Instructions Prior to Operation

⚠ Safety Instructions

The following instructions are to ensure the safe and proper use of our products in order to prevent injury to workers and damage to components or products, and are classified into three categories, Danger, Warning, and Caution, according to the potential severity and likelihood of the danger or damage. Be sure to observe these instructions, together with ISO 4414, JIS B 8370, and other relevant safety rules.

⚠ **Danger**: State in which there is a danger of death or serious injury unless urgently avoided

⚠ **Warning**: State in which there may be a danger of death or injury if mishandled

⚠ **Caution**: State in which there is a danger of minor or medium injury or property damage if mishandled

The states that fall under the Caution category may involve serious injury or property damage,depending on the surrounding conditions.

⚠ Warning:

(1) Our products are designed and manufactured as components of general industrial machines. The specifications of the system in which these products are used shall be determined only by pneumatic-system design engineers or those with sufficient knowledge and experience of the system, after the conditions of the workpiece are analyzed and tested where necessary.

(2) To ensure safety, review all the specifications based on the operation manual for the products, the specific and common safety instructions, and the technical note in this catalog.

(3) Contact us in advance if the ejector is to be used under the following circumstances or conditions:
1. Applications for nuclear power equipment, railways, aircraft, vehicles, medical instruments, machines in contact with beverages or food, entertainment machines, emergency circuit breakers, or safety equipment
2. Applications that may affect human health or personal property, or those for which a high level of safety is required

Common Safety Instructions

⚠ Warning — Design and Selection

1. Design your system to ensure safety in the event of power failure or problems with the air source resulting in a decrease in the degree of vacuum. When the degree of vacuum drops, the vacuum pad loses its absorbing force and drops the workpiece it is holding. This may injure workers or damage the machine. Install a mechanical system to prevent workpieces from falling.

2. In a system in which the ejector is equipped with two or more vacuum pads, all other pads will release their workpieces when one of the vacuum pads does so. When a vacuum pad releases its workpiece, the degree of vacuum in the ejector drops to make other pads release their workpieces.

⚠ Caution — Design and Selection

1. Efficiently lay piping.
   The piping on the vacuum side shall have an effective cross-sectional area to ensure maximum discharge volume of the ejector flow. Lay it so that the volume is as small as possible.
   Do not throttle the piping or create an air leak. The pipe diameter on the air-supply side depends on the amount of air consumed by the ejector (nozzle diameter). Make the effective cross-sectional area as great as possible for tubes, joints, electromagnetic valves, and branch pipes, in order to minimize the pressure decrease in the piping to the ejector. Do not use spiral hoses with a large piping resistance. Use straight hoses. Do not clog the discharge port of the ejector.

⚠ Danger — Cautions for Equipment

1. Do not use the ejector in explosive atmospheres.

⚠ Warning — Cautions for Equipment

1. Supply the specified voltage ±10% to the electromagnetic valves.
2. Do not use the ejector in locations subject to shock or vibration.
3. Install the ejector a significant distance from high-tension equipment and circuits, and motor circuits which produce a large amount of noise.

Common Safety Instructions

⚠ Caution — Cautions for Equipment

1. Use the ejector within the specified temperature range of 0°C to 55°C (without freezing), except for some series products, which shall be used at 0°C to 60°C.
2. Compressed air contains a large volume of drainage (water, oxidized oil, tar, and other foreign substances), which will significantly reduce the performance of the ejector. To improve the quality of the compressed air, remove moisture using an after-cooler or air dryer, and tar using a tar-removing filter. Do not use a lubricator.
3. Position an air-pressure filter of 5 µm or less immediately before the air-supply side of the ejector.
4. Where necessary, take appropriate measures to protect the ejector from water drops, oil, or welding spatter.
5. Do not expose the ejector to corrosive gases, chemicals, water, or salt.
6. Take measures to disperse heat from the ejector, and keep it within the specified temperature range when it is in an enclosed area or power is supplied for an extended peri

⚠ Warning — Cautions for Maintenance

1. Cut off the power and the air supplies before disassembling the ejector or replacing parts.
2. The ejector shall be disassembled and assembled only by those with expert knowledge of it.
3. Wear goggles, safety shoes, a helmet, and gloves when disassembling the ejector, as parts may spring out.
4. When the ejector is used at a manifold, the supply-air pressure shall be 0.53 MPa to 0.55 MPa for type S, and 0.38 MPa to 0.4 MPa for type R.

⚠ Caution — Cautions for Maintenance

1. Tighten the screws at a torque of 6 kgf•cm or less for M3, 14 kgf•cm or less for M4, and 29 kgf•cm or less for M5.
2. Regularly inspect, clean, and replace the vacuum filter element and ejector silencer, as they may become clogged and reduce the degree of vacuum.
3. Regularly inspect the ejector using a vacuum gauge.
4. Regularly inspect the vacuum pad for cracks and loosening of metal parts.

Technical Note

Procedures for Selecting Ejector System Components

Follow the steps specified below to create a vacuum system with ejectors and vacuum pads.

(1) Analysis of Workpiece
a) Weight
b) Profile ... Area, flatness, and profile of the absorbing surface
c) Characteristics ... Surface conditions, permeability, rigidity (paper, vinyl, and other non-rigid materials)

(2) Directions for Workpiece Handling and Vacuum-Pad Installation
Determine the directions for handling workpieces and installing vacuum pads.
Workpieces are generally lifted with their horizontal surface absorbed (horizontal lift), or with their vertical face absorbed (vertical lift).

(3) Safety Factor for Thrust Calculation
a) Four or more times the theoretical lifting ability for horizontal lift
b) Eight or more times the theoretical lifting ability for vertical lift

(4) Calculation of Lifting ability
See pages 23 and 24.

(5) Acceleration and Centroid of the Workpiece
a) When a workpiece is absorbed, lifted, and moved in the horizontal direction, if its mass (m) is large and acceleration (α) is high, the resulting force (F) may not be neglected in comparison with the absorption force.

$F=m\alpha$ (n)
m: Mass of workpiece (kg)
α: Acceleration (m/s^2)

Take the maximum value for acceleration. When workpieces are moved at a high acceleration, conduct measurement using an accelerometer to determine the maximum value. Confirm the friction force between the absorption pad and the workpiece absorbing surface for this horizontal lift as for vertical lift when the workpiece absorbing surface is slippery.
b) When workpieces with a large area are moved, the air resistance may need to be taken into account. Exercise care when attempting to lift piled plates individually, as they may stick together, or two or more plates may be lifted simultaneously.
c) The centroid of the workpiece is also important. When the centroid G is not on the extension of the pad center line P, a couple (moment) serves as an arm between G and P. See Fig. 1. As a result, the workpiece will incline and slip off the pad. As the absorbing force of the pad is extremely small compared with this rotating force, be sure to set the absorbing position so that the centroid of the workpiece is directly below the pad.
Even when the centroid is directly below the pad, however, a couple acts at the centroid due to the acceleration when it is moved in the horizontal direction, if the distance between the pad and the centroid of a heavy workpiece is too great. See Fig. 2. In such a situation, the workpiece swings and inclines in the horizontal direction. If a shock-free handling system is to be created, therefore, the distance between the centroids of the workpiece and the pad should be as short as possible, or a mechanism should be installed to prevent workpieces from swinging.

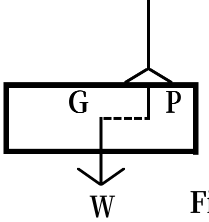


Fig.1

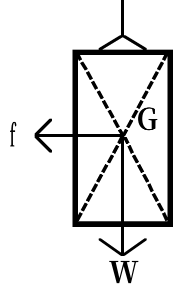


Fig.2

Technical Note

Procedures for Selecting Ejector System Components

(6) Pads

a) Determine the degree of vacuum when a workpiece is absorbed based on its characteristics. The required degree of vacuum will not be achieved for workpieces with high permeability or a rough absorbing surface. When such workpieces are handled, test the system to confirm that the absorbing force is sufficient. The type-H ejector normally provides a maximum degree of vacuum of 86.6 KPa to 92 KPa.
Select pads that enable a vacuum of 80 KPa to be attained, even for workpieces with low permeability.
b) Select pads made of a material resistant to heat, chemicals, abrasion, oil, and static electricity. See page 23.

(7)Ejector

a) Calculate the volume of the piping from the vacuum-generating port to the vacuum pad. The larger the volume, the longer the response time. To minimize the response time, therefore, lay piping so that it is as short and straight as possible.
b) Determine the nozzle diameter based on the desired response time and the volume of the piping.

(8) Absorption time

Calculate the absorption time using the following formula:

$T=(L/C)^{1/\alpha}$

T(sec): Time to the ultimate vacuum
L(l): Volume of the vacuum system
C: Constant related to the degree of vacuum
α: Index of the ejector type
See page 25.

(9) Time to the ultimate vacuum Specify the time required to reach the ultimate vacuum, the weight of the workpiece, and the permeability.
Type H is appropriate for workpieces with low permeability, and type L for those with high permeability.

(10) Supply-air pressure

a) Select type (S) when a stable air supply at 0.5 Mpa or higher is available, and type (R) (0.35 Mpa specification) when the supply-air pressure is lower.
b) When two or more manifold-type ejectors are used, set the supply-air pressure approximately 8% higher than the value specified for a single ejector.
* The specified supply-air pressure shall be the value when the ejector is activated.

Technical Note

Procedures for Selecting Ejector System Components

(11) Vacuum Sensor (Vacuum Switch)
A vacuum sensor (vacuum switch) is required for automatic control of the absorption system.
The ejectors of some series equipped with a vacuum sensor (vacuum switch) can be selected.
See pages 29 and 30, Technical Note: Vacuum Sensor (Vacuum Switch).

(12) Vacuum Breakdown
Workpieces can quickly be released from the absorption pad by supplying positive pressure to the vacuum system.
The ejectors of some series equipped with a vacuum-breaking valve can be selected.

(13) Vacuum Filter
The vacuum filter removes foreign materials adhered to workpieces that would enter the ejector to lower its performance. This will extend the life of the ejector. TF-3 is normally used for ejector nozzles 05 to 10, TF-5 for ejector nozzle 15, and TF-6 for ejector nozzle 20.
When large amounts of foreign materials are adhered to the workpiece, use a filter one level above that recommended, such as TF-5 instead of TF-3.
Available compact filter(TFC Series).
* The ejectors of some series are equipped with a filter.

(14) Electromagnetic Valve *1 (See the table on the bottom)
Select an electromagnetic valve with a cross-sectional area that is at least three times that of the ejector nozzle. The recommended cross-sectional area of the electromagnetic valve is 3mm2 for ejector nozzle diameters of 0.5 mm to 1.0 mm, 7 mm2 for 1.3 mm to 1.5 mm, 12 mm2 for 2.0 mm, 17.5 mm2 for 2.5 mm, and 25 mm2 for 3.0 mm. An electromagnetic valve is installed as a standard component, or can be installed optionally in the TVA, TVF2, TVG, TVS, TVM, TV2, and TVR2 series.

*1
TV, TVF-1, TVU, TV-1 are without electromagnetic valve.
Basically, select the solenoid valves having effective sectional area three times or more larger than the sectional area formed by the nozzle diameter.

Nozzle diameter of ejector (mm)	Sectional area of nozzle (mm^2)	Effective sectional area of recommended solenoid valve (mm^2)
φ0.5～φ1.0	0.2～0.8	3
φ1.3～φ1.5	1.3～1.8	7
φ2.0	3.1	12
φ2.5	4.9	17.5
φ3.0	7.1	25

Technical Note

Procedures for Selecting Ejector System Components

(15) Piping
a) Use nylon or urethane tubes capable of withstanding a breaking pressure of 3 MPa (30 kgf/cm2)
b) The piping resistance may cause problems. For example, connection of a tube having a length diameter of 2 mm to a 10HS ejector will result in a pressure decrease of 53.2 kpa due to piping resistance. When a vacuum sensor is used under these conditions, it may turn on even when the degree of vacuum has not reached the specified level at the tip of the tube.
c) To minimize the piping resistance, lay the piping so that it is as short and straight as possible on the supply-air and vacuum sides. Do not use a spiral tube unless absolutely necessary, and then use it only up to the regulator (equipped with a gauge). Never use it between the electromagnetic valve and the ejector, or for ejectors or vacuum pads.
d) On the supply-air side, use a tube that is the same size as or one level larger than that on the vacuum side, in order to preventa pressure decrease when the ejector is activated. Depending on the piping material and the valve type, the inner diameter or orifice of some pipes is smaller than it appears, despite the fact that the connection diameter is large. Confirm thatthe inner diameter is sufficient before using a tube. If the piping is to be branched on the vacuum side, make the diameter smalleron the vacuum-pad side and larger on the pressure-source side.
e) When two or more manifold-type ejectors are activated simultaneously, the supply pressure may decrease rapidly if the piping diameter is insufficient. In such an event, use a tube one level larger.
f) When it is necessary to bend the piping, do so at an obtuse angle so as not to increase the piping resistance. The pressure will decrease on the positive side before the bending point, and the discharge of air will be decreased on the negative side thereafter.
g) The pressure loss due to the use of elbow-type joints may need to be taken into account on the vacuum side.
h) As the piping for ejectors and vacuum pads is subject to vacuum, use piping apparatus with high sealing performance.
i) See the table on the bottom about piping.

(16) Compressor
The output of the compressor motor can be determined from the ratio of the volume of air consumed by the ejector to that discharged by a 1-HP compressor motor.
As a rule of thumb, the volume of air discharged by a 1-HP (735 W) motor is approximately 80 L/min (ANR) As the volume of air consumed by a TV-15HS ejector is 100 L/min (ANR), for example, the required motor output is 735 W x 100/80 = 735 W x 1.25 = 918.8 W.
Therefore, in this case, use a compressor motor of at least 1 KW.

*Relation between the nozzle diameters and the inner diameters of tubes arranged on the air supply side.

Ejector nozzle diameter (mm)	Inner diameter of tubes (mm)
ϕ0.5	ϕ4
ϕ0.7	ϕ4
ϕ0.9	ϕ4
ϕ1.0	ϕ4
ϕ1.5	ϕ5
ϕ2.0	ϕ6.5
ϕ2.5	ϕ8
ϕ3.0	ϕ8

Caution: The inner diameters of tubes shown in this table are the standard values, as a reference. If the length of piping becomes longer, etc. to enlarge the effective sectional area, is necessary.

Technical Note

Calculation of Lifting ability

$$W = \frac{P \times C}{101} \times f \times (10.13)$$

W	Lifting ability (N)
P	Degree of vacuum (kPa)
C	Absorption area of pad
f	Safety coefficient (inverse of safety factor)

●Select a sufficiently large value for the safety factor for handing workpieces, taking into consideration their.
●Calculate the absorption area of the pad as approximately 10% larger than the actual area when it absorbs a workpiece.
●When the workpiece is inclined, the absorbing force becomes extremely small. Be sure to absorb the workpiece directly above its centroid.
●Select an appropriate value for the safety factor in accordance with the lifting conditions.
(normally 4 or higher for horizontal lift and 8 or higher for vertical lift.)

Characteristics of rubber materials

Rubber material	Hardness HS	Tensile strength N／cm²	Tear strength N／cm²	Elongation %	Withstand temperature ℃
Nitrile rubber (NBR)	50～90	686～1961	313～490	150～620	−26～120
Silicon rubber (SI)	54～80	441～784	117～411	100～300	−60～250
Urethane rubber (U)	50～80	686～4315	588～1961	310～750	−20～75
Fluoro rubber (FKM)	58～90	931～1765	166～470	100～350	−10～230
Chloroprene rubber (CR)	47～80	1529～2079	382～608	190～630	−30～130
Natural rubber (NR)	48～73	1324～2648	353～471	460～640	−60～80

Rubber material	Oil resisance	Sunlight resistance	Ozone resistance	Alkali resistance	Acid resistance	Wear resistance	Electrical insulation	Gas Permeability
Nitrile rubber (NBR)	◎	×	×	○	△	◎	×	○
Silicon rubber (SI)	△	◎	◎	○	△	×	◎	×
Urethane rubber (U)	△	◎	◎	×	×	◎	○	○
Fluro rubber (FKM)	◎	◎	◎	△	◎	◎	◎	◎
Chloroprene rubber (CR)	○	○	◎	◎	○	○	○	○
Natural rubber (NR)	×	△	×	○	○	○	◎	△

◎: Excellent (Can be used)　○: Good (No detrimental effects)
△: Good under some conditions (Can be used under some conditions)
×: Inappropriate (Cannot be used)

Technical Note

Theoretical Lifting Force of Pads

The figures in the Table were determined using the calculation formula, with the safety factor taken as 1. N

Pad diameter	2	2X4	3.5	3.5X7	5	6	8	10	15	18	20	25	30
Absorption area	0.031	0.071	0.096	0.218	0.196	0.282	0.502	0.785	1.767	2.543	3.141	4.908	7.068
−93.3kPa	0.293	0.664	0.900	2.074	1.834	2.645	4.703	7.349	16.53	23.79	29.39	45.93	66.14
−80.8kPa	0.254	0.575	0.779	1.767	1.591	2.291	4.073	6.364	14.32	20.68	25.45	39.78	57.28
−66.7kPa	0.210	0.475	0.648	1.158	1.313	1.891	3.362	5.254	11.82	17.01	21.01	32.83	47.28
−53.4kPa	0.168	0.380	0.515	1.168	1.051	1.514	2.692	4.206	9.464	13.61	16.82	26.29	37.85
−40.0kPa	0.126	0.285	0.385	0.875	0.787	1.134	2.016	3.150	7.089	10.20	12.60	19.69	28.35

N

Pad diameter	35	40	50	60	70	75	80	95	100	120	150	200
Absorption area	9.621	12.56	19.63	28.27	38.46	44.15	50.26	70.88	78.53	113.0	176.7	314.1
−93.3kPa	90.03	117.5	183.7	264.5	359.8	413.1	470.3	663.2	734.9	1058	1653	2939
−80.8kPa	77.96	101.8	159.1	229.1	311.6	357.7	407.3	574.4	636.4	916.5	1432	2545
−66.7kPa	64.36	84.06	131.3	189.1	257.2	295.3	336.2	474.1	525.4	756.5	1182	2101
−53.4kPa	51.52	67.30	105.1	151.4	205.9	236.4	269.2	379.6	420.6	605.7	947.4	1682
−40.0kPa	38.59	50.41	78.77	113.4	154.2	177.1	201.6	284.3	315.0	453.7	708.9	1260

Table of characteristics of conductive pads

Rubber material	Pad diameter (mm)	Volume resistivity (Ωcm)	Hardness	Operating temperature
Nitrile	φ2〜φ200	800〜1000	Hs70±5	Max 60°C
Silicone		200	Hs55±5	Max130°C

*Shows resistance valve per 1cm³

Please use a conductive silicon rubber about a low resistance type.

Technical Note

Index of Ejector Nozzle

Diffuser-type ejector nozzle	C						α
	−39. 9kpa	−46. 6kpa	−53. 2kpa	−66. 5kpa	79. 8kpa	−86. 5kpa	
05HS	0.19		0.12	0.08	0.05	0.03	1.02
05LS	0.26	0.18	0.11				1.06
07HS	0.42		0.25	0.15	0.09	0.06	1.02
07LS	0.71	0.5	0.31				1.02
07HR	0.49		0.33	0.19	0.09	0.06	1.01
07LR	0.76	0.56	0.32				1
08QS	1.04						1
08QR	0.86						1
09HS	0.54		0.32	0.19	0.11	0.07	1.09
09LS	0.66	0.45	0.25				1.07
10HS	0.58		0.32	0.18	0.1	0.05	1.09
10LS	0.86	0.56	0.23				1.02
10HR	0.82		0.46	0.26	0.13	0.08	1.06
10LR	0.82	0.52	0.27				1.17
10QS	1.3						1
10QR	1.5						1
13HS	1.5		0.92	0.53	0.28	0.18	1.03
13QS	3.3						1
13QR	2.6						1
15HS	1.85		1.17	0.76	0.45	0.25	1
15LS	2.3	1.6	0.74				1.09
15HR	1.75		1.1	0.65	0.39	0.24	1.06
15LR	2.3	1.5	0.76				1.17
15QS	4						1
15QR	3.2						1
20HS	3.8		2.3	1.45	0.86	0.62	1.09
20LS	3.6	2.4	1				1.06
20HR	2.85		1.75	1	0.58	0.37	1.17
20LR	3.5	2.4	1.2				1.17
25HS	6.1		3.51	2.11	1.14	0.69	1
25LS	6.8	4.72	3.27				1
30HS	10.3		5.7	3.15	1.6	1.97	1
30LS	10	7.4	4.88				1

The figures in this Table are for reference purposes.

Technical Note

International Standard Unit (SI) system

All figures in the catalogs and operation manuals have been expressed in SI units since the introduction of the international standard unit (SI) system into the Japan Industrial Standards.
The following Table shows the correspondence between SI units (in the bold frames) and conventional units.

■ Pressure

Pa	hPa	kPa	MPa	bar	kgf／cm^2	atm	mmH_2O	mmHg
1	1X10^{-2}	1X10^{-3}	1X10^{-6}	1X10^{-5}	1.019 X10^{-5}	9.869 X10^{-6}	1.019 X10^{-1}	7.501 X10^{-3}
1X10^{2}	1	1X10^{-1}	1X10^{-4}	1X10^{-3}	1.019 X10^{-3}	9.869 X10^{-4}	1.019 X10	7.501 X10^{-1}
1X10^{3}	1X10	1	1X10^{-3}	1X10^{-2}	1.019 X10^{-2}	9.869 X10^{-3}	1.019 X10^{2}	7.501
1X10^{6}	1X10^{4}	1X10^{3}	1	1X10	1.019 X10	9.869	1.019 X10^{5}	7.501 X10^{3}
1X10^{5}	1X10^{3}	1X10^{2}	1X10^{-1}	1	1.019	9.869 X10^{-1}	1.019 X10^{4}	7.501 X10^{2}
9.807 X10^{4}	9.807 X10^{2}	9.807 X10	9.807 X10^{-2}	9.807 X10^{-1}	1	9.678 X10^{-1}	1X10^{4}	7.355 X10^{2}
1.013 X10^{5}	1.013 X10^{3}	1.013 X10^{2}	1.013 X10^{-1}	1.013	1.033	1	1.033 X10^{4}	7.600 X10^{2}
9.807	9.807 X10^{-2}	9.807 X10^{-3}	9.807 X10^{-6}	9.807 X10^{-5}	1X10^{-4}	9.678 X10^{-5}	1	7.356 X10^{-2}
1.333 X10^{2}	1.333	1.333 X10^{-1}	1.333 X10^{-4}	1.333 X10^{-3}	1.359 X10^{-3}	1.316 X10^{-3}	1.359 X10	1

Note) 1Pa＝1N／m^2

■ Force and Weight

N	dyn	kgf
1	1X10^{5}	1. 019X10^{-1}
1X10^{-5}	1	1. 019X10^{-6}
9.807	9. 807X10^{5}	1

■ Power and Heat Flow

W	kgf·m／s	PS	kcal／h
1	1. 019X10^{-1}	1. 359X10^{-3}	8. 600X10^{-1}
9.807	1	1. 333X10^{-2}	8.434
7. 355X10^{2}	7. 5X10	1	6.325X10^{2}
1.163	1. 186X10^{-1}	1.581X10^{-3}	1

Note) 1 W = 1 J/s, PS: French horsepower

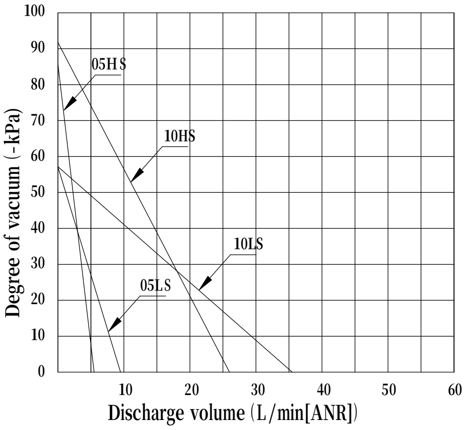
■Changes in marks of screw threads

Current marks		Old marks
R	·····	PT male screw
Rc	·····	PT female screw
Rp	·····	PS female screw
G	·····	PF male/female screw

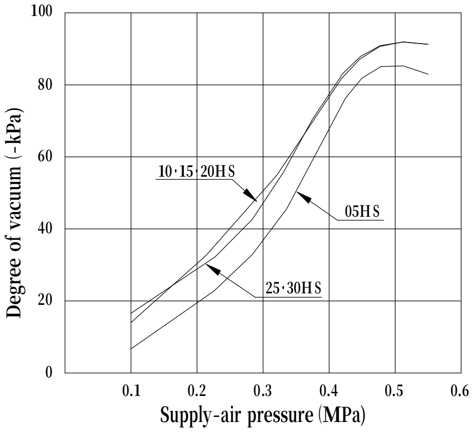
Technical Note

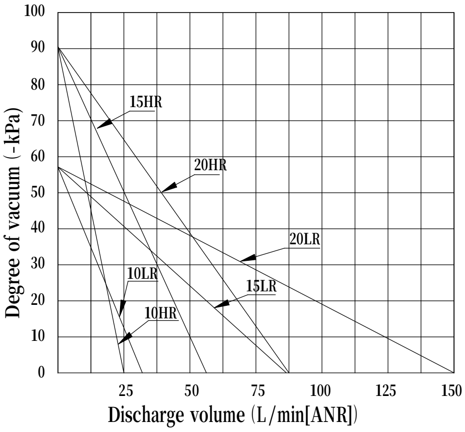
Back pressure characteristics・Maximum vacuum degree

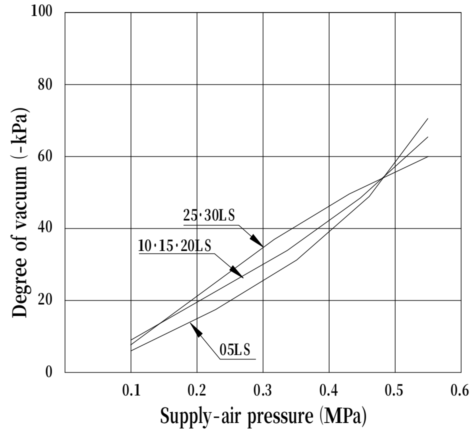
Back pressure characteristics

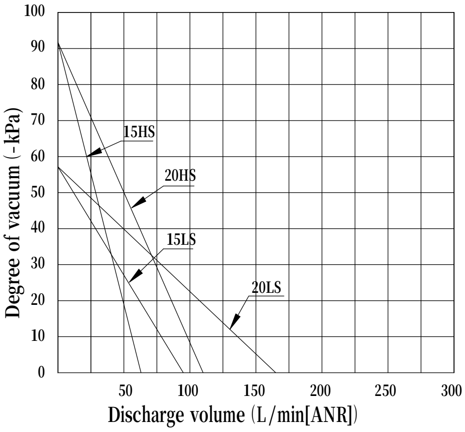


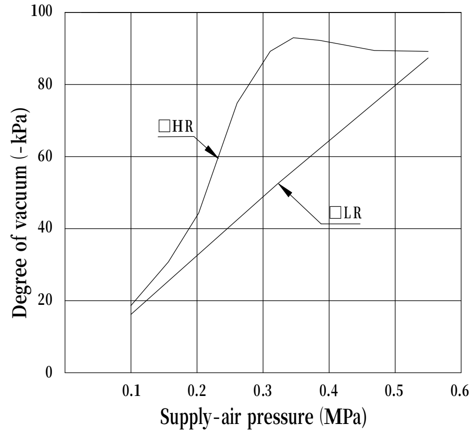
Maximum vacuum degree

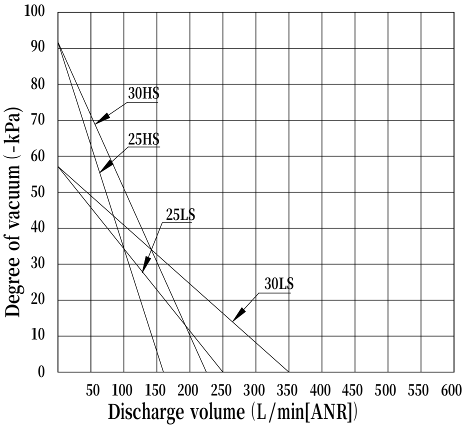








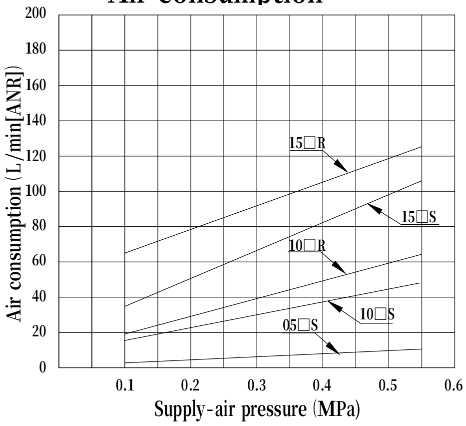


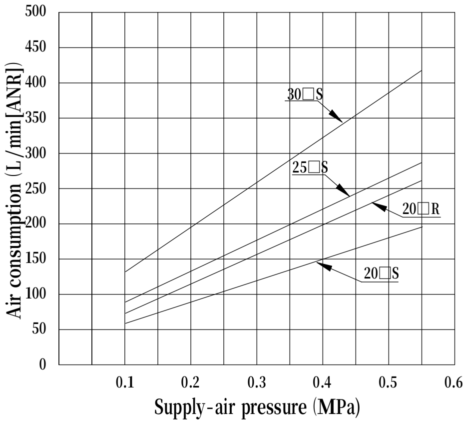


Technical Note

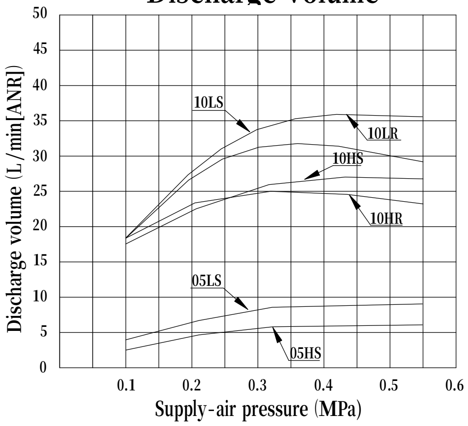
Air consumption · Discharge volume

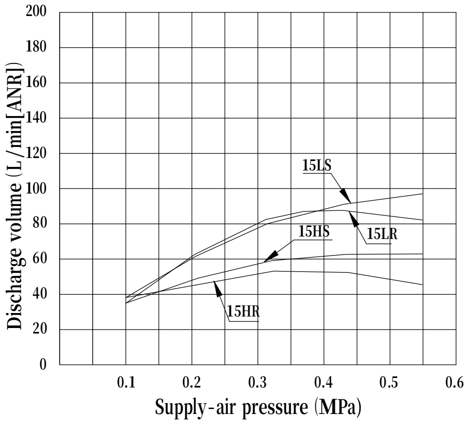
Air consumption

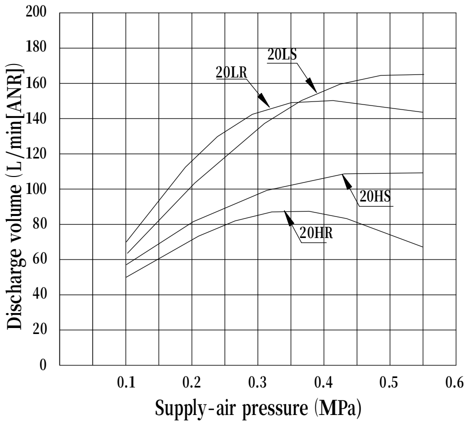


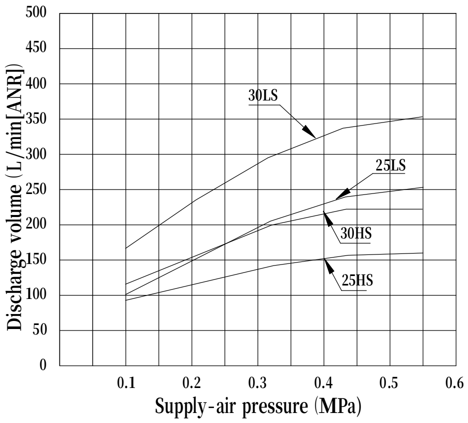


Discharge volume









Technical Note

Vacuum Sensor (Vacuum Switch)

■ Mechanical Vacuum Switch

Ejector series equipped with a vacuum switch (TV and TVA when installation of a mechanical vacuum switch is specified; TVB and TX when installation of a mechanical vacuum switch is specified

The vacuum switches for TV, TVA-V, TVB, and TX are basically composed of movable parts and a micro limit switch.
Observe the following precautions when using a vacuum switch

(1) Vacuum switches are not protected against water or oil. Do not install them in locations subject to water or oil.
(2) The opening/closing capacity of contact differs between DC and AC systems. Check whether the specified load current and rated voltage are for a DC or AC system.

Source Voltage \ Load		Resistance load	Induction load
DC	30V	4A	3A
AC	125V	5A	3A
	250V	3A	2A

(3) Depending on the type of load, the stationary and rush currents may differ greatly. Use the vacuum switch for currents smaller than the allowable rush current (10 A). The larger the rush current when the contacts close, the more they wear and transfer, causing welding and making it impossible to open them.
(4) An induction load generates a counter-electromotive force. Higher counter-electromotive voltages accompany larger amounts of energy, increasing the wear on and transfer of contacts. The rated conditions should therefore be confirmed. To prevent surge currents, install a surge protector at a distance of up to 0.5 m from the load, or take other countermeasures.

Ejector series equipped with a vacuum switch (TVM when installation of a bellows-type vacuum switch is specified, TVU)

The bellows-type vacuum switch of the TVM ejector and the vacuum switches of TVU and TXU use a proximity switch. Observe the following precautions when these vacuum switches are used:

(1) These switches have a built-in magnetic proximity switch. When a vacuum switch is used, least 20mm from all iron-based metallic objects, and do not use it near magnets or strong magnetic devices.
(2) When the cable between the vacuum switch and the load is longer than 10 m, a rush current flows due to the stray capacity between lines when the contacts are open. This will weld lead switch contacts. To limit the rush current, insert a resistance or a surge presser (NSS-1 manufactured by NEC) near the switch. For this reason, a resistance or surge presser that maintains a sufficient voltage for operation should be used.
(3) When a vacuum switch for relays, solenoids, or other induction loads is used, a counter-electromotive force will be generated, causing contacts to wear and weld. Therefore, a surge protector or other other protective circuit should be positioned within 0.5 m of the load.
When a vacuum switch for a DC system is used, connect a diode that can withstand a voltage of at least three times the source voltage, in parallel with the load.
When a vacuum switch is used for an AC system, connect a resistance and a capacitor in parallel with the load. Use a resistance of greater than 1 KΩ, as the lead switch will weld due to
(4) Motors, lamps, and other loads in which a rush current above the maximum opening/closing current flows, will cause contacts to weld and stick. Insert a relay with a capacity of no more than 1/10 the maximum opening/closing capacity, or take other countermeasures.

Technical Note

Vacuum Sensor (Vacuum Switch)

■ Electronic Vacuum Sensor

Ejectors equipped with a vacuum sensor
【TVA, TVE, TVF, TVM, TV1, TV2, TVR2, VCB Serie】

①Sensors are not protected against water or oil.

②Do not use sensors for corrosive or inflammable gases.

③Do not insert a screwdriver or wire into the pressure inlet.

④The rated pressure is 0.2 MPa (2 kgf/cm^2), and the allowable maximum pressure is 0.5 MPa (5 kgf/cm^2). Do not apply a pressure over the allowable maximum pressure.

⑤When an ejector is installed, do not use a spanner other than the metal adapter.

⑥Do not place wiring in the ducts of motors or high-tension lines.

⑦When an ejector with analog output terminals is used, but the terminals are not used, wrap them with insulating tape to prevent contact with other terminals.

⑧Do not connect a load over the rated voltage or current to the digital output (open-collector output) terminals (even for an instant).

⑨To adjust the degree of vacuum, turn the setting trimmer with a screwdriver. Turn it clockwise to increase the degree of vacuum to absolute vacuum, and counterclockwise to decrease the degree of vacuum to atmospheric pressure.

⑩Circuit diagram
See page of sensor from 265 to 282.