CKD

Technical Manual

Engineering Manual for Proportional Control Electric Motor-operated Valve
Model No.: MXBC-10～25-0/E-3

* Before use, read this manual carefully.
  Pay special attention to the descriptions about safety.
* Keep this manual handy, ready for reference at any time.

CKD Co., Ltd.
SM-50575-A

INTRODUCTION

Thank you for your choice of CKD's proportional control electric motor-operated valve, Model MXBC.

1. TYPE OF PRODUCT AND FIELD OF USE

This product is an electric motor-driven, proportional control ball valve (proportional control motor valve, or simply valve for short) for use in industrial machinery and equipment.

2. APPLICATION

This valve is suitable for controlling the flow of fluid used in air conditioning including heating and dehumidifying, and in cooling control of heat generating objects.

3. GENERAL CAUTION

* This manual describes basic steps in handling the product including unpacking, installation, use, and maintenance.
* The description of installation assumes the readers to be engineers in the fields of machinery and electricity.

  Be sure to read this manual carefully before engineering design and installation, of machinery and equipment, and use sufficient caution to secure safe use of them as well as this product.

4. TIPS FOR SAFETY

* Strictly observe the caution clauses described in appropriate places of this manual to avoid consequential damages to property, and to prevent injury and fire.
* While there are three words for drawing attention to safety in general, namely DANGER, WARNING, and CAUTION, only the word CAUTION is used in this manual because the product is for use as a component in machines and equipment.

INDICATION EXAMPLE

CAUTION: followed by description of calling attention.

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1. **Unpacking**

＊Check if the model No. on the product's nameplate is the same as that you have ordered.

＊Check if the rated voltage is correct.

＊Check external appearance for damages.

＊When storing the product, apply a seal plug to prevent foreign matter from entering inside. Remove the seal plug when piping.

2. **Basic things**

2.1 What can be done?

This proportional control motor operated valve can change the opening of a ball valve according to signals input from outside.

2.2 Necessary components (See FIG. 2.1)

When in use, the following three components are necessary:

(1) Proportional control motor operated valve

(2) Control section (Adjustment section), for example; temperature controller, adjuster, and PC.

(3) Detecting section (Sensor), for example; temperature measuring resistor, thermocouple, and flow meter.

3. **Example of actual usage**

For controlling confectionery drying with hot water

Dryer for candies.

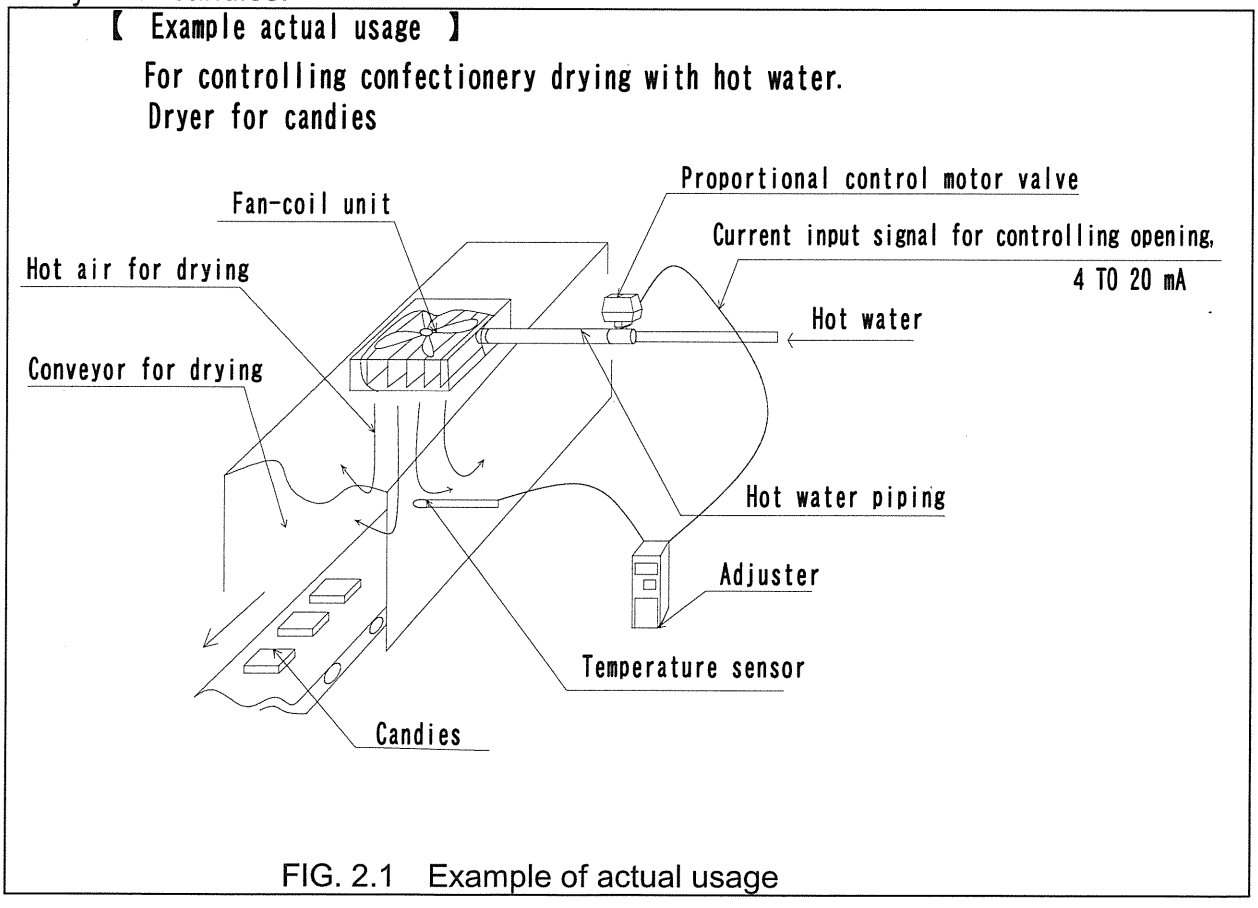


FIG. 2.1 Example of actual usage

4. Before use

4.1 Tips for choosing proportional control electric motor-operated valve

CAUTION

＊Do not use as an emergency shut-off valve.

This valve is not designed for use as an emergency shut-off valve

In case this valve is to be used as a shut-off valve in a system, the system must be provided with a separate means for securing safety.

＊Do not use in an explosive atmosphere.

For use in an explosive atmosphere, choose one from explosion-proof solenoid valve series.

＊Working fluid

Use only the working fluids listed in the specifications.

＊Fluid temperature

Use within the fluid temperature range listed in the specifications.

＊Ambient atmosphere

Do not use in an atmosphere which contains a corrosive gas or erodes component materials.

Do not use near a heat generating object or in a place receiving radiant heat.

Use within the specified ambient temperature for use.

For use in a cold climate area, take appropriate measures against freezing.

＊Use within the specified working pressure

4.1.1 Choosing bore

Choose a bore that is suitable for the required flow rate.

4.1.2 Fluid to be used

Tap water for cooling control, and hot water for heating control may be used.

Permissible temperature range is from 0 to 80 degrees C. However, when in use at high temperatures, keep the atmosphere below 50 degrees C by providing ventilation or the like.

This valve can be used with a fluid of a viscosity of up to 500 m^2/sec. However, pay attention to the fact that the valve characteristic may vary with the type of fluid used.

4.1.3 System to be used

Engineering design of the entire system should be based on a control, that is free from useless actions, such as the PID control rather than the on-and-off control.

The on-and-off control results in actions in small steps, a short service life of the actuator section, and other troubles such as overheating of the electric motor.

4.2 Items to be checked before use

4.2.1 Internal leak.

The initial leak, 0 cm^3/min by water pressure increases with the lapse of service time. The amount varies widely depending on the angular range used, frequency and pressure, so that it is difficult to be specified. However, if a leak-free function is required, interpose a fluid flow stop valve in the piping.

4.2.2 Service durability

The service life of the product varies largely with conditions in use and it is hard to state definitely. However, the life of the gears in the actuator which wear fastest is 500 continuous hours under the rated conditions. Since that life span is based on a continuous use, the product life can be elongated by shortening the actual action (current-carrying) time and by reducing the current-carrying frequency by employing a control that eliminates waste of time, such as with the PID control.

Another point to be taken into consideration in designing the system is that reducing the bore or fluid pressure alleviates the load on the actuator.

4.2.3 Variations among individual products

Even if you purchase several pieces of the product of the same model No. and the same bore, and set with the same control signal, the resultant flow rates are not always the same. That is due to variations from product to product.

4.2.4 Reproducibility (Repeatability).

Although the variation occurs among individual products as described above, for any single piece of the product, the resultant opening amount has reproducibility, without variation, for the same control signal vale. Although a difference occurs in the opening amount depending on the direction of action, opening or closing, repeated actions in one direction produce no difference.

4.2.5 Control signal noise and Power line noise.

Minimize the control signal noise and power line noise as possible (For specific measures, see section 5).

Noises that come along with the current input control signal are received directly as signals for changing the opening and causes to increase extremely the current-carrying frequency. An extreme increase in the current-carrying frequency results in a shorter valve life and a motor current shutoff due to blowing of the thermal fuse.

Noises that come along with the power cause the same results as described above.

4.2.6 Generated noise

The stepping motor for rotating the ball valve requires about 1 A current, and this in turn causes a voltage drop or noise in the power line. Therefore, anti-noise means such as a noise filter is required for devices, vulnerable to noise, such as PCs.

4.2.7 Voltage drop.

Since changes in the power voltage are directly reflected to changes in the opening control amount, use a power source having a sufficient capacity. (Use a commercially available switching power supply of about 50 W.)

4.2.8 Use of power from sequencer or the like.

The power source usually provided in sequencers is not suitable for use because of small capacity.

4.3 Before running actual control

CAUTION: Why tests are indispensable

＊Before installing the product in a system, check the product for the following points by a test run. Intended performance may not be attained depending on the controlling method. In many oases, it is difficult to modify the entire system after starting the operation, so be sure to carry out preliminary checking by the test run.

4.3.1 Action frequency.

Confirm it because the operation frequency influences longevity and the stability etc. of the entire device. Actually control, and confirm the operation frequency by the movement of the opening and shutting display hole etc.

It becomes Table 4.1 as notes.

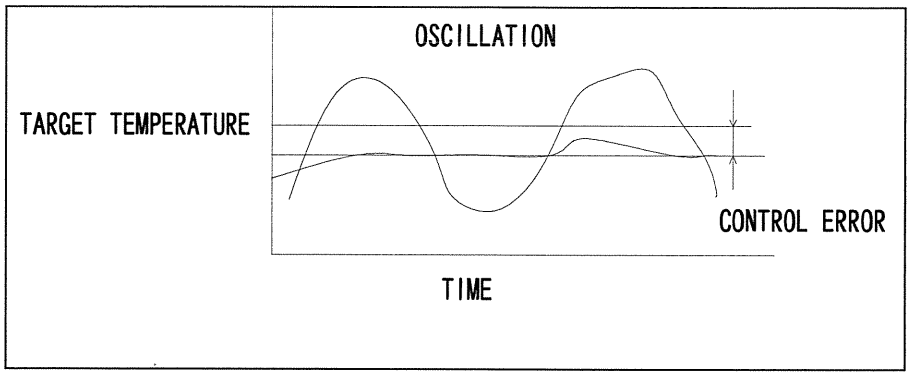
The maximum energizing frequency is a stop for three seconds and operation/five seconds. Please observe this strictly.Especially, stop operating at once, and iron out the problem because it enters the state of a continuous energizing when the ball valve locks.

Table 4.1

Action	Determination	Comment
Works for less than 2 seconds in 10 seconds.	◎	Working ideally. (However, error may increase depending on the subject.)
Continuously opens and closes.	×	Even if the control itself is stabilized without errors, this is a high frequency operation causing adverse effects. Review the PID factor of the adjuster.

4.3.2 Stability

Check the temperature control for the extent of errors relative to the target temperature, or for the presence of oscillation (fluctuation).



(FIG. 4.1 State of control)

* When the actual control oscillates (fluctuates) relative to the target temperature as shown in FIG. 4.1, the flow rate at the minimum resolution might be too high. Therefore, check the working fluid for its flow rate and temperature in addition to reviewing the PID constant of the adjuster.
* The control error results from the imbalance between the heat amount given and heat amount removed (radiation and absorption of heat). In such a case, also check for the flow rate and temperature.

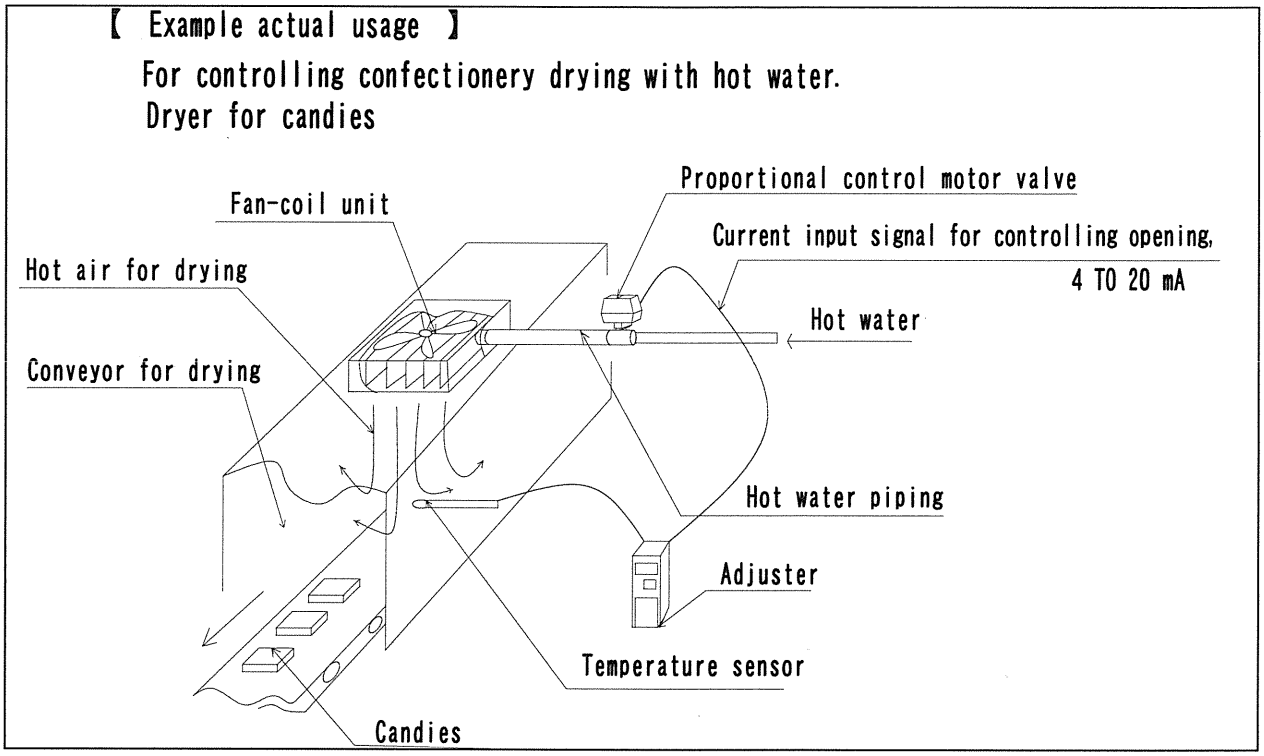
4.3.3 Accuracy

An error is the extent of deviation of a controlled temperature relative to a target temperature. While the deviation varies with the controlling method, even with an almost ideal control, the best accuracy practicable will be within the range of about ±1℃. Improving the accuracy inevitably requires increase in the action frequency, resulting in adverse effects such as overheating, blow of the thermal fuse, and a shorter service life. Therefore, set the error range as wide as permissible.

4.4 Actual control

4.4.1 Control example in the past

An actual application example of the valve is the same as the one already shown in FIG. 2.1.



(FIG. 4.2 Example of actual usage)

This device is used for drying candies carried on a moving conveyor. The candy is dried under the best controlled temperature condition within the drying conveyor by adjusting the flow rate of hot water flowing into a fan-and-coil unit.

Since the drying temperature is one of the vital factors for the taste of food, the valve plays a decisive role in the food processing.

4.4.2 Examples of suitable and unsuitable controls.

＊Suitable control.

A suitable application is a stabilized temperature control for heating and cooling in which balance is established between the heat amount supplied and the heat amount taken to the atmosphere.

＊Unsuitable control.

An unsuitable, unstable control occurs when the control of flow rate or pressure is done with finely divided steps of opening according to position accuracy required. This results in undesirable, frequent current-carrying and operation of the valve.

4.4.3 Controlling flow rate, pressure and temperature

＊Flow rate control

Since the resolution is 2.5 % (about 40 divisions), if the pressure is high, the flow

rate may change extremely with only one step of operation. Therefore, minute flow rate control is difficult.

* Pressure control

Like the flow rate control, the pressure may change extremely with only one step of operation. Therefore, minute pressure control is difficult.

* Temperature control

Although the subject of control is the flow rate, since the control is effected through a heat exchanger, the response is less sharp and less affected with the resolution. Therefore, this can be said to be the most effective control.

Table 4.2

Control subject	Effect	Comment
Flow rate	△	Controllable if 0.1 MPa or less.
Pressure	△	Controllable if 0.1 MPa or less.
Temperature	◎	Most effective when combined with temperature controller.

4.4.4 Responsiveness

Since the rotation moment (torque) is produced with a geared motor, the operation time from the fully closed state to the wide open state is about 7 to 9 seconds. This operation time must be taken into consideration when quick response is required as in the flow rate control. However, the operation time is out of question when slow response is enough as in the temperature control.

4.4.5 Control devices (Temperature controller, Adjuster)

Use of commercially available temperature controllers and adjusters can reduce the system cost while securing favorable functions.

Commercially available temperature controllers has many functions including the automatic tuning function for the PID control which makes the control efficient. Therefore, they are effective in designing a system in a small size.

4.4.6 Control with PC (personal computer) and use of microcomputer board

When PCs and one board microcomputers are used for a control, do not employ the on-off control relative to a target value; otherwise the service life is adversely affected by frequent application and shutoff of electric current.

4.4.7 Types of sensors to be chosen

When designing a control system, thoroughly examine sensors to be used.

The characteristic of the sensor may not be a big question in the temperature control. However, the flow rate control is greatly affected by the characteristic of a flow rate sensor.

Do not use pulse type sensors because they produce waves in signal values, and makes a control unstable.

5. Tips for wiring

CAUTION: Incorrect wiring of power supply results in short circuit accidents. Be sure to wire correctly.

5.1 Power supply.

For the power supply, pay attention to the following:

* Choose a power supply with a sufficient margin of capacity. (A capacity of about 50 W is recommended.)
* Do not use a full-wave rectification circuit: it is affected by ripples or zero voltage. Instead, use a stabilized power supply.
* The variation in the power supply finally affects the ball valve opening. So, keep the power supply within a range of 24 V DC ±10 %.
* Because of a large amount of current consumed and the use of the stepping motor, noises due to rush current and operation current are inevitable. Therefore, use a noise filter when devices vulnerable to noise such as PCs are connected to the same power supply.

5.2 How to wire

* Use breakers such as fuses for the safety of the electric equipment.
* Use a wire of a cross-sectional area of about 0.5 mm^2.
* To avoid possible effect of noise from peripheral devices depending on the wiring method, pay attention to the following:
  (1) Use separate lines for the power supply and for signals, as apart as possible from each other.
  (2) Do not wire collectively in a single duct.
  (3) Do not route wires near high frequency devices.

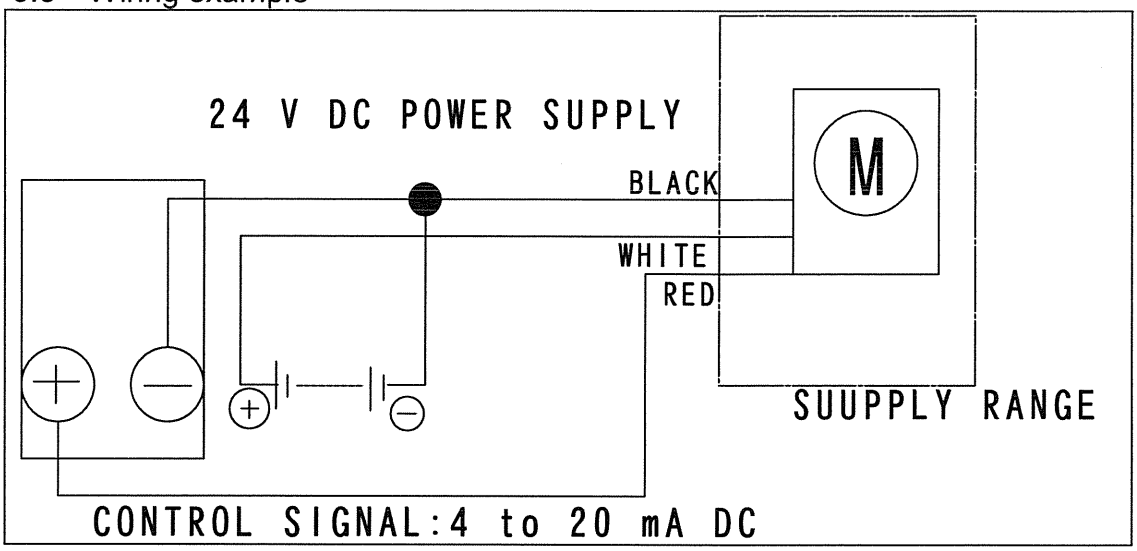
〈About noise〉

Noises result in unexpected troubles.

Noises may result in incorrect operation, shorter service life, and influence on overall control.

Therefore, observe descriptions given in appropriate parts in this manual about the noise measures.

5.3 Wiring example



(FIG. 5.1 Wiring diagram)

Wiring is made as shown in FIG. 5.1. Points of wiring work are listed in Table 5.1 below.

Table 5.1 Contents of wiring work

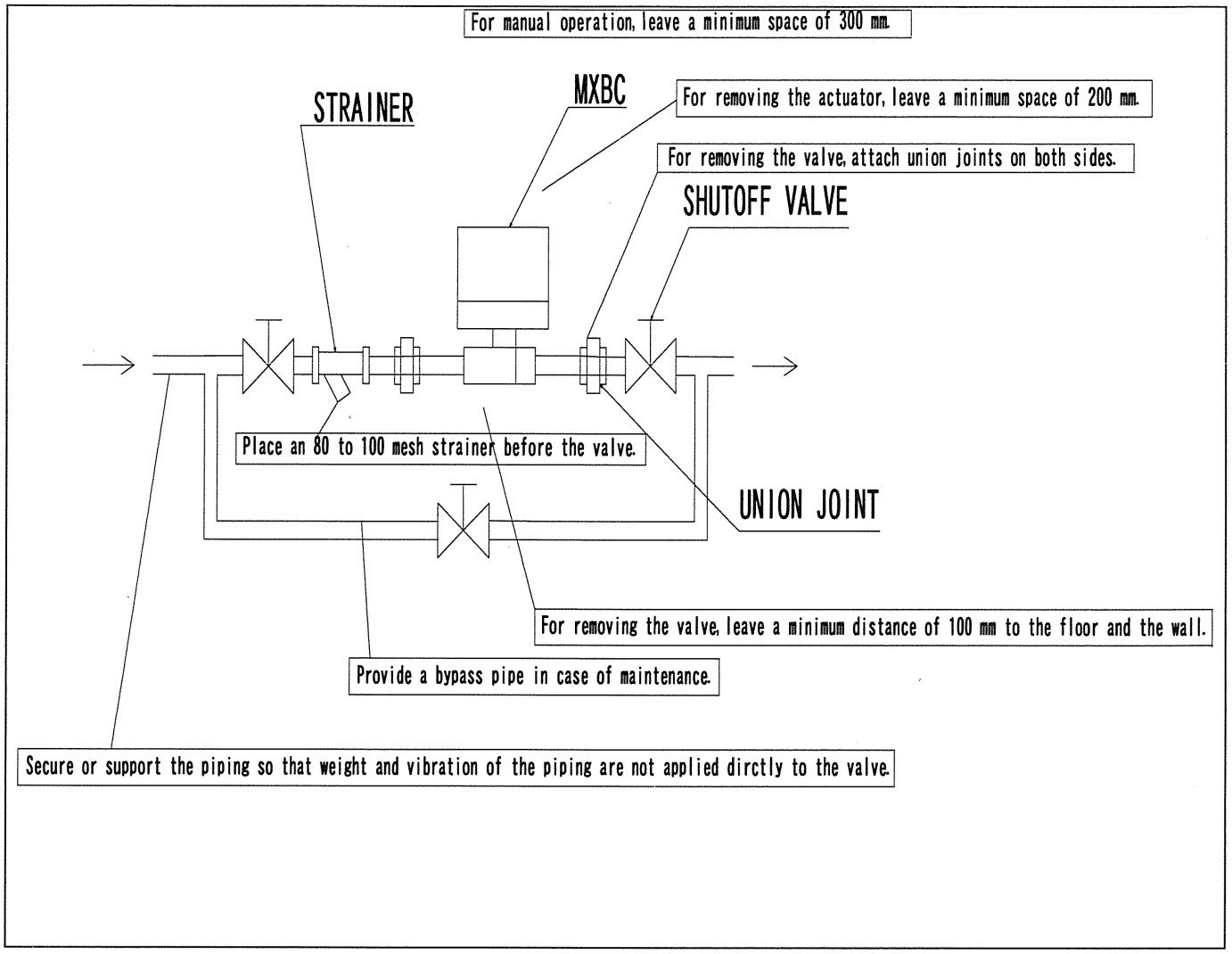
Color of motor-operated valve cable.	How to wire.
WHITE	Connect to +24 V side of power supply.
BLACK	Connect to 0 V (GND) side of power supply and 0 V (GND) of control signal.
RED	Connect to 4 (0) to 20 mA of control signal on positive side.

Secure the wiring with a plastic band or the like so that lead wires are not taut.
Connection points should be securely connected and treated for insulation so as to avoid poor connection or poor insulation.

6. Tips for installation, piping, and location.

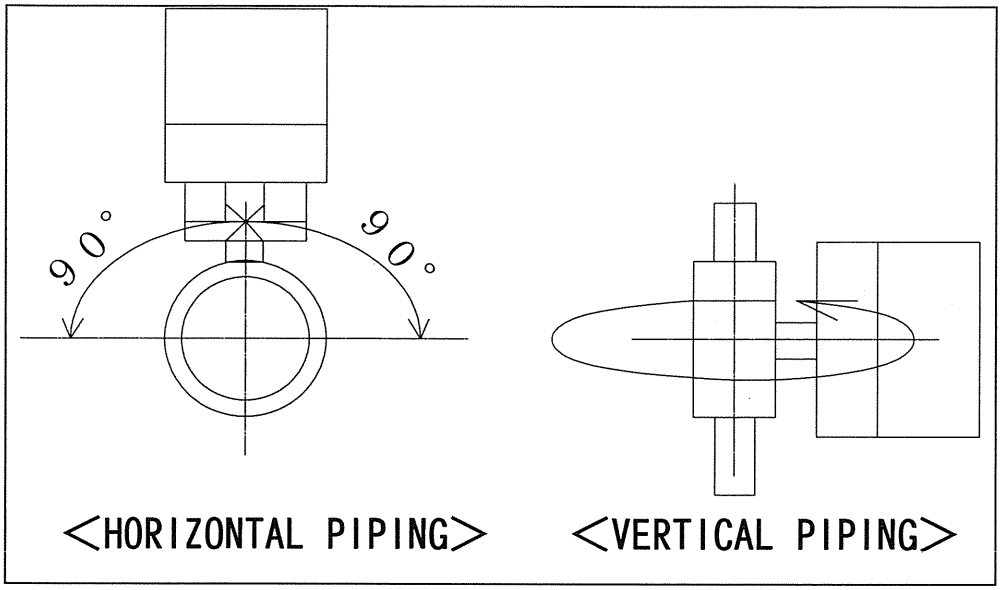
6.1 Installation

Lay the piping while taking into consideration sufficient space for maintenance as illustrated below.



(FIG. 6.1 Piping example)

Attachment attitude should be ±90° with the actuator section on the upper side.



(FIG. 6.2 Attachment attitude)

6.2 Piping.

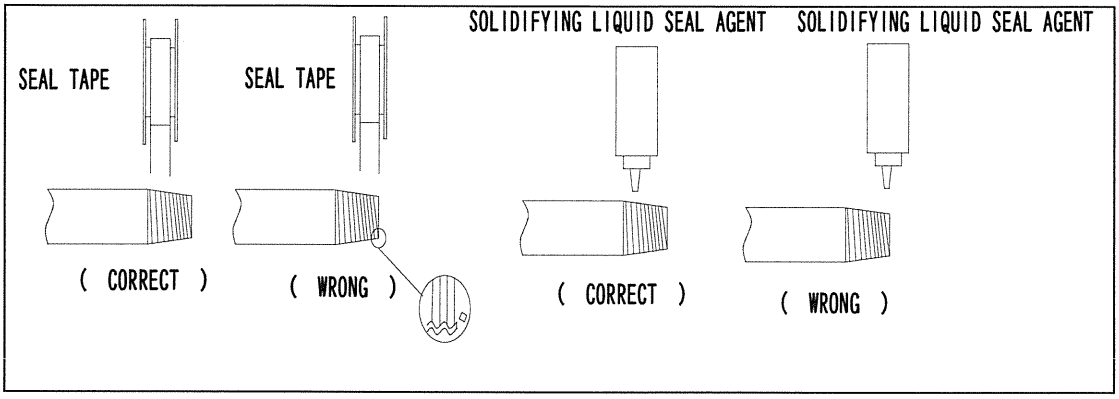
* The manufacturer does not specify the flow direction through the valve connected to a piping.
* Do not apply force onto the actuator section at the time of piping connection work.
* Grip the cap with a spanner or the like when the cap side is connected to the piping, or grip the body when the body side is connected to the piping, and screw in.
* See Table 6.1 below for the tightening torque at piping.

Table 6.1 Recommended tightening torque values at piping.

Nominal pipe diameter	Recommended tightening torque for piping
Rc3/8	3 1～3 3 N.m
Rc1/2	4 1～4 3 N.m
Rc3/4	6 2～6 5 N.m
Rc1	8 3～8 6 N.m

* Before piping, check piping materials for presence of foreign matter, machining dust, and burrs.
* Secure an effective thread length on the pipe. The fore-end of the thread portion should be beveled by about a half pitch.
* Clean the inside of the pipe: Remove foreign matter, machining dust, and burrs by blowing pressurized air of at least 0.3 Mpa.
* When using a sealing agent, use caution so that the agent neither enters the inside of the pipe nor extrudes outside.
When the thread portion is wrapped with a sealing tape, leave unwrapped two to three

pitches from the fore-end. Also when sealing agent of liquid state is used, use caution to use as less amount of sealing liquid as possible so as to leave two to three pitches from the fore-end of the thread without application of the sealing liquid. Do not apply it on the female thread of the valve.



(FIG. 6.3 Sealing agent)

6.3 Location

* Location site may be outdoors as long as a protective structure is permitted. In that case, however, provide plastic piping for avoiding direct sunlight and damage by thunderbolts.
* Do not use in locations where vibration of 5 G or greater is present.
* In cold climate areas, provide appropriate measures against freezing.

6.4 Sensors.

Carefully choose the location of the sensor.

Pay special attention to the installation location of the temperature sensor as deviations in temperature may cause data errors and incorrect control of the entire system. To cope with such a situation, install the sensor at a location where the best average temperature can be detected by thoroughly stirring the air around the location.

7. Care to be taken during control, and checking items

7.1 Initial period of control

(1) Single component operation

Correction of incorrect electric wiring is difficult after finishing the system piping. To avoid such a situation, check the wiring for correct control operation by applying current as soon as the wiring is over.

(2) Leak

Check joints for leaks with the working fluid under pressure.

Recommended checking method is that, apply soap water to joints, supply air under pressure of 0.3 MPa to 0.5 MPa, and watch if bubbles appear.

(3) Initial operation

* If possible, check the power supply line and the signal line with a synchro-scope or the like for the presence of noises. Also check the voltage during operation for drops under the allowable range.
* Find the action frequency of the valve (current-carrying) during the control. In case the current-carrying and shutoff occur too frequently, the product is adversely affected. In that case, see the following examples and take appropriate measures for correction.

Table 7.1

When adjuster and temperature contro-ller are used.	Use instruments having auto-tuning function, run the auto-tuning with an actual load, and arrange an efficient control with less action frequency (free from waste time).
When PC and microcomputer board are used.	Install software for PID control or the like on the program for comparison between target and detected values. (For details, refer to generally available document.)

8. Tips for use

CAUTION

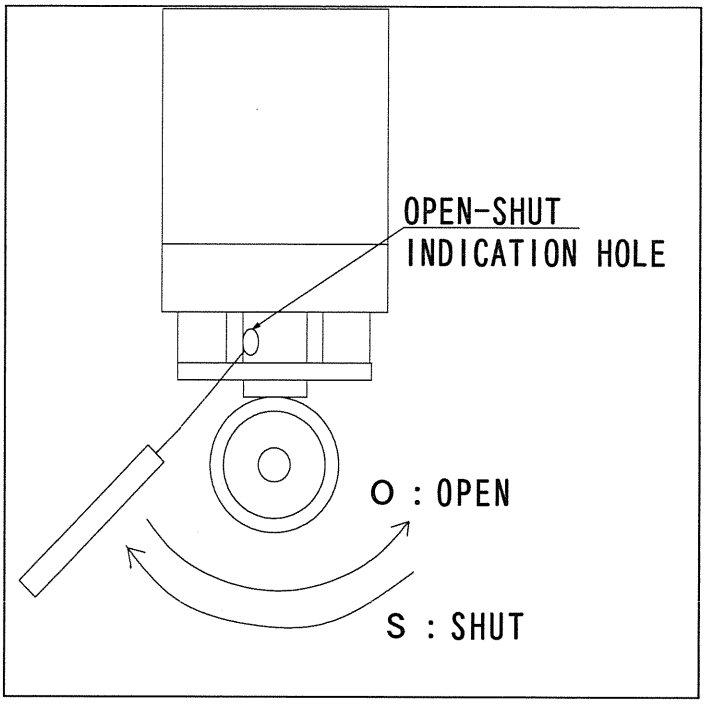
* Do not touch the hood during operation: It is hot due to heat of the motor. Do not remove the hood; otherwise electric shocks and burns may result.
* Do not touch live (exposed) electric joints by hand or body; otherwise electric shocks may result

8.1 Manual operation

Do not operate manually except in case of emergency as in a power failure. The manual operation should follow the steps of:

(1) Turn off the power supply.

(2) Insert a Phillips (cross-head) screwdriver (type H2, No. 2) in the open-shut indication hole in the intermediate bushing, apply gradually increasing force to turn slowly, taking about 20 seconds between the markings S and O, and between O and S.



(FIG. 8.1 Manual operation)

8.2 Turning on and off power supply

Since a large operation current from the power supply is turned on and off, contact points such as in relays should have sufficient capacities (for 24 V DC or more, you may need 3 A or more).

8.3 Breaker capacity

Fuses and breakers should have a capacity of about 5 A.

8.4 Function of thermal protector

The actuator is protected with a thermal fuse protector against burning damage of the motor. This makes it possible to temporarily shut off current when the motor is overheated with any trouble or very frequent operations, and to resume operation. Since the functioning of the thermal protector means the presence of some problems, review the control method and check the ball valve for the presence of foreign matter.

8.5 Others

* Do not step on the device.
* When the valve is not in use for an extended period of time, drain the internal residual water completely; otherwise the residual water may cause rust and other troubles such as incorrect operations and leaks.

9. Tips for maintenance

9.1 Check and maintenance

To maintain a good condition for use of this product, check periodically at least once in six months for the following items.

＊Operation

Even if the valve continues to work in order, some parts wear and deteriorate.
So, check the following items:

Table 9.1

Sound	Has the sound level increased? Has the sound become uneven?
Heat	Is the actuator surface hotter than 60 degrees C?

If any of the above problems is found and the operation is adversely affected, replace the actuator.

＊Internal leak.

In the proportional control, the ball valve seat wears unevenly and tends to leak earlier. If the wear goes on, the actuator is affected. Check periodically for the leak with a complete closure input signal.
If the leak is several tens cm^3/mn or greater, replace the ball valve.

＊Check the strainer for clogging.

9.2 Parts for maintenance

The parts to be maintained are the actuator and the ball valve.
In case any problem is found, replace appropriate parts as described in Section 10.

10. Disassembly and assembly

CAUTION: Turn OFF the power supply and stop the fluid before starting the work.

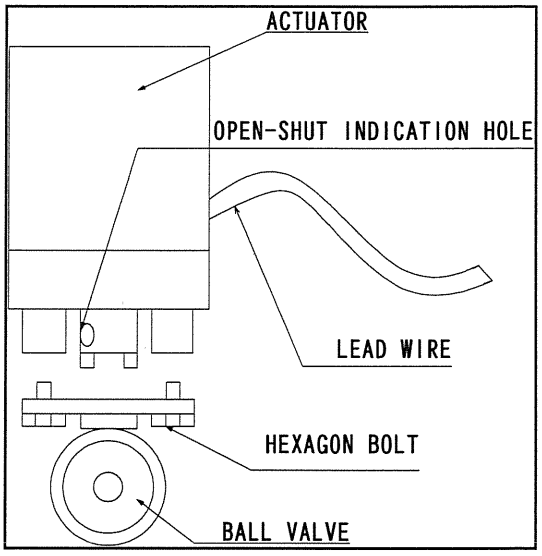
10.1 Replacing actuator

＊Disassembly steps

(1) Disconnect wires.
(2) Loosen hexagon bolt(s) with a spanner.
(3) Lift the actuator to separate it from the ball valve.

＊Assembly steps

(1) Align the open-shut position of the ball valve with the open-shut indication hole of a new actuator.



(2) Tighten hexagon bolt(s) with a torque of 5 to 7.5 Nm.

(3) Connect wires.

(4) Turn on the power, and check for operation.

10.2 Replacing ball valve

＊Disassembly steps

(1) Loosen hexagon bolt(s) with a spanner to separate the actuator.
However, watch that the lead wires are not taut.

(2) Loosen the piping to the ball valve and remove the ball valve.

＊Assembly steps.

(1) Lay piping to the new ball valve. When the piping is laid on the cap side, secure the cap with a spanner. When the piping is laid on the body side, secure the body with a spanner.

(2) Place the actuator on the ball valve and tighten with a tightening torque of 5 to 7.5 Nm.

(3) Apply a fluid pressure and confirm that the fluid does not leak out.

(4) Turn on the power, and check for operation.

11. Basic knowledge of proportional control motor-operated

11.1 Proportional control

11.1.1 Current input signal

The current input signal for controlling the opening is in the range of 4 to 20 mA. Although the ball valve starts opening at about 4 mA, the value is not accurate due to variation from piece to piece of the product. So, assume the relation between the input signal and the opening as shown below:

Table 11.1

Input signal	Opening
0mA	Fully closed position
20mA	Wide open position

Since the internal impedance is about 240 ohms, a necessary control voltage is about 4.8 V (= 240 ohms x 0.02 A).

11.1.2 PID control

Most of commercially available adjusters have an auto-tuning function capable of PID control. This function is to provide the best current-carrying timing specifically matched to a control subject.

No matter how frequently the ball valve may move, the movement is ineffective depending on the subject of control. It is said that the auto-tuning is to find the ineffective control amount. This enables to eliminate ineffective current-carrying and to lower the operation frequency. Since this control is necessary to elongate the service life of the product, be sure to use an adjuster with PID.

11.1.3 On relation between input signal and flow rate.

The relation between the input signal for control and the ball valve flow rate characteristic (Cv value) is as illustrated below.

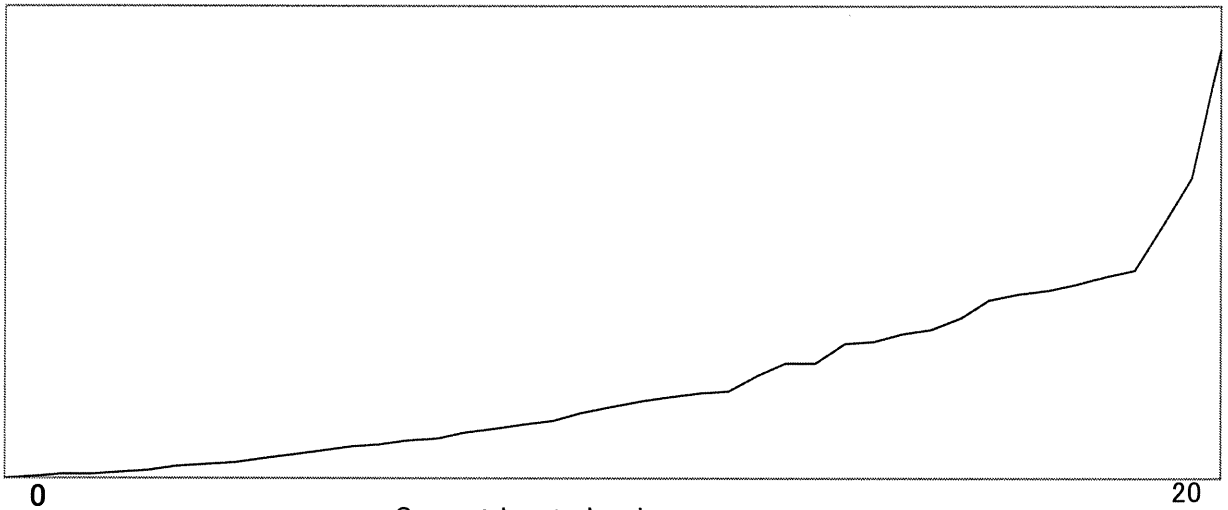


FIG. 11.2 Flow rate characteristic

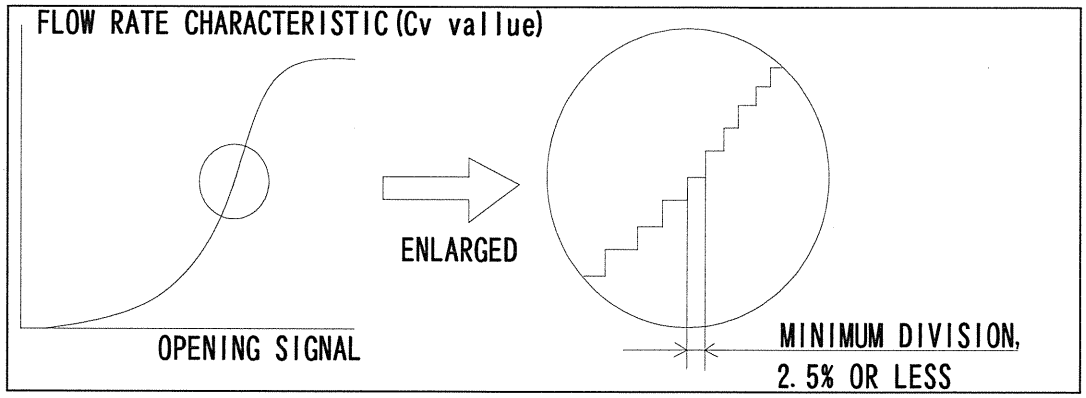
However, the characteristic illustrated above is a general guideline because it varies to some extent from piece to piece of the product.

Moreover, part of the characteristic curve near the fully closed and wide open state is not suitable for practical use: As a nature of the ball valve, the amount of change in the flow rate per one step (minimum width of change) is large near that part.

Stabilized control will be realized if the bore is set so that the control can be performed near a half of the maximum Cv value.

11.1.4 Resolution.

The resolution can be expressed as the number of divisions to the working angle (90 degrees) of the ball valve. Although a continuous change in the opening relative to the input signal is an ideal, the change is made in fine steps because of the structure of the ball valve.



(FIG. 11.3 Resolution)

The width of a single step is the minimum division called the resolution. Therefore, the expression “2.5 %” means that 90 degrees are divided into 40, or by 2.25 degrees.

11.2 Other control possibilities

11.2.1 Temperature control using steam

Of the motor-operated valve series, the MHBP type is suitable for this application: Its specifically intended for the temperature control

11.2.2 Oil-less structure

The shaft rotating parts structurally requires grease application. Although perfect oil-less structure is impossible, it is possible to employ a semi-oil-less structure near the ball seat region only.

11.2.3 Large bore (up to 50 A)

The actual proportional control range is mostly not over the entire opening range but part of it, even in the piping for a 50 A class. Therefore, examine possible combination of a standard, large-bore, motor-operated valve and a proportional control valve.

11.2.4 Gas flow rate control

The ball valve, as its flow passage cross-sectional area changes largely, is not suitable for use with gasses in which a high accuracy is required.

11.2.5 Monitor display of ball valve opening only

Use the simplified control type (MXBC-N). However, since there is play in the ball valve component joint, the opening includes an error. So, use it as a general guideline.

11.2.6 Changes in zero position and span position

The zero position (fully closed position) and the span position (wide open position) are adjusted at the factory before shipment. Although it is possible to change the flow rate range with a trimmer (half-fixed resistor) on the control board, it is very difficult to return to the initial state once the change is made. Therefore, the change in the control range should be made on the control signal side as practicable as

possible. (Please call us when a change is required.)

11.3 Basic things about electricity

11.3.1 Consumed current

Most of the current requirement of this product goes to the stepping motor.
The motor, like a coil, has an inductance, so that the current and the voltage are different in phase from each other. The current does not follow simply to the Ohm's law, and is expressed with a peak value and an average value. While the average value is 750±100 mA, the instantaneous peak current is about 1200 mA (1.2 A).
Therefore, a stabilized power supply of about 50 W is recommended.

11.3.2 Current input signal

The opening is controlled generally between 4 mA and 20 mA.
The advantage of the current control is that it is less affected with voltage noises and the electric transfer distance.
However, since the proportionality relation between the opening start position and the input signal is hard to establish with the ball valve, the fully closed position is set to 0 mA.

11.3.3 Input impedance

On the motor-operated valve side, the control signal is received as a current as described above. In the internal circuit, the signal is converted to a voltage and subjected to comparative calculating operations.
A resistance value for the above-mentioned conversion to voltage is called an input(internal) impedance.
The impedance value of this product is 240 ohms. Therefore, the internal circuit controls with a current of between 0.96 V and 4.8 V calculated as the input current of 4 to 20 mA multiplied by the (internal) impedance of 240 ohms.

12. Troubleshooting

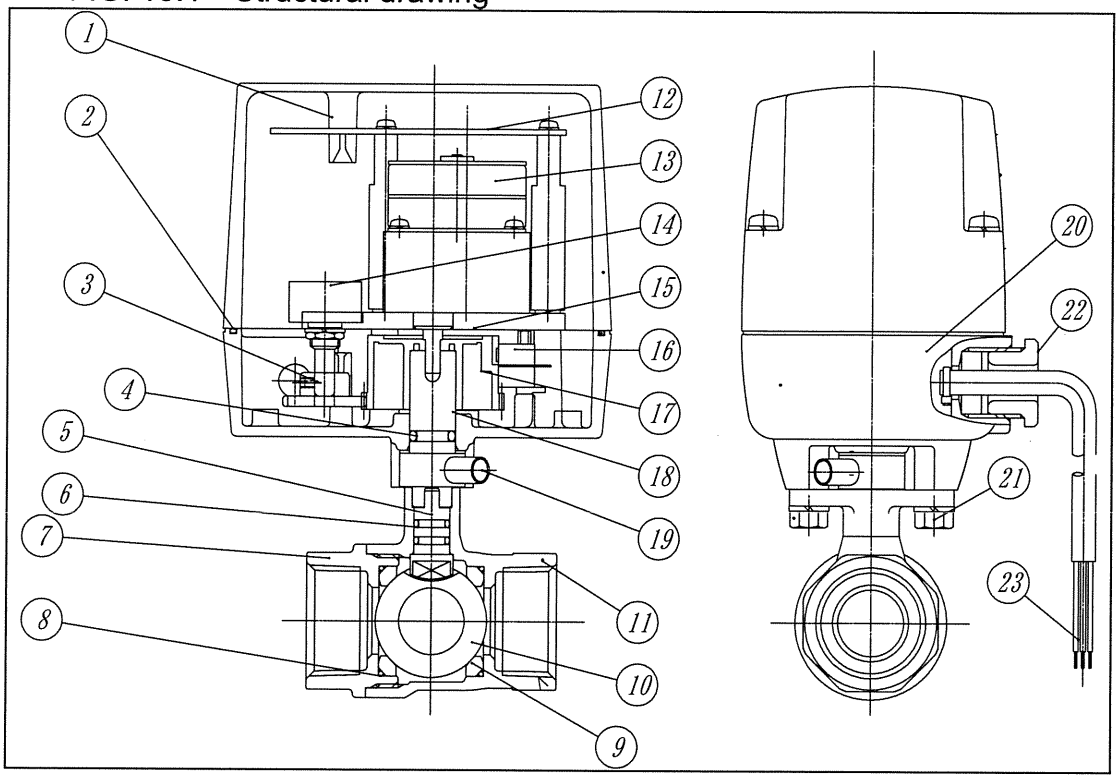
In case the motor-operated valve does not work as intended, check and correct according to the table below.

Table 12.1

Symptom	Cause	When: at start(S) / in the middle(M)	Remedy
Inoperative.	Full-wave rectification circuit is used.	(S)	Change to stabilized power supply (50 W).
	Incorrect wiring.	(S)	Referring to the wiring diagram, check both motor valve side and control side.
	Insufficient power; Voltage drop.	(S)/(M)	Use a power supply of a sufficient capacity.
	Foreign matter in the ball valve. Valve seat stuck.	(S)/(M)	Replace the ball valve.
	Thunderbolt damage, wrong voltage application, wrong wiring.	中(M)	Replace the actuator section.
	Breaker has worked.	(S)/(M)	Remove the cause of breaker action and apply current again.
	Thermal protector has worked.	(M)	Change control method to avoid frequent operations.
	Gear damage due to incorrect manual operation.	(M)	Replace the actuator section.
	Opening seems incorrect after zero and span adjustments.	(M)	Readjust. (Please call us for the readjustment procedure).
Uncontrollable	Foreign matter caught in the ball valve.	(S)/(M)	Replace the ball valve.
	Worn valve seat.	(S)/(M)	Replace the ball valve.
	Opening seems incorrect after zero and span adjustments.	(M)	Readjust. (Please call us for the readjustment procedure).
	Gear damage due to incorrect manual operation.	(M)	Replace the actuator section.
	Thermal protector has worked.	(S)/(M)	Change control method to avoid frequent operations.
	Uneven wear of valve seat due to frequent operations near the lower limit.	(M)	Replace the ball valve.
Unstable	Incorrect PID constant of adjuster.	(S)/(M)	Set a correct constant for the control subject by auto-tuning.
	Noises in control signal, power line, and from valve.	(S)/(M)	Use a noise filter.
	Flow rate is too high.	(S)/(M)	Reduce the flow rate, or use a smaller bore.
Large error.	Poor heat radiation, or poor heat absorption.	(S)/(M)	Correct flow rate and temperature.

13. Internal structure

FIG. 13.1 Structural drawing



(Table 13.1 Parts list)

Table 13.1 Parts list

Part No.	Description	Material	Part No.	Description	Material
1	Hood	ADC12	13	Motor	
2	Gasket	NBR	14	Potentiometer	
3	Spur gear	C3604	15	Attachment plate	A2017
4	O-ring	FKM	16	Microswitch	
5	Shaft	SUS303(SUS304)	17	Cam	POM
6	O-ring	FKM,NBR	18	Middle bush	SUS303
7	Cap	CAC408(SCS13)	19	Stopper	C2700T
8	O-ring	FKM	20	Adapter	ZDC2
9	Valve ball	C3771+chromium-plated(SUS304)	21	Hexagon bolt	SWCH
10	Ball seat	PTFE	22	Bushing	PF
11	Body	CAC408(SCS13)	23	Cord	
12	Control board				

( ) : Stainless Body "E"

14. Product specifications

14.1 Model number indication

MXBC－10－0－3

III	Voltage
II	Body sheet material
I	Bore

I : Connection bore	
10	Rc3/8
15	Rc1/2
20	Rc3/4
25	Rc1

II : Body, Valve sheet material	
0	Bronze, PTFE
E	Stainless,PTFE

III : Voltage	
3	DC24V

14.2 Major specifications

Model / Item	2-port valve			
	MXBC-10	MXBC-15	MXBC-20	MXBC-25
Pressure strength in MPa	2 (Water pressure)			
Working fluid	Water; hot water			
Fluid pressure in MPa	0 to 1			
Fluid temperature in ℃	0 to 80 (without freezing)			
Ambient temperature in ℃	-10 to 50			
Rated voltage	DC24V			
Ambient humidity in %	95 or less			
Consumed current in mA	750±100			
Input signal	4 (0) mA to 20 mA DC; internal impedance of 240 Ω			
Resolution	2.5 % or less			
Action frequency	3 sec. action, 5 sec. stop			
Port size	Rc3/8	Rc1/2	Rc3/4	Rc1
Orifice mm	10	10	15	20
Cv flow factor	10	6	16	29
Mass kg	2.0	2.0	2.2	2.3