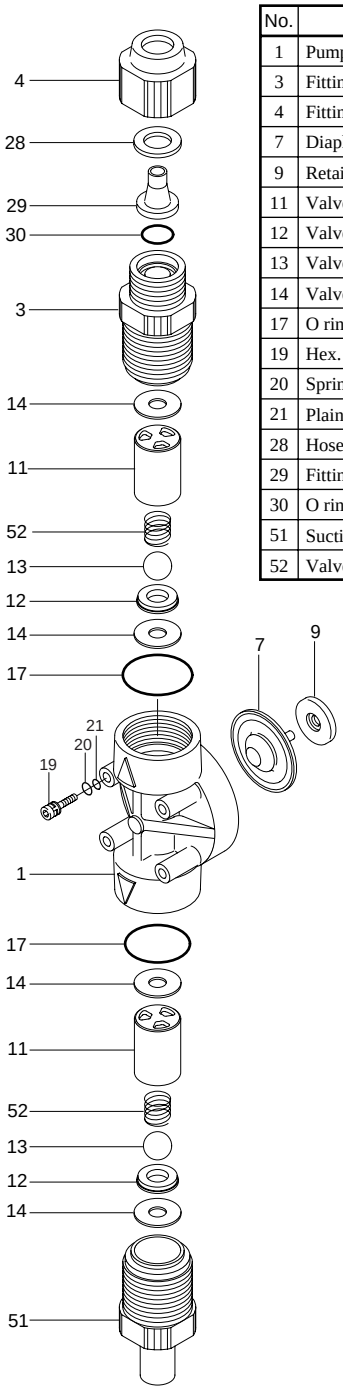
● EK-C12, C14



No.	Name	Q'ty
1	Pump head	1
4	Fitting nut	2
7	Diaphargm	1
9	Retainer	1
11	Valve guide	2
12	Valve seat	2
13	Valve	2
14	Valve gasket	5
17	O ring	2
19	Hex. sock. cap bolt	4
20	Spring washer	4
21	Plain washer	4
31	Spacer	1
51	Suction fitting	1
52	Discharge fitting	1
53	Joint	1
54	Tubephragm	1
55	Suction tube guide	1
56	Suction tube cylinder	1
57	Discharge tube guide	1
58	Discharge tube cylinder	1
59	O ring	2
60	O ring	2
61	Cap	2
62	O ring	2
63	O ring	2

High viscosity type

● EK-B20, C20, C30



No.	Name	Q'ty
1	Pump head	1
3	Fitting	1
4	Fitting nut	1
7	Diaphragm	1
9	Retainer	1
11	Valve guide	2
12	Valve seat	2
13	Valve	2
14	Valve gasket	4
17	O ring	2
19	Hex. sock. cap bolt	4
20	Spring washer	4
21	Plain washer	4
28	Hose stopper	1
29	Fitting spacer	1
30	O ring	1
51	Suction fitting	1
52	Valve spring	2

9. Accessories

■ Specification of check valve(CA, CS), back pressure valve(BVC) (Optional Items)

Type	Set Pressure MPa	Diameter of Fitting mm	Material of Liquid Contacting Parts	Applicable Pump	Material Code of Liquid Contacting Parts of Pump
CA-1V-4	0.17 ± 0.04	$\phi 4 \times \phi 9$	CFRPP	EK-B10, B15, B20 C15, C20	PC
CA-1E-4					PH
CA-1V-6		$\phi 6 \times \phi 8$			PC
CA-1E-6					PH
CA-1V-4 × 6		$\phi 4 \times \phi 6$			PC
CA-1E-4 × 6					PH
CA-2V-8		$\phi 8 \times \phi 13$		EK-C30	PC
CA-2E-8					PH
CA-2V-9		$\phi 9 \times \phi 12$			PC
CA-2E-9					PH
CA-2VL-8	0.05 $^{+0.04}_{-0.03}$	$\phi 8 \times \phi 13$		EK-B30, C35	PC
CA-2VE-8					PH
CA-2VL-9		$\phi 9 \times \phi 12$			PC
CA-2EL-9					PH
CA-1VC-4	0.17 ± 0.04	$\phi 4 \times \phi 9$	PVC	EK-B10, B15, B20 C15, C20	VC
CA-1VE-4					VH
CA-1VC-4 × 6		$\phi 4 \times \phi 6$			VC
CA-1VE-4 × 6					VH
CA-1VC-6		$\phi 6 \times \phi 8$			VC
CA-1VE-6					VH
CA-2VC-8		$\phi 8 \times \phi 13$		EK-C30	VC
CA-2VE-8					VH
CA-2VC-9		$\phi 9 \times \phi 12$			VC
CA-2VE-9					VH
CA-2VCL-8	0.05 $^{+0.04}_{-0.03}$	$\phi 8 \times \phi 13$		EK-B30, C35	VC
CA-2VEL-8					VH
CA-2VCL-9		$\phi 9 \times \phi 12$			VC
CA-2VEL-9					VH
BVC-1VV-4H	0.2 ± 0.02	$\phi 4 \times \phi 6$		EK-B10, B15, B20 C15, C20	VC
BVC-1VV-9H		$\phi 9 \times \phi 12$		EK-C30	
	0.10 $^{+0.02}_{-0.01}$			EK-B30, C35	
BVC-1TV-4H	0.2 ± 0.02	$\phi 4 \times \phi 6$	PVDF	EK-B10, B15, B20 C15, C20	TC
BVC-1TV-10H		$\phi 10 \times \phi 12$		EK-C30	
	0.10 $^{+0.02}_{-0.01}$			EK-B30, C35	
CS-1S	0.2 ± 0.03	Rc 1/4	SUS316	EK-B10, B15, B20 C15, C20, C30	SH
CS-1SL	0.05 ± 0.03			EK-B30, C35	

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U.S.A.	: IWAKI WALCHEM Corporation	TEL : (1)508 429 1440	FAX : 508 429 1386	Spain	: IWAKI Iberica Pumps, S.A.	TEL : (34)943 630030	FAX : 943 628799
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