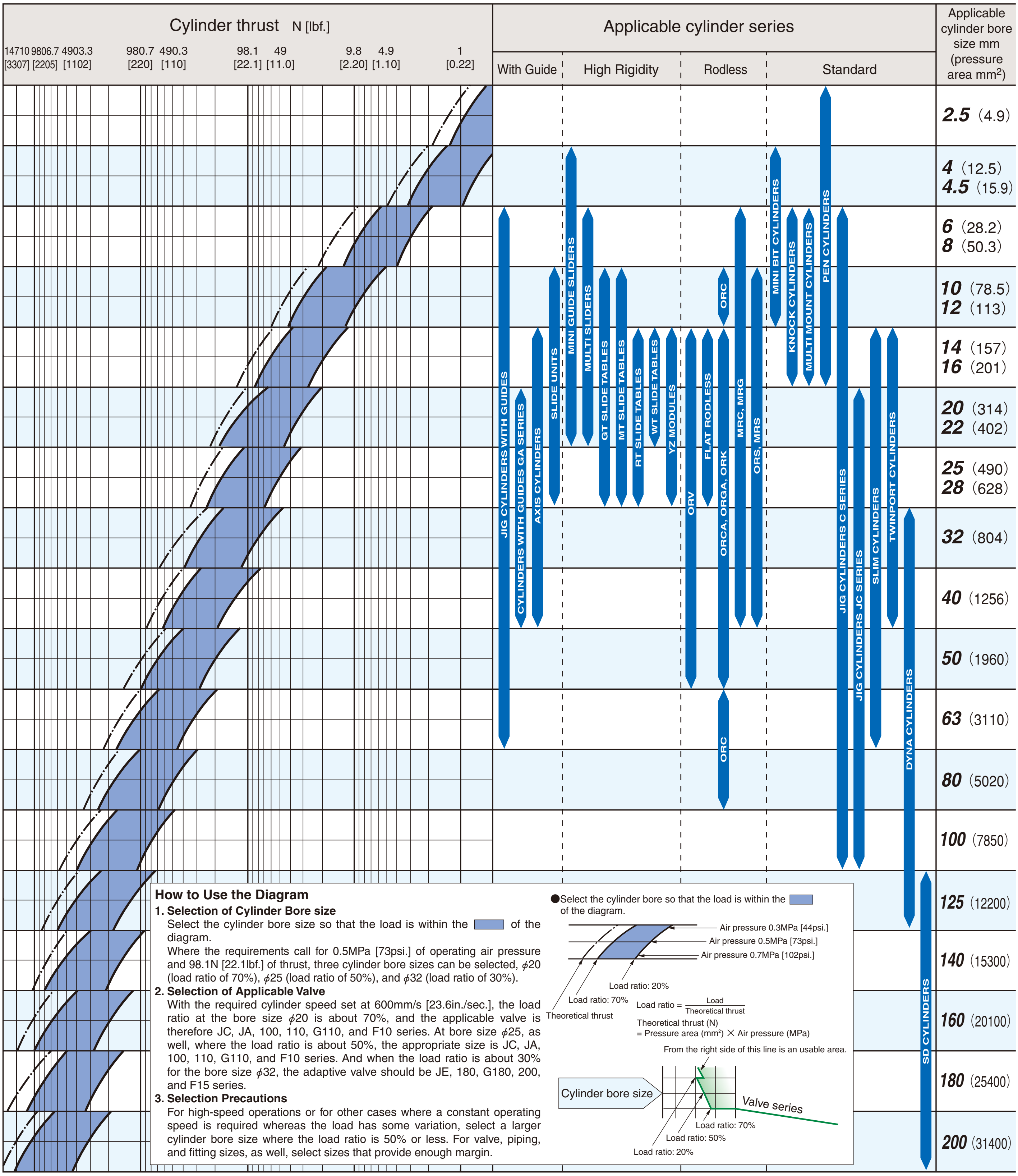
BEST SELECTION

The BEST SELECTION Selection chart for air cylinders and their associated pneumatic system equipment.

1st Step

Select bore size of the cylinder according to the required cylinder thrust.



How to Use the Diagram

1. Selection of Cylinder Bore size

Select the cylinder bore size so that the load is within the ▨ of the diagram.

Where the requirements call for 0.5MPa [73psi.] of operating air pressure and 98.1N [22.1lbf.] of thrust, three cylinder bore sizes can be selected, ϕ20 (load ratio of 70%), ϕ25 (load ratio of 50%), and ϕ32 (load ratio of 30%).

2. Selection of Applicable Valve

With the required cylinder speed set at 600mm/s [23.6in./sec.], the load ratio at the bore size ϕ20 is about 70%, and the applicable valve is therefore JC, JA, 100, 110, G110, and F10 series. At bore size ϕ25, as well, where the load ratio is about 50%, the appropriate size is JC, JA, 100, 110, G110, and F10 series. And when the load ratio is about 30% for the bore size ϕ32, the adaptive valve should be JE, 180, G180, 200, and F15 series.

3. Selection Precautions

For high-speed operations or for other cases where a constant operating speed is required whereas the load has some variation, select a larger cylinder bore size where the load ratio is 50% or less. For valve, piping, and fitting sizes, as well, select sizes that provide enough margin.

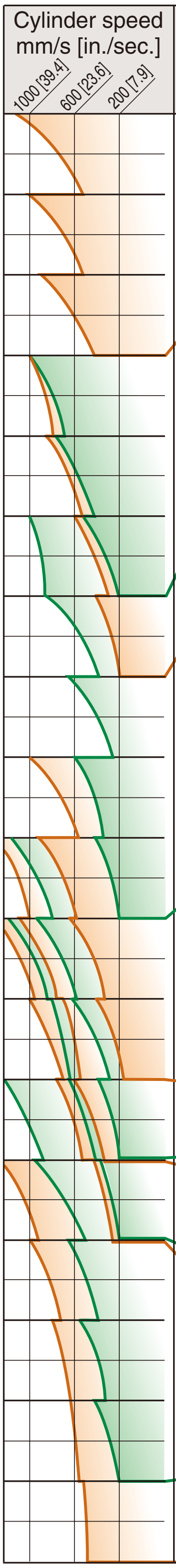
Remark: Due to space limitations, representative samplings of models are listed above.

2nd Step

Decide valve size according to the cylinder bore size and speed.

3rd Step

Determine valve model according to cylinder function and control method.



Applicable valve series	Solenoid valve				Wiring saving measures, etc.
	2-, 3-port	4, 5-port			
	2-position			3-position	
	Single solenoid		Double solenoid		
G010, 010 Series	**G010E1** Direct acting type S=0.2　Cv=0.01	**010-4E1** Pilot type ←			
025, 030 Series	**025E1** Direct acting type S=0.5　Cv=0.03				（Low current type 0.5W）
	030E1 Direct acting type S=0.6　Cv=0.03	**030-4E1** Pilot type ←			
EA, EB, 050 Series	**EB10□F1～F4,A1～A4** Pilot type S=1.3　Cv=0.07　C=0.26				Standard type 0.55W Low current type 0.15W
	EA10□F1～F4,A1～A4 Pilot type S=1.3　Cv=0.07　C=0.26	**EA10□F5,A5** ← ←	**EA10□F6,A6** ← ←		Standard type 0.55W Low current type 0.15W
	050E1,050LE1 Direct acting type S=1.5　Cv=0.08	**050-4E1,050-4LE1** ← S=1.2　Cv=0.07	**050-4E2** ← ←		
JC, JA, 100, 110, G110, F10 Series	**JC10□F1～F4,A1～A4** Pilot type S=3.0　Cv=0.17　C=0.60	**JC10□F5,A5** ← ←	**JC10□F6,A6** ← ←	**JC10□F7～F9,A7～A9** ← S=2.85　Cv=0.16　C=0.57	Standard type 0.55W Low current type 0.15W
	JA10□A1～A4 Pilot type S=3.5　Cv=0.19	**JA10□A5** ← ←	**JA10□A6** ← ←	**JA10□A7～A9** ← S=3.4　Cv=0.19	4-position, tandem 3-port For serial transmission system
	100E1 Direct acting type S=5.0　Cv=0.28	**100-4E1** ← S=3.4　Cv=0.19	**100-4E2** ← S=3.0　Cv=0.17		
	111E1, 112E1 Pilot type S=4.2　Cv=0.23	**110-4E1** ← ←	**110-4E2,110-4KE2** ← ←	**113-4E2,113-4KE2** ← S=3.8　Cv=0.21	PC board manifold For wire saving system Stacking manifold FM solid manifold For serial transmission system
			A110-4ME2 Pilot type S=4.0　Cv=0.22	**A113-4ME2** ← S=3.6　Cv=0.2	
	G110E1 Pilot type S=4.2　Cv=0.23	**G110-4E1** ← ←	**G110-4E2** ← ←	**G113-4E2** ← S=3.8　Cv=0.21	
		F10T0（Single only）**, F10T1,F10T2** Pilot type S=5.0　Cv=0.28		**F10T3,F10T4,F10T5** ← S=4.5　Cv=0.25	PC board manifold Flat cable connector type D-sub connector type Terminal block type, low current type 0.9W For serial transmission system
JE, 180, G180, 200, F15 Series	**JE12□A1～A4** Pilot type S=9.5　Cv=0.53　C=1.90	**JE12□A5** ← ←	**JE12□A6** ← ←	**JE12□A7～A9** ← S=7.45　Cv=0.41　C=1.49	Standard type 0.55W Low current type 0.15W
	181E1,182E1 Pilot type S=10.2　Cv=0.57	**180-4E1** ← ←	**180-4E2,180-4KE2** ← ←	**183-4E2,183-4KE2** ← S=9.0　Cv=0.50	For wire saving system Stacking manifold FM solid manifold For serial transmission system Sub-base regulator
			A180-4ME2 Pilot type S=8.2　Cv=0.46	**A183-4ME2** ← ←	
	200E1 Direct acting type S=8.5　Cv=0.47	**200-4E1** ← S=7.5　Cv=0.42	**200-4E2** ← ←	**203-4E2** ← S=6.5　Cv=0.36	Sub-base regulator
	G180E1 Pilot type S=10.2　Cv=0.57	**G180-4E1** ← ←	**G180-4E2** ← ←	**G183-4E2** Pilot type S=9.0　Cv=0.50	
		F15T0（Single only）**, F15T1,F15T2** Pilot type S=10.0　Cv=0.56		**F15T3,F15T4,F15T5** ← ←	PC board manifold Flat cable connector type D-sub connector type Terminal block type, low current type 0.9W For serial transmission system
240 Series		**240-4E1** Pilot type S=16　Cv=0.88	**240-4E2** ← ←	**243-4E2** ← S=15　Cv=0.83	For wire saving system
F18 Series		**F18T0**（Single only）**, F18T1,F18T2** Pilot type S=18　Cv=1		**F18T3,F18T4,F18T5** ← ←	Flat cable connector type D-sub connector type Terminal block type Low current type 0.9W For serial transmission system
PA24, PB24, 300 Series		**PA24,PB24** Pilot type S=25　Cv=1.4	**PA24,PB24** ← ←	**PA24,PB24** ← ←	For wire saving system For serial transmission system
		300-4E1,300-4LE1 Pilot type S=25　Cv=1.39	**300-4E2,300-4LE2** ← ←	**303-4E2** ← S=20　Cv=1.11	
PA24H, PB24H, 430 Series		**PA24H,PB24H** Pilot type S=36　Cv=2.0	**PA24H,PB24H** ← ←	**PA24H,PB24H** ← ←	For wire saving system For serial transmission system
		430-4E1 Pilot type S=40　Cv=2.22（S=35　Cv=1.94）	**430-4E2** ← ←	**433-4E2** ← S=35　Cv=1.94（S=30　Cv=1.67）	For wire saving system Parentheses（　）are Rc1/4
600 Series		**600-4E1** Pilot type S=60　Cv=3.33	**600-4E2** ← ←	**603-4E2** ← ←	
750, 1000, 1250 Series	**750E1** Pilot type S=140　Cv=7.0	**750-4E1** ← S=100　Cv=5.0			
	1000E1, 1250E1 Pilot type S=280　Cv=14	**1000-4E1, 1250-4E1** ← S=240　Cv=12			

S: Effective area (mm²)　Cv=Cv coefficient　C: Sonic conductance (dm³/(s・bar))

Criteria for Selection: Air Flow Rate and Air Consumption

While the air cylinder's air flow rate and air consumption can be found through the following calculations, the quick reference table below provides the answers more conveniently.

Air flow rate: $$Q_1=\frac{\pi D^2}{4}\times L\times\frac{60}{t}\times\frac{P+0.1013}{0.1013}\times10^{-6}$$

Air consumption: $$Q_2=\frac{\pi D^2}{4}\times L\times2\times n\times\frac{P+0.1013}{0.1013}\times10^{-6}$$

Q_1 : Required air flow rate for cylinder ℓ/min(ANR)
Q_2 : Air consumption of cylinder ℓ/min(ANR)
D : Cylinder bore size mm
L : Cylinder stroke mm
t : Time required for cylinder to travel one stroke s
n : Number of cylinder reciprocations per minute times/min
P : Operating pressure MPa

Air flow rate: $$Q_1'=\frac{\pi D'^2}{4}\times L'\times\frac{60}{t}\times\frac{P'+14.696}{14.696}\times\frac{1}{1728}$$

Air consumption: $$Q_2'=\frac{\pi D'^2}{4}\times L'\times2\times n\times\frac{P'+14.696}{14.696}\times\frac{1}{1728}$$

Q_1' : Required air flow rate for cylinder ft^3/min.(ANR)※
Q_2' : Air consumption of cylinder ft^3/min.(ANR)※
D′ : Cylinder bore size in.
L′ : Cylinder stroke in.
t : Time required for cylinder to travel one stroke sec.
n : Number of cylinder reciprocations per minute times/min.
P′ : Operating pressure psi.

※Refer to p.54 for an explanation of ANR.

Air Consumption for Each 1mm [0.0394in.] Stroke

cm^3 [ft^3]/Reciprocation (ANR)

Bore size mm [in.]	Air pressure MPa [psi.]								
	0.1 [15]	0.2 [29]	0.3 [44]	0.4 [58]	0.5 [73]	0.6 [87]	0.7 [102]	0.8 [116]	0.9 [131]
2.5 [0.098]	—	—	—	0.05 [1.77×10^{-6}]	0.06 [2.12×10^{-6}]	0.07 [2.47×10^{-6}]	0.08 [2.83×10^{-6}]	—	—
4 [0.157]	—	—	—	0.12 [4.24×10^{-6}]	0.15 [5.30×10^{-6}]	0.17 [6.00×10^{-6}]	0.20 [7.06×10^{-6}]	—	—
6 [0.236]	—	0.17 [6.00×10^{-6}]	0.22 [7.77×10^{-6}]	0.28 [9.89×10^{-6}]	0.34 [1.20×10^{-5}]	0.39 [1.38×10^{-5}]	0.45 [1.59×10^{-5}]	—	—
10 [0.394]	0.31 [1.09×10^{-5}]	0.47 [1.66×10^{-5}]	0.62 [2.19×10^{-5}]	0.78 [2.75×10^{-5}]	0.93 [3.28×10^{-5}]	1.09 [3.85×10^{-5}]	1.24 [4.38×10^{-5}]	—	—
16 [0.630]	0.80 [2.83×10^{-5}]	1.20 [4.24×10^{-5}]	1.59 [5.62×10^{-5}]	1.99 [7.03×10^{-5}]	2.39 [8.44×10^{-5}]	2.78 [9.82×10^{-5}]	3.18 [1.12×10^{-4}]	—	—
20 [0.787]	1.25 [4.41×10^{-5}]	1.87 [6.60×10^{-5}]	2.49 [8.79×10^{-5}]	3.11 [1.10×10^{-4}]	3.73 [1.32×10^{-4}]	4.35 [1.54×10^{-4}]	4.97 [1.76×10^{-4}]	5.59 [1.97×10^{-4}]	6.21 [2.19×10^{-4}]
25 [0.984]	1.95 [6.89×10^{-5}]	2.92 [1.03×10^{-4}]	3.89 [1.37×10^{-4}]	4.86 [1.72×10^{-4}]	5.83 [2.06×10^{-4}]	6.80 [2.40×10^{-4}]	7.77 [2.74×10^{-4}]	8.73 [3.08×10^{-4}]	9.70 [3.43×10^{-4}]
32 [1.260]	3.20 [1.13×10^{-4}]	4.78 [1.69×10^{-4}]	6.37 [2.25×10^{-4}]	7.96 [2.81×10^{-4}]	9.55 [3.37×10^{-4}]	11.14 [3.93×10^{-4}]	12.72 [4.49×10^{-4}]	14.31 [5.05×10^{-4}]	15.90 [5.62×10^{-4}]
40 [1.575]	4.99 [1.76×10^{-4}]	7.48 [2.64×10^{-4}]	9.96 [3.52×10^{-4}]	12.44 [4.39×10^{-4}]	14.92 [5.27×10^{-4}]	17.40 [6.14×10^{-4}]	19.88 [7.02×10^{-4}]	22.36 [7.90×10^{-4}]	24.84 [8.77×10^{-4}]
50 [1.969]	7.80 [2.75×10^{-4}]	11.68 [4.12×10^{-4}]	15.56 [5.49×10^{-4}]	19.43 [6.86×10^{-4}]	23.31 [8.23×10^{-4}]	27.19 [9.60×10^{-4}]	31.06 [1.097×10^{-3}]	—	—
63 [2.480]	12.39 [4.38×10^{-4}]	18.54 [6.55×10^{-4}]	24.70 [8.72×10^{-4}]	30.85 [1.089×10^{-3}]	37.01 [1.307×10^{-3}]	43.16 [1.524×10^{-3}]	49.32 [1.742×10^{-3}]	—	—
80 [3.150]	19.98 [7.06×10^{-4}]	29.90 [1.056×10^{-3}]	39.83 [1.407×10^{-3}]	49.75 [1.757×10^{-3}]	59.67 [2.107×10^{-3}]	69.60 [2.458×10^{-3}]	79.52 [2.808×10^{-3}]	89.45 [3.159×10^{-3}]	99.37 [3.509×10^{-3}]
100 [3.937]	31.21 [1.102×10^{-3}]	46.72 [1.650×10^{-3}]	62.23 [2.198×10^{-3}]	77.73 [2.745×10^{-3}]	93.24 [3.293×10^{-3}]	108.75 [3.840×10^{-3}]	124.25 [4.388×10^{-3}]	139.76 [4.936×10^{-3}]	155.27 [5.483×10^{-3}]
125 [4.921]	48.77 [1.722×10^{-3}]	73.00 [2.578×10^{-3}]	97.23 [3.434×10^{-3}]	121.46 [4.289×10^{-3}]	145.69 [5.145×10^{-3}]	169.92 [6.001×10^{-3}]	194.14 [6.856×10^{-3}]	218.37 [7.712×10^{-3}]	242.60 [8.567×10^{-3}]
140 [5.512]	61.18 [2.161×10^{-3}]	91.57 [3.234×10^{-3}]	121.97 [4.307×10^{-3}]	152.36 [5.381×10^{-3}]	182.75 [6.454×10^{-3}]	213.14 [7.527×10^{-3}]	243.54 [8.601×10^{-3}]	273.93 [9.674×10^{-3}]	304.32 [1.075×10^{-2}]
160 [6.299]	79.91 [2.822×10^{-3}]	119.61 [4.224×10^{-3}]	159.30 [5.626×10^{-3}]	199.00 [7.028×10^{-3}]	238.69 [8.429×10^{-3}]	278.39 [9.831×10^{-3}]	318.09 [1.123×10^{-2}]	357.78 [1.263×10^{-2}]	397.48 [1.404×10^{-2}]
180 [7.087]	101.13 [3.571×10^{-3}]	151.38 [5.346×10^{-3}]	201.62 [7.120×10^{-3}]	251.86 [8.894×10^{-3}]	302.10 [1.067×10^{-2}]	352.34 [1.244×10^{-2}]	402.58 [1.422×10^{-2}]	452.82 [1.599×10^{-2}]	503.06 [1.777×10^{-2}]
200 [7.874]	124.86 [4.409×10^{-3}]	186.88 [6.600×10^{-3}]	248.91 [8.790×10^{-3}]	310.93 [1.098×10^{-2}]	372.96 [1.317×10^{-2}]	434.98 [1.536×10^{-2}]	497.01 [1.755×10^{-2}]	559.04 [1.974×10^{-2}]	621.06 [2.193×10^{-2}]

The figures in the table show the air flow rate and air consumption when an air cylinder makes one reciprocation with stroke of 1mm [0.0394in.]. The air flow rate and consumption actually required are found by the following calculations.

● Finding the air flow rate (for selecting F.R.L., valves, etc.)
Example: When operating an air cylinder with bore size of 40mm at speed of 300mm/s and at air pressure of 0.5Mpa

$$14.92\times\frac{1}{2}\times300\times10^{-3}=2.24\ \ell/s\ (ANR)$$

(At this time, the air flow rate per minute is $14.92\times\frac{1}{2}\times300\times60\times10^{-3}=134.28\ \ell/min$ (ANR).)

● Finding the air consumption
Example 1. When operating an air cylinder with bore size of 40mm and stroke of 100mm, and at air pressure of 0.5MPa, for 1 reciprocation

$$14.92\times100\times10^{-3}=1.492\ \ell/Reciprocation\ (ANR)$$

Example 2. When operating an air cylinder with bore size of 40mm and stroke of 100mm, and at air pressure of 0.5MPa, for 10 reciprocations per minute

$$14.92\times100\times10\times10^{-3}=14.92\ \ell/min\ (ANR)$$

● Finding the air flow rate (for selecting F.R.L., valves, etc.)
Example: When operating an air cylinder with bore size of 1.575in. (40mm) at speed of 11.81in./sec. (300mm/s) and at air pressure of 73psi. (0.5Mpa)

$$\frac{1}{t}=\frac{11.81}{0.0394}=300\qquad5.27\times10^{-4}\times\frac{1}{2}\times300=0.0791ft^3/sec.\ (ANR)$$

(At this time, the air flow rate per minute is $5.27\times10^{-4}\times\frac{1}{2}\times300\times60=4.74ft^3/min.$ (ANR).)

● Finding the air consumption
Example 1. When operating an air cylinder with bore size of 1.575in. (40mm) and stroke of 3.94in. (100mm), and at air pressure of 73psi. (0.5Mpa), for 1 reciprocation

$$5.27\times10^{-4}\times\frac{3.94}{0.0394}=0.0527ft^3/Reciprocation.\ (ANR)$$

Example 2. When operating an air cylinder with bore size of 1.575in. (40mm) and stroke of 3.94in. (100mm), and at air pressure of 73psi. (0.5Mpa), for 10 reciprocations per minute

$$5.27\times10^{-4}\times\frac{3.94}{0.0394}\times10=0.527ft^3/min.\ (ANR)$$

Criteria for Selection: Cylinder Thrust

N [lbf.]

Cylinder bore size mm [in.]	Rod dia. mm [in.]	Operating type	Operation direction	Pressure area mm^2 [in^2]	Air pressure MPa [psi.]								
					0.1 [15]	0.2 [24]	0.3 [44]	0.4 [58]	0.5 [73]	0.6 [87]	0.7 [102]	0.8 [116]	0.9 [131]
2.5 [0.098]	1 [0.039]	Single acting push type		4.9 [0.0076]	—	—	—	0.8 [0.18]	1.3 [0.29]	1.7 [0.38]	2.2 [0.49]	—	—
4 [0.157]	2 [0.079]	Single acting push type		12.6 [0.0195]	—	—	—	2.2 [0.49]	3.5 [0.79]	4.8 [1.08]	6.0 [1.35]	—	—
4.5 [0.177]	2 [0.079]	Double acting type	Push side	15.9 [0.0246]	—	3.2 [0.72]	4.8 [1.08]	6.4 [1.44]	8.0 [1.80]	9.5 [2.14]	11.1 [2.50]	—	—
			Pull side	12.8 [0.0198]	—	2.6 [0.58]	3.8 [0.85]	5.1 [1.15]	6.4 [1.44]	7.7 [1.73]	9.0 [2.02]	—	—
		Single acting push type		15.9 [0.0246]	—	—	1.9 [0.43]	3.5 [0.79]	5.1 [1.15]	6.6 [1.48]	8.2 [1.84]	—	—
6 [0.236]	3 [0.118]	Single acting push type		28.3 [0.0439]	—	—	5.0 [1.12]	7.8 [1.75]	10.7 [2.41]	13.5 [3.03]	16.3 [3.66]	—	—
		Single acting pull type		21.2 [0.0329]	—	—	2.9 [0.65]	5.0 [1.12]	7.1 [1.60]	9.2 [2.07]	11.3 [2.54]	—	—
		Double acting type	Push side	28.3 [0.0439]	—	5.7 [1.28]	8.5 [1.91]	11.3 [2.54]	14.2 [3.19]	17 [3.82]	19.8 [4.45]	—	—
			Pull side	21.2 [0.0329]	—	4.2 [0.94]	6.4 [1.44]	8.5 [1.91]	10.6 [2.38]	12.7 [2.85]	14.8 [3.33]	—	—
10 [0.394]	4 [0.157]	Single acting push type		78.5 [0.1217]	—	9.8 [2.20]	17.7 [3.98]	25.5 [5.73]	33.4 [7.51]	41.2 [9.26]	49.1 [11.0]	—	—
		Single acting pull type		66 [0.102]	—	7.3 [1.64]	13.9 [3.12]	20.5 [4.61]	27.1 [6.09]	33.7 [7.58]	40.3 [9.06]	—	—
		Double acting type	Push side	78.5 [0.1217]	7.9 [1.78]	15.7 [3.53]	23.6 [5.31]	31.4 [7.06]	39.3 [8.83]	47.1 [10.6]	55 [12.4]	—	—
			Pull side	66 [0.102]	6.6 [1.48]	13.2 [2.97]	19.8 [4.45]	26.4 [5.93]	33 [7.42]	39.6 [8.90]	46.2 [10.4]	—	—
16 [0.630]	5 [0.197]	Single acting push type		201 [0.312]	—	30.4 [6.83]	50.5 [11.4]	70.6 [15.9]	90.7 [20.4]	110.8 [24.91]	130.9 [29.43]	—	—
		Single acting pull type		181 [0.281]	—	26.4 [5.93]	44.5 [10.0]	62.6 [14.1]	80.7 [18.1]	98.8 [22.2]	116.9 [26.28]	—	—
		Double acting type	Push side	201 [0.312]	20.1 [4.52]	40.2 [9.04]	60.3 [13.6]	80.4 [18.1]	100.5 [22.59]	120.6 [27.11]	140.7 [31.63]	—	—
			Pull side	181 [0.281]	18.1 [4.07]	36.2 [8.14]	54.3 [12.2]	72.4 [16.3]	90.5 [20.3]	108.6 [24.41]	126.7 [28.48]	—	—
20 [0.787]	8 [0.315]	Single acting push type		314 [0.487]	—	24.6 [5.53]	56 [12.6]	87.4 [19.6]	118.8 [26.71]	150.2 [33.76]	181.6 [40.82]	213 [47.88]	244.4 [54.94]
		Double acting type	Push side	314 [0.487]	31.4 [7.06]	62.8 [14.1]	94.2 [21.2]	125.6 [28.23]	157 [35.29]	188.4 [42.35]	219.8 [49.41]	251.2 [56.47]	282.6 [63.53]
			Pull side	264 [0.409]	26.4 [5.93]	52.8 [11.9]	79.2 [17.8]	105.6 [23.74]	132 [29.67]	158.4 [35.61]	184.8 [41.54]	211.2 [47.48]	237.6 [53.41]
25 [0.984]	10 [0.394]	Single acting push type		490 [0.760]	—	98 [22.0]	147 [33.0]	196 [44.1]	245 [55.1]	294 [66.1]	343 [77.1]	392 [88.1]	441 [99.1]
		Double acting type	Push side	490 [0.760]	49 [11.0]	98 [22.0]	147 [33.0]	196 [44.1]	245 [55.1]	294 [66.1]	343 [77.1]	392 [88.1]	441 [99.1]
			Pull side	412 [0.639]	41.2 [9.26]	82.4 [18.5]	123.6 [27.79]	164.8 [37.05]	206 [46.31]	247.2 [55.57]	288.4 [64.83]	329.6 [74.09]	370.8 [83.36]
32 [1.260]	12 [0.472]	Single acting push type		804 [1.246]	—	161 [36.2]	241 [54.2]	322 [72.4]	402 [90.4]	482 [108]	563 [127]	643 [145]	724 [163]
		Double acting type	Push side	804 [1.246]	80 [18.0]	161 [36.2]	241 [54.2]	322 [72.4]	402 [90.4]	482 [108]	563 [127]	643 [145]	724 [163]
			Pull side	690 [1.070]	69 [15.5]	138 [31.0]	207 [46.5]	276 [62.0]	345 [77.6]	414 [93.1]	483 [109]	552 [124]	621 [140]
40 [1.575]	16 [0.630]	Single acting push type		1256 [1.947]	—	251 [56.4]	377 [84.7]	502 [113]	628 [141]	754 [169]	879 [198]	1005 [225.9]	1130 [254.0]
		Double acting type	Push side	1256 [1.947]	126 [28.3]	251 [56.4]	377 [84.7]	502 [113]	628 [141]	754 [169]	879 [198]	1005 [225.9]	1130 [254.0]
			Pull side	1055 [1.635]	106 [23.8]	211 [47.4]	317 [71.3]	422 [94.9]	528 [119]	633 [142]	739 [166]	844 [190]	950 [214]
50 [1.969]	16 [0.630]	Double acting type	Push side	1963 [3.043]	196 [44.1]	393 [88.3]	589 [132]	785 [176]	982 [221]	1178 [264.8]	1374 [308.9]	—	—
			Pull side	1762 [2.731]	176 [39.6]	352 [79.1]	529 [119]	705 [158]	881 [198]	1057 [237.6]	1233 [277.2]	—	—
63 [2.480]	20 [0.787]	Double acting type	Push side	3117 [4.831]	312 [70.1]	623 [140]	935 [210]	1247 [280.3]	1559 [350.5]	1870 [420.4]	2182 [490.5]	2494 [560.7]	2805 [630.6]
			Pull side	2803 [4.345]	280 [62.9]	561 [126]	841 [189]	1121 [252.0]	1402 [315.2]	1682 [378.1]	1962 [441.1]	2242 [504.0]	2523 [567.2]
80 [3.150]	25 [0.984]	Double acting type	Push side	5026 [7.790]	503 [113]	1005 [225.9]	1508 [339.0]	2010 [451.8]	2513 [564.9]	3016 [678.0]	3518 [790.8]	4021 [903.9]	4523 [1017]
			Pull side	4536 [7.031]	454 [102]	907 [204]	1361 [306.0]	1814 [407.8]	2268 [509.8]	2722 [611.9]	3175 [713.7]	3629 [815.8]	4082 [917.6]
100 [3.937]	30 [1.181]	Double acting type	Push side	7853 [12.172]	785 [176]	1571 [353.2]	2356 [529.6]	3141 [706.1]	3927 [882.8]	4712 [1059]	5497 [1236]	6282 [1412]	7068 [1589]
			Pull side	7147 [11.078]	715 [161]	1429 [321.2]	2144 [482.0]	2859 [642.7]	3574 [803.4]	4288 [963.9]	5003 [1125]	5718 [1285]	6432 [1446]
125 [4.921]	36 [1.417]	Double acting type	Push side	12271 [19.020]	1227 [275.8]	2454 [551.7]	3681 [827.5]	4908 [1103]	6136 [1379]	7363 [1655]	8590 [1931]	9817 [2207]	11044 [2483]
			Pull side	11254 [17.443]	1125 [252.9]	2251 [506.0]	3376 [758.9]	4502 [1012]	5627 [1265]	6752 [1518]	7878 [1771]	9003 [2024]	10129 [2277]

REFERENCE

1. Model Selection Procedure (pneumatic cylinder)

① Checklist

With the exception of special circumstances, the following items should normally be used as a checklist for selecting pneumatic cylinders (hereafter called “cylinders”).

Checklist	Selection criteria
1) Is load carried in only one direction?	Single acting, double acting
2) Is it a linear movement or a swing movement?	Supporting type
3) What are the force requirements for carrying the load?	Cylinder bore size (cylinder thrust calculation), operating pressure
4) What is the distance the load to be carried?	Cylinder stroke (allowable stroke due to cylinder buckling)
5) What is the speed at which the load is to be carried?	Valve size, piping size
6) What is the load’s impact force on the stroke end?	Cushioning (check cushioning effect)
7) Is the ambient temperature within the range of 5～60°C [41～140°F]?	Seal materials
8) Is the ambient atmosphere suitable? Is it being subjected to dust? Are there metal chips?	Dust cover
9) Is there a possibility of corrosion?	Corrosion resistant cylinder (use of rust prevention coating, plating, and corrosion resistant materials)

② Cylinder thrust calculation

● Double acting type cylinder

Cylinder thrust is determined by the bore size, piston rod diameter, and operating pressure.

With the exception of single acting cylinder and other special cases, the actual cylinder thrust F_A is determined by the following formula.

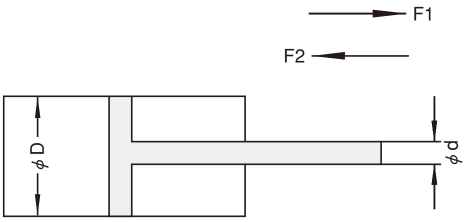
$$F_A = F \cdot \eta = (A \cdot P) \times \eta$$

The theoretical thrust is obtained by setting the cylinder efficiency (η) in the above formula to 100 (%).

The push side cylinder thrust F_1 (N) is $F_1 = \frac{\pi}{4} D^2 \cdot P \cdot \eta$.

The pull side cylinder thrust F_2 (N) becomes $F_2 = \frac{\pi}{4} (D^2 - d^2) \cdot P \cdot \eta$.

F_A : Actual cylinder thrust (N)
F : Theoretical cylinder thrust (N)
η : Cylinder thrust efficiency (%)
A : Piston pressure area (mm^2)
P : Operating pressure (MPa)
D : Bore size (mm)
d : Piston rod diameter (mm)



The theoretical cylinder thrust by a cylinder bore size is shown on p.42.

② Cylinder thrust calculation

● Double acting type cylinder

Cylinder thrust is determined by the bore size, piston rod diameter, and operating pressure.

With the exception of single acting cylinder and other special cases, the actual cylinder thrust F_A' is determined by the following formula.

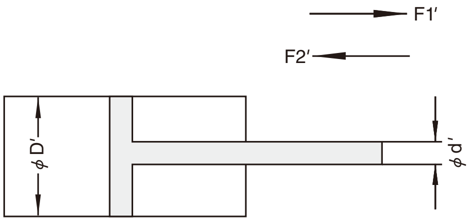
$$F_A' = F' \cdot \eta = (A' \cdot P') \times \eta$$

The theoretical thrust is obtained by setting the cylinder efficiency (η) in the above formula to 100 [%].

The push side cylinder thrust F_1' [lbf.] is $F_1' = \frac{\pi}{4} D'^2 \cdot P' \cdot \eta$.

The pull side cylinder thrust F_2' [lbf.] becomes $F_2' = \frac{\pi}{4} (D'^2 - d'^2) \cdot P' \cdot \eta$.

F_A': Actual cylinder thrust [lbf.]
F': Theoretical cylinder thrust [lbf.]
η : Cylinder thrust efficiency [%]
A': Piston pressure area [in.^{2}]
P': Operating pressure [psi.]
D': Bore size [in.]
d': Piston rod diameter [in.]



The theoretical cylinder thrust by a cylinder bore size is shown on p.42.

●Single acting type cylinder

Because single acting type cylinders use a built-in spring to return the piston, the cylinder thrust differs from the one in the double acting type cylinder.

While the thrust for the single acting type cylinder is a value equal to the double acting type cylinder thrust less by the spring return force, the thrust also varies depending on whether the cylinder is a single acting push type or single acting pull type. Moreover, the spring return force varies at the zero stroke and the end of the stroke.

Thrust of single acting push type cylinder

$F_3 = \frac{\pi}{4} D^2 \cdot P \cdot \eta -$ (Spring return force)

Thrust of single acting pull type cylinder

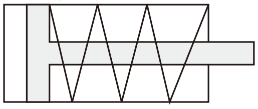
$F_4 = \frac{\pi}{4} (D^2 - d^2) \cdot P \cdot \eta -$ (Spring return force)

※Use the spring return force at the end of the stroke.

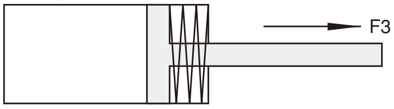
F : Theoretical cylinder thrust (N)
η : Cylinder thrust efficiency (%)
P : Operating pressure (MPa)
D : Bore size (mm)
d : Piston rod diameter (mm)

Single acting push type

Spring return force—Small

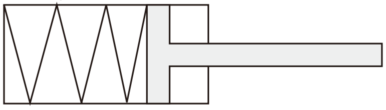


Spring return force—Large

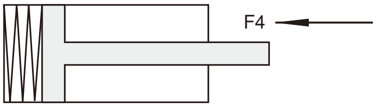


Single acting pull type

Spring return force—Small



Spring return force—Large



●Single acting type cylinder

Because single acting type cylinders use a built-in spring to return the piston, the cylinder thrust differs from the one in the double acting type cylinder.

While the thrust for the single acting type cylinder is a value equal to the double acting type cylinder thrust less by the spring return force, the thrust also varies depending on whether the cylinder is a single acting push type or single acting pull type. Moreover, the spring return force varies at the zero stroke and the end of the stroke.

Thrust of single acting push type cylinder

$F_3' = \frac{\pi}{4} D'^2 \cdot P' \cdot \eta -$ (Spring return force)

Thrust of single acting pull type cylinder

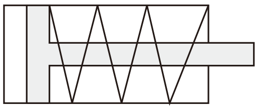
$F_4' = \frac{\pi}{4} (D'^2 - d'^2) \cdot P' \cdot \eta -$ (Spring return force)

※Use the spring return force at the end of the stroke.

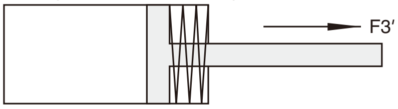
F′: Theoretical cylinder thrust [lbf.]
η : Cylinder thrust efficiency [%]
P′: Operating pressure [psi.]
D′: Bore size [in.]
d′: Piston rod diameter [in.]

Single acting push type

Spring return force—Small

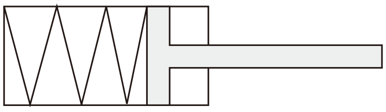


Spring return force—Large

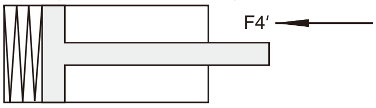


Single acting pull type

Spring return force—Small



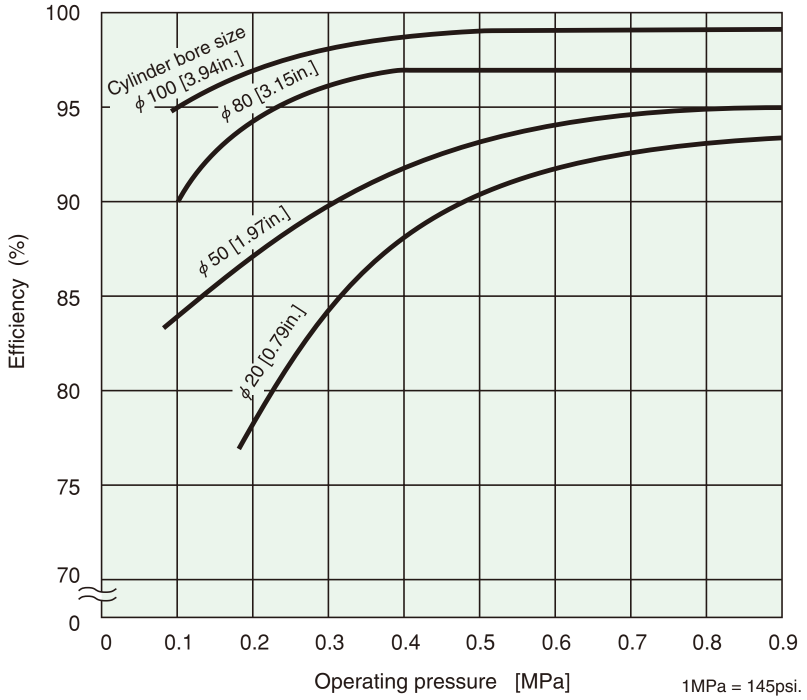
Spring return force—Large



③ Cylinder efficiency

Since the theoretical thrust is a calculated value that does not consider friction resistance, etc., it needs to consider the efficiency in practical use. The thrust efficiency by bore size is shown to the right. As is clear from the graph, while cylinder efficiency reaches 80～95 (%) at pressures of 0.3MPa [44psi.] or more, the efficiency in general should more probably be taken to be at around 50 (%).

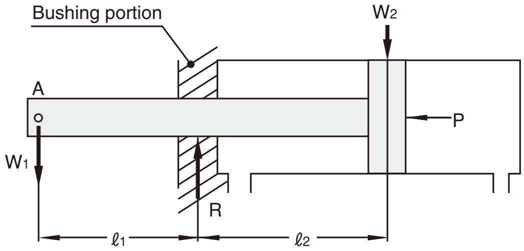
Thrust efficiency by bore size



1MPa = 145psi.

④ Allowable lateral load

When lateral loads are applied on the piston rod, they generate large contact pressure on the bushing and/or on the inner surfaces of the cylinder tube, which can be a factor in increased scuffing and/or friction resistance. JIS standard B 8377 “Pneumatic Cylinders,” therefore, requires for lateral loads that “bushing must be able to withstand the lateral load which is 1/20 of the maximum cylinder thrust over the sliding surface.” The strength relative to lateral loads is therefore designed based on JIS.



W_1 : Lateral load applied to some arbitrary point A of the rod (N) [lbf.]
W_2 : Contact force acting on piston (N) [lbf.]
R : Reaction force acting on bushing (N) [lbf.]
ℓ_1 : Distance from bushing center to W_1 (mm) [in.]
ℓ_2 : Distance between bushing and piston center (mm) [in.]
D : Bore size (mm) [in.]
P : Maximum operating pressure for cylinder (MPa) [psi.]

If, in the above diagram, the bushing is designed based on the JIS standard, and if the piston width is adequately large enough so that the piston is not affected by the lateral load, then the maximum allowable lateral load on the pneumatic cylinder can be calculated as follows.
Let F (N) [lbf.] represent the maximum cylinder force, then

$$R = \frac{F}{20} \quad \text{where} \quad F = \frac{\pi}{4} D^2 \cdot P$$

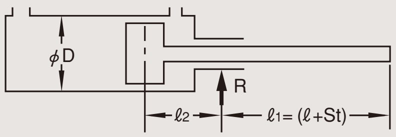
As is clear from the above diagram, the relation between R and W_1 is determined in the following moment equation.

$$R \cdot \ell_2 = W_1 (\ell_1 + \ell_2)$$

Therefore, the maximum allowable lateral load must be

$$W_1 \leqq \frac{\ell_2}{\ell_1 + \ell_2} \cdot R$$

Be aware in cylinder applications to avoid applying lateral load to the piston rod. Should a certain amount of lateral load be unavoidable, however, try to keep it within the range of the allowable lateral load. For lateral loads above that level, it should be necessary to consider using such supporting measures as intermediate support brackets or guide bars for the piston rod.
(Reference material: “Pneumatic application mechanisms and circuit design,” Published by Nikkan Kogyo Shinbunsha, Japan)

Dimensions				
Type	ϕD (mm) [in.]	ℓ_2 (mm) [in.]	ℓ (mm) [in.]	R (N) [lbf.]
Twin rod cylinder B series (Standard)	10 [0.394]	16.5 [0.650]	11.15 [0.439]	5.4 [1.21]
	16 [0.630]	23.0 [0.906]	15.0 [0.591]	13.7 [3.08]
	20 [0.787]	22.5 [0.886]	14.5 [0.571]	21.5 [4.83]
	25 [0.984]	25.0 [0.984]	18.7 [0.736]	33.7 [7.58]
Twin rod cylinder B series (Long bushing)	10 [0.394]	21.5 [0.846]	16.2 [0.638]	10.8 [2.43]
	16 [0.630]	28.0 [1.102]	20.0 [0.787]	27.5 [6.18]
	20 [0.787]	27.5 [1.083]	19.5 [0.768]	43.0 [9.67]
	25 [0.984]	30.0 [1.181]	23.7 [0.933]	67.5 [15.18]
Slim cylinder (Standard)	20 [0.787]	28.0 [1.102]	45.0 [1.772]	13.7 [3.08]
	25 [0.984]	31.5 [1.240]	46.5 [1.831]	21.6 [4.86]
	32 [1.26]	36.5 [1.437]	46.5 [1.831]	35.3 [7.94]
	40 [1.57]	37.5 [1.476]	45.5 [1.791]	55.9 [12.57]
	50 [1.97]	61.0 [2.402]	38.5 [1.516]	67.2 [15.11]
	63 [2.48]	61.0 [2.402]	38.5 [1.516]	106.9 [24.03]
DYNA cylinder (Standard)	32 [1.26]	51.0 [2.008]	45.0 [1.772]	40.2 [9.04]
	40 [1.57]	47.5 [1.870]	50.5 [1.988]	62.8 [14.12]
	50 [1.97]	47.5 [1.870]	58.5 [2.303]	98.2 [22.08]
	63 [2.48]	49.5 [1.949]	58.5 [2.303]	155.9 [35.05]
	80 [3.15]	60.0 [2.362]	73.0 [2.874]	251.3 [56.49]
	100 [3.94]	59.0 [2.323]	74.0 [2.913]	392.7 [88.28]
	125 [4.92]	63.0 [2.480]	88.0 [3.465]	613.6 [137.9]
SD cylinder (Standard)	125 [4.92]	55.0 [2.165]	105.0 [4.134]	420.7 [94.58]
	140 [5.51]	55.0 [2.165]	105.0 [4.134]	528.6 [118.8]
	160 [6.30]	59.0 [2.323]	115.0 [4.528]	689.4 [155.0]
	180 [7.09]	62.5 [2.461]	129.0 [5.079]	872.8 [196.2]
	200 [7.87]	62.5 [2.461]	129.0 [5.079]	1077.8 [242.3]

For cylinders other than the above, or for single acting type cylinders, consult us.

2. Model Selection Procedure (rotary actuator)

For selection of rotary actuators, use the following selection procedure to select the appropriate rotary actuator.

STEP 1. Check the swing time

Set the swing time to within the range of times listed in the catalog. Setting the time out of the range could result in instability of actuator operation and possible damage to the actuator. Always use at a swing time that falls within the stipulated range.

STEP 2. Calculate the torque

Loads are divided broadly into three main types. Calculate the required torque for each case. In case of compound loads, total the torques to obtain the required torque. Find the operating pressure on the effective torque table and torque graph to select a size that satisfies the required torque.

① Static load (T_s)
When a clamp or other static pushing force is needed:

$T_s = F_s \times L$

T_s: Required torque (N・m)
F_s: Pushing force (N)
L: Distance from center of rotation to point of application (m)

Note: If the clamp lever is considered to be a mass object, calculate the clamp as an inertial load.

② Resistance load (T_R)
When friction, gravity, or other external force acts:

$T_R = F_R \times L \times K$

T_R: Required torque (N・m)
F_R: Pushing force (N)
L: Distance from center of rotation to point of application (m)
K: Marginal coefficient (2 to 5), set through load varying conditions

Note: If the arm, etc., is considered to be a mass object, calculate the arm, etc., as an inertial load.

③ Inertial load (T_A)
When an actuator is used to rotate the object:

$T_A = I \times \dot{\omega} \times K$

$$\dot{\omega} = \frac{2\theta}{t^2}$$

T_A : Required torque (N・m)
I : Mass moment of inertia (kg・m^2)
$\dot{\omega}$: Uniform angular acceleration (rad/s^2)
K : Marginal coefficient 5 or larger
θ : Swing angle (rad)
90°→1.57rad
180°→3.14rad
t : Swing time (s)

Use the diagrams for calculating mass moment of inertia on p.47～50 to calculate the mass moment of inertia.

Calculation of mass moment of inertia
I : Mass moment of inertia (kg・m^2)
m: Mass (kg)

STEP 3. Calculate the kinetic energy

For inertial loads, if the kinetic energy at the swing end exceeds the allowable kinetic energy, it could result in damage to the actuator. Always select a model that falls within the allowable energy range. If the allowable kinetic energy is large, mount a shock absorber to the outside of the unit, and avoid directly applying large inertial force.

$$E = \frac{1}{2} \times I \times \omega^2$$

$$\omega = \frac{2\theta}{t}$$

E : Kinetic energy (J)
I : Mass moment of inertia (kg・m^2)
ω : Angular velocity (rad/s)
θ : Swing angle (rad)
90°→1.57rad
180°→3.14rad
t : Swing time (s)

STEP 1. Check the swing time

Set the swing time to within the range of times listed in the catalog. Setting the time out of the range could result in instability of actuator operation and possible damage to the actuator. Always use at a swing time that falls within the stipulated range.

STEP 2. Calculate the torque

Loads are divided broadly into three main types. Calculate the required torque for each case. In case of compound loads, total the torques to obtain the required torque. Find the operating pressure on the effective torque table and torque graph to select a size that satisfies the required torque.

① Static load (T'_s)
When a clamp or other static pushing force is needed:

$T'_s = F'_s \times L'$

T'_s: Required torque [ft・lbf]
F'_s: Pushing force [lbf.]
L′: Distance from center of rotation to point of application [ft.]

Note: If the clamp lever is considered to be a mass object, calculate the clamp as an inertial load.

② Resistance load (T'_R)
When friction, gravity, or other external force acts:

$T'_R = F'_R \times L' \times K$

T'_R: Required torque [ft・lbf]
F'_R: Pushing force [lbf.]
L′: Distance from center of rotation to point of application [ft.]
K: Marginal coefficient (2 to 5), set through load varying conditions

Note: If the arm, etc., is considered to be a mass object, calculate the arm, etc., as an inertial load.

③ Inertial load (T'_A)
When an actuator is used to rotate the object:

$T'_A = I' \times \dot{\omega} \times K$

$$\dot{\omega} = \frac{2\theta}{t^2}$$

T'_A: Required torque [ft・lbf]
I′ : Mass moment of inertia [lbf・ft・sec.^{2}]
$\dot{\omega}$: Uniform angular acceleration [rad/sec.^{2}]
K : Marginal coefficient 5 or larger
θ : Swing angle [rad]
90°→1.57rad
180°→3.14rad
t : Swing time [sec.]

Use the diagrams for calculating mass moment of inertia on p.47～50 to calculate the mass moment of inertia.

Calculation of mass moment of inertia
I′ : Mass moment of inertia [ft・lbf・sec.^{2}]
w : Weight [lb.]

STEP 3. Calculate the kinetic energy

For inertial loads, if the kinetic energy at the swing end exceeds the allowable kinetic energy, it could result in damage to the actuator. Always select a model that falls within the allowable energy range. If the allowable kinetic energy is large, mount a shock absorber to the outside of the unit, and avoid directly applying large inertial force.

$$E' = \frac{1}{2} \times I' \times \omega^2$$

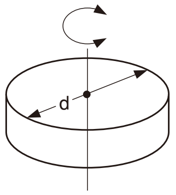
$$\omega = \frac{2\theta}{t}$$

E′ : Kinetic energy [ft・lbf]
I′ : Mass moment of inertia [ft・lbf・sec.^{2}]
ω : Angular velocity [rad/sec.]
θ : Swing angle [rad]
90°→1.57rad
180°→3.14rad
t : Swing time [sec.]

Diagram for calculating mass moment of inertia

【When the rotation axis passes through the workpiece】

Disk



- Diameter d (m)
- Mass m (kg)

Mass moment of inertia I (kg·m²)

$$I=\frac{md^2}{8}$$

Rotating radius

$$\frac{d^2}{8}$$

- Diameter d [ft.]
- Weight w [lbf.]

Mass moment of inertia I′ [lbf·ft·sec²]

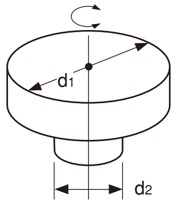
$$I'=\frac{wd^2}{8\times32.2}$$

Rotating radius

$$\frac{d^2}{8}$$

Remark: For sliding use, see separate materials.

Stepped disk



- Diameter d_1 (m)
  d_2 (m)
- Mass d_1 portion m_1 (kg)
  d_2 portion m_2 (kg)

Mass moment of inertia I (kg·m²)

$$I=\frac{1}{8}(m_1d_1^2+m_2d_2^2)$$

Rotating radius

$$\frac{d_1^2+d_2^2}{8}$$

- Diameter d_1 [ft.]
  d_2 [ft.]
- Weight d_1 portion w_1 [lbf.]
  d_2 portion w_2 [lbf.]

Mass moment of inertia I′ [lbf·ft·sec²]

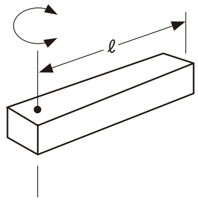
$$I'=\frac{1}{8\times32.2}\times(w_1d_1^2+w_2d_2^2)$$

Rotating radius

$$\frac{d_1^2+d_2^2}{8}$$

Remark: The d_2 portion can be negligible when it is much smaller than the d_1 portion.

Bar (rotation center is at the edge)



- Bar length ℓ (m)
- Mass m (kg)

Mass moment of inertia I (kg·m²)

$$I=\frac{m\ell^2}{3}$$

Rotating radius

$$\frac{\ell^2}{3}$$

- Bar length ℓ [ft.]
- Weight w [lbf.]

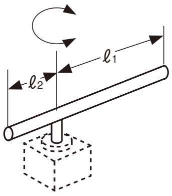
Mass moment of inertia I′ [lbf·ft·sec²]

$$I'=\frac{w\ell^2}{3\times32.2}$$

Rotating radius

$$\frac{\ell^2}{3}$$

Slender rod



- Rod length ℓ_1 (m)
  ℓ_2 (m)
- Mass m_1 (kg)
  m_2 (kg)

Mass moment of inertia I (kg·m²)

$$I=\frac{m_1\ell_1^2}{3}+\frac{m_2\ell_2^2}{3}$$

Rotating radius

$$\frac{\ell_1^2+\ell_2^2}{3}$$

- Rod length ℓ_1 [ft.]
  ℓ_2 [ft.]
- Weight w_1 [lbf.]
  w_2 [lbf.]

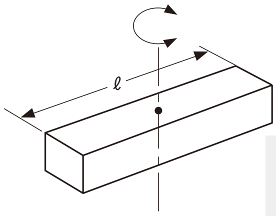
Mass moment of inertia I′ [lbf·ft·sec²]

$$I'=\frac{w_1\ell_1^2}{3\times32.2}+\frac{w_2\ell_2^2}{3\times32.2}$$

Rotating radius

$$\frac{\ell_1^2+\ell_2^2}{3}$$

●Bar (rotation center is through the center of gravity)



●Bar length	ℓ (m)
●Mass	m (kg)

■Mass moment of inertia I (kg·m²)

$$I=\frac{m\ell^2}{12}$$

■Rotating radius

$$\frac{\ell^2}{12}$$

●Bar length	ℓ [ft.]
●Weight	w [lbf.]

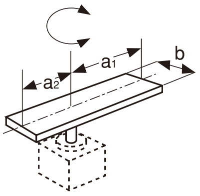
■Mass moment of inertia I′ [lbf·ft·sec²]

$$I'=\frac{w\ell^2}{12\times32.2}$$

■Rotating radius

$$\frac{\ell^2}{12}$$

●Thin rectangular plate (rectangular solid)



●Plate length	a_1 (m)
	a_2 (m)
●Length of side	b (m)
●Mass	m_1 (kg)
	m_2 (kg)

■Mass moment of inertia I (kg·m²)

$$I=\frac{m_1}{12}(4a_1^2+b^2)+\frac{m_2}{12}(4a_2^2+b^2)$$

■Rotating radius

$$\frac{(4a_1^2+b^2)+(4a_2^2+b^2)}{12}$$

●Plate length	a_1 [ft.]
	a_2 [ft.]
●Length of side	b [ft.]
●Weight	w_1 [lbf.]
	w_2 [lbf.]

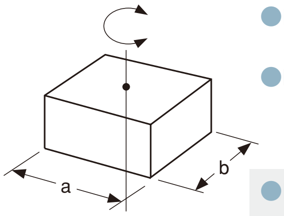
■Mass moment of inertia I′ [lbf·ft·sec²]

$$I'=\frac{w_1}{12\times32.2}(4a_1^2+b^2)+\frac{w_2}{12\times32.2}(4a_2^2+b^2)$$

■Rotating radius

$$\frac{(4a_1^2+b^2)+(4a_2^2+b^2)}{12}$$

●Rectangular parallelepiped



●Length of sides	a (m)
	b (m)
●Mass	m (kg)

■Mass moment of inertia I (kg·m²)

$$I=\frac{m}{12}(a^2+b^2)$$

■Rotating radius

$$\frac{a^2+b^2}{12}$$

●Length of sides	a [ft.]
	b [ft.]
●Weight	w [lbf.]

■Mass moment inertia I′ [lbf·ft·sec²]

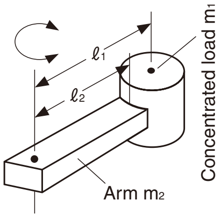
$$I'=\frac{w}{12\times32.2}(a^2+b^2)$$

■Rotating radius

$$\frac{a^2+b^2}{12}$$

Remark: For sliding use, see separate materials.

●Concentrated load



●Shape of concentrated load	
●Distance to center of gravity of concentrated load	ℓ_1 (m)
●Length of arm	ℓ_2 (m)
●Mass of concentrated load	m_1 (kg)
●Mass of arm	m_2 (kg)

■Mass moment of inertia I (kg・m²)

$$I = m_1k^2 + m_1\ell_1^2 + \frac{m_2\ell_2^2}{3}$$

Rotating radius: k^2 is calculated according to shape of the concentrated load.

Remark: When m_2 is much smaller than m_1, calculate as $m_2 = 0$.

●Shape of concentrated load	
●Distance to center of gravity of concentrated load	ℓ_1 [ft.]
●Length of arm	ℓ_2 [ft.]
●Weight of concentrated load	w_1 [lbf.]
●Weight of arm	w_2 [lbf.]

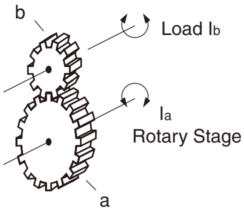
■Mass moment of inertia I´ [lbf・ft・sec²]

$$I' = \frac{w_1k^2}{32.2} + \frac{w_1\ell_1^2}{32.2} + \frac{w_2}{32.2} \times \frac{\ell_2^2}{3}$$

Rotating radius: k^2 is calculated according to shape of the concentrated load.

Remark: When w_2 is much smaller than w_1, calculate as $w_2 = 0$.

●Gear Equation for calculating the load J_L with respect to Rotary Stage axis when transmitted by gears



●Gear Rotary Stage side	a	
Load side	b	
●Inertia moment of load		N・m

■Mass moment of inertia I (kg・m²)

Mass moment of inertia of load with respect to Rotary Stage axis

$$I_a = \left(\frac{a}{b}\right)^2 I_b$$

●Gear Rotary Stage side	a	
Load side	b	
●Inertia moment of load		ft・lbf

■Mass moment of inertia I´ [lbf・ft・sec²]

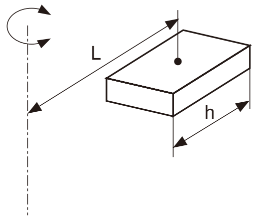
Mass moment of inertia of load with respect to Rotary Stage axis

$$I_a = \left(\frac{a}{b}\right)^2 I_b$$

Remark: If the shapes of the gears are too large, the mass moment of inertia of the gears must be also taken into consideration.

【When the rotation axis is offset from the workpiece】

●Rectangular parallelepiped



●Length of side	h (m)
●Distance from rotation axis to the center of load	L (m)
●Mass	m (kg)

■Mass moment of inertia I (kg·m^2)

$$I=\frac{mh^2}{12}+mL^2$$

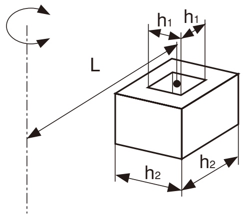
●Length of side	h [ft.]
●Distance from rotation axis to the center of load	L [ft.]
●Weight	w [lbf.]

■Mass moment of inertia I′ [lbf·ft·sec^2]

$$I'=\frac{wh^2}{32.2\times12}+\frac{wL^2}{32.2}$$

Remark: Same for cube.

●Hollow rectangular parallelepiped



●Length of side	h_1 (m)
	h_2 (m)
●Distance from rotation axis to the center of load	L (m)
●Mass	m (kg)

■Mass moment of inertia I (kg·m^2)

$$I=\frac{m}{12}(h_2{}^2+h_1{}^2)+mL^2$$

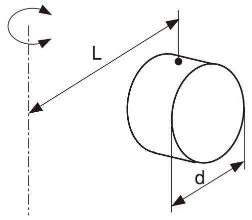
●Length of side	h_1 [ft.]
	h_2 [ft.]
●Distance from rotation axis to the center of load	L [ft.]
●Weight	w [lbf.]

■Mass moment of inertia I′ [lbf·ft·sec^2]

$$I'=\frac{w(h_2{}^2+h_1{}^2)}{32.2\times12}+\frac{wL^2}{32.2}$$

Remark: Cross-section is square only.

●Circular cylinder



●Diameter	d (m)
●Distance from rotation axis to the center of load	L (m)
●Mass	m (kg)

■Mass moment of inertia I (kg·m^2)

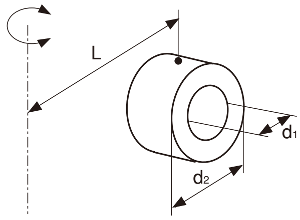
$$I=\frac{md^2}{16}+mL^2$$

●Diameter	d [ft.]
●Distance from rotation axis to the center of load	L [ft.]
●Weight	w [lbf.]

■Mass moment of inertia I′ [lbf·ft·sec^2]

$$I'=\frac{wd^2}{32.2\times16}+\frac{wL^2}{32.2}$$

●Hollow circular cylinder



●Diameter	d_1 (m)
	d_2 (m)
●Distance from rotation axis to the center of load	L (m)
●Mass	m (kg)

■Mass moment of inertia I (kg·m^2)

$$I=\frac{m}{16}(d_2{}^2+d_1{}^2)+mL^2$$

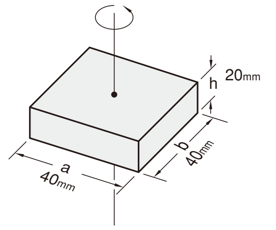
●Diameter	d_1 [ft.]
	d_2 [ft.]
●Distance from rotation axis to the center of load	L [ft.]
●Weight	w [lbf.]

■Mass moment of inertia I′ [lbf·ft·sec^2]

$$I'=\frac{w(d_2{}^2+d_1{}^2)}{32.2\times16}+\frac{wL^2}{32.2}$$

Calculation example

Calculate the torque and kinetic energy when the workpiece is rectangular parallelepiped



Select the Rotary Actuator for swinging the load (material: Fe) in the diagram under the conditions shown below.

- Operating air pressure 0.5MPa
- Swing angle .... 180°
- Swing time 1.0s

(1) Calculate the torque

① Find the mass m

$m = a \times b \times h \times r$ (r: Specific gravity; Fe : $7.85 \times 10^3 kg/m^3$)

$= 0.04 \times 0.44 \times 0.02 \times 7.85 \times 10^3$

$= 0.25$ (kg)

② Find the mass moment of inertia I

$$I = \frac{m}{12}(a^2 + b^2)$$

$$= \frac{0.25}{12}(0.04^2 + 0.04^2)$$

$$= 6.7 \times 10^{-5} \ (kg \cdot m^2)$$

③ Find the uniform angular acceleration $\dot{\omega}$

$$\dot{\omega} = \frac{2\theta}{t^2}$$

$$= \frac{2 \times 3.14}{1.0^2}$$

$$= 6.28 \ (rad/s^2)$$

④ Find the torque T_A

$T_A = I \times \dot{\omega} \times K$

$= 6.7 \times 10^{-5} \times 6.28 \times 5$

$= 2.1 \times 10^{-3}$ (N·m)

(2) Calculate the kinetic energy

① Find angular velocity ω

$$\omega = \frac{2\theta}{t}$$

$$= \frac{2 \times 3.14}{1.0}$$

$$= 6.28 \ (rad/s)$$

② Calculate the kinetic energy

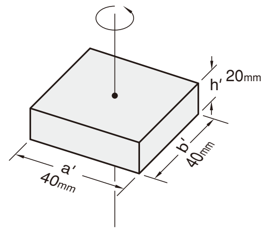
$$E = \frac{1}{2} \times I \times \omega^2$$

$$= \frac{1}{2} \times 6.7 \times 10^{-5} \times 6.28^2$$

$$= 0.00132 \ (J)$$

Calculation example

Calculate the torque and kinetic energy when the workpiece is rectangular parallelepiped



Select the Rotary Actuator for swinging the load (material: Fe) in the diagram under the conditions shown below.

- Operating air pressure .... 73psi.
- Swing angle .... 180°
- Swing time .... 1.0sec.

(1) Calculate the torque

① Find the mass m′

First, find the weight w′

$w' = a' \times b' \times h' \times r'$ [r′: Specific gravity; Fe : 490lbf./ft.³]

$$= \frac{40}{25.4 \times 12} \times \frac{40}{25.4 \times 12} \times \frac{20}{25.4 \times 12} \times 490$$

$= 0.554$ [lbf.]

$$m' = \frac{w'}{g} = \frac{0.554}{32.2} = 0.0172 \ [lbf \cdot sec.^2 \cdot ft.^{-1}]$$

② Find the mass moment of inertia I′

$$I' = \frac{m'}{12}(a'^2 + b'^2)$$

$$= \frac{0.0172}{12}\left\{\left(\frac{40}{25.4 \times 12}\right)^2 + \left(\frac{40}{25.4 \times 12}\right)^2\right\}$$

$$= 4.93 \times 10^{-5} \ [lbf \cdot ft \cdot sec.^2]$$

③ Find the uniform angular acceleration $\dot{\omega}$

$$\dot{\omega} = \frac{2\theta}{t^2}$$

$$= \frac{2 \times 3.14}{1.0^2}$$

$$= 6.28 \ [rad/sec.^2]$$

④ Find the torque T_A'

$T_A' = I' \times \dot{\omega} \times K$

$= 4.93 \times 10^{-5} \times 6.28 \times 5$

$= 1.55 \times 10^{-3}$ [ft·lbf]

(2) Calculate the kinetic energy

① Find angular velocity ω

$$\omega = \frac{2\theta}{t}$$

$$= \frac{2 \times 3.14}{1.0}$$

$$= 6.28 \ [rad/sec.]$$

② Calculate the kinetic energy

$$E' = \frac{1}{2} \times I' \times \omega^2$$

$$= \frac{1}{2} \times 4.93 \times 10^{-5} \times 6.28^2$$

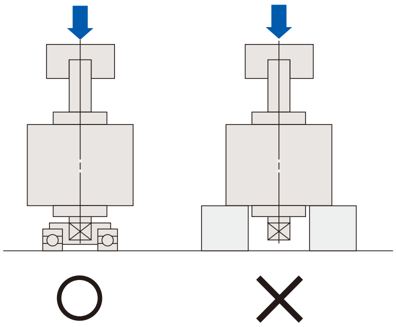
$$= 9.72 \times 10^{-4} \ [ft \cdot lbf]$$

Precautions concerning load direction

(1) Since thrust loads in the rod axial direction of the vane type rotary actuator can result in defective operation or reduction in endurance performance, take adequate precautions during mounting and using.
Although this catalog lists allowable thrust loads, these are reference values and not guaranteed values.

(2) Although specification values for radial loads perpendicular to the rod can be applied as static loads, dynamic loads are restricted to loads (weight) that are within the allowable energy values. Moreover, since eccentric loads perpendicular to the rod could cause abnormal friction and/or damage in the bearings, use flexible couplings whenever possible for such rod connections.

(3) When mounting, be sure to set loads or select fittings that avoid applying stresses or loads on the body.



3. Explanation of Terms Used in the Catalog

Air consumption

In pneumatic equipment or systems, the amount of consumed air under a certain condition. The amount of consumed air per unit of time is converted and displayed as the standard state's value.

Air volume

The volume of flowing air per unit of time, converted to standard condition.

Apparent power

Expresses the power consumption in the case of alternating current. Expressed as Voltage (V) × Current (A). The unit of measurement is VA.

Back pressure

Pressure applied on the return side of a circuit, on the exhaust side, or the behind side of a pressure applied surface.

Breakaway pressure

The minimum pressure required to start an operation on a specific device.

Burst pressure

The pressure that actually bursts the outer wall of a device.

Collected liquid

Water or oil/water of a whitish liquid found inside pneumatic equipment or piping, in either a flowing or being deposited state.

Connection port

A port installed on a device for connection to piping. Normally, taper pipe thread is used.

Contamination control

Control of undesirable substances included in an operating media.

Continuous energizing

Describes continuous application of a rated frequency and/or a rated voltage to a solenoid.

Cracking pressure

The pressure at a certain flow rate when pressure in a check value or relief valve has risen and the valve has begun to open.

Cv

Cv is a coefficient showing the flow rate characteristics of valves. The coefficient is obtained by using G.P.M. (3.785 ℓ /min≒1G.P.M.) to calculate water flow rate through a valve at 15.5°C (60°F), at a specified opening of the valve under a pressure drop of 6.9kPa [1psi.].

Cylinder output force

The mechanical force transmitted from a piston rod.

Dew point

The temperature at which the water vapor becomes saturated, when gases containing water vapor are chilled under a constant pressure.

Effective area of valve

The amount of area obtained by calculating pressure resistance based on the actual flow rate of a valve in terms of an equivalent orifice. Used as a value for expressing the flow performance of a pneumatic valve.

Filtration rating

Expresses the size of particles eliminated by filtration material when an operating media is passed through a filter. The unit of measurement is μm (1/1000mm) [0.0000394in.].

Holding current

The current when an electrical equipment has completed its starting operation, appearing after an inrush current.

Inrush current

A momentary rush of current in electrical equipment that occurs when power of a rated frequency and voltage is switched from stationary condition to beginning of movement.

Insulation resistance

The amount of resistance in an insulating material. As the insulation resistance is much larger than conductive resistance, it is normally stated in terms of mega-ohms (symbol: MΩ).

Manifold

A block that is used internally to shape a passageway that performs the piping function, and externally to mount 2 or more devices.

●Maximum operating frequency
The maximum frequency of operations without occurrence of erratic operation when equipment is operated continuously.

●Maximum operating pressure
The maximum pressure to ensure device or system use.

●Minimum flow rate for dripping oil
The minimum amount of air flow rate required for causing oil droplets to flow from a lubricator under specified conditions.

●Minimum operating pressure
The minimum pressure needed to ensure device or system operation.

●Minimum using pressure
The minimum pressure needed to allow device use.

●Momentarily energized to hold valve position type
Expresses the construction that actually maintains the state when a valve has been activated by applying 1 pulse at a rated frequency and rated voltage to a solenoid.

●Non-lubricant pneumatic device
A pneumatic equipment capable of operating without lubrication, either because of its specific construction, or through use of a self-lubricating material.

●Normal state
State of dry gas at a temperature of 0°C [32°F] and an absolute pressure of 101.3kPa [14.7psi.].

●Oil mist
Fine particles of oil entrained in operating air.

●Operating life
Number of cycles, amount of time, etc., that a device can ensure operation, while maintaining a specified performance, when used under recommended conditions.

●Operating pressure range
The pressure required during actual operation of a device or system.

●Operating temperature range
Temperature of the environment surrounding an operating device; or the temperature of the media being used.

●Pilot pressure
Pressure used in a pilot pipe line.

●Pre-lubed pneumatic device
Pneumatic equipment pre-lubricated with such as grease, that is then capable of operating for extended periods without supply of lubricant.

●Pressure pulsation
Nearly periodic fluctuations in pressure that occur under normal operating conditions. Excludes transient fluctuations in pressure.

●Primary pressure
Pressure on device’s inlet side.

●Proof pressure
The pressure at which devices must withstand without performance degradation after the maximum operating pressure has been restored. The pressure value should be determined under specified conditions.

●Residual magnetism
Magnetic force remaining in a material, after the material has been placed in a magnetic field, become magnetized, and then removed the magnetic field.

●Residual pressure
Unwanted pressure remaining inside a circuit system or device after pressure supply has been shut off.

●Response time
Time required from an input signal being sent to a valve or circuit, to securing a certain output value.

●Secondary pressure
Pressure on device’s outlet side.

●Set pressure
Pressure regulated in a pressure control valve, etc.

●Standard condition (ANR)
The state of air at a temperature of 20°C [68°F], absolute pressure of 101.3kPa [14.7psi.], and relative humidity of 65%. In ISO/DIS5598, this is called the “standard reference atmospheric condition,” and expressed in abbreviated form as “A.N.R.,” from the French term.

4. Explanation of Conversion of the International System of Units (SI units)

This Catalog uses SI units for specifications and other data. The following figures are used when converting from old unit measurements.

Pressure 1MPa ＝10.1972kgf/cm^2 ＝145psi.
Force, load 1N ＝0.101972kgf ＝0.2248lbf.
Torque, moment 1N・m ＝0.101972kgf・m ＝0.7376ft・lbf
Vacuum pressure －1kPa ＝－7.5006mmHg ＝－0.145psi.
Acceleration 1m/s^2 ＝0.101972G ＝3.281ft./sec.^{2}

Unit Conversion Table

1. Pressure

1-1）MPa→kgf/cm^2 (1MPa＝10.1972kgf/cm^2) 〔Unit: kgf/cm^2〕

MPa	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.00	1.02	2.04	3.06	4.08	5.10	6.12	7.14	8.16	9.18
1	10.20	11.22	12.24	13.26	14.28	15.30	16.32	17.34	18.35	19.37
2	20.39	21.41	22.43	23.45	24.47	25.49	26.51	27.53	28.55	29.57

Example: For 1.5MPa, the intersection of row 1 and the 0.5 column indicates 15.30kgf/cm^2.

1-2) kgf/cm^2→MPa (1kgf/cm^2＝0.0980665MPa) 〔Unit: MPa〕

kgf/cm^2	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.0000	0.0098	0.0196	0.0294	0.0392	0.0490	0.0588	0.0686	0.0785	0.0883
1	0.0981	0.1079	0.1177	0.1275	0.1373	0.1471	0.1569	0.1667	0.1765	0.1863
2	0.1961	0.2059	0.2157	0.2256	0.2354	0.2452	0.2550	0.2648	0.2746	0.2844
3	0.2942	0.3040	0.3138	0.3236	0.3334	0.3432	0.3530	0.3628	0.3727	0.3825
4	0.3923	0.4021	0.4119	0.4217	0.4315	0.4413	0.4511	0.4609	0.4707	0.4805
5	0.4903	0.5001	0.5099	0.5198	0.5296	0.5394	0.5492	0.5590	0.5688	0.5786
6	0.5884	0.5982	0.6080	0.6178	0.6276	0.6374	0.6472	0.6570	0.6669	0.6767
7	0.6865	0.6963	0.7061	0.7159	0.7257	0.7355	0.7453	0.7551	0.7649	0.7747
8	0.7845	0.7943	0.8041	0.8140	0.8238	0.8336	0.8434	0.8532	0.8630	0.8728
9	0.8826	0.8924	0.9022	0.9120	0.9218	0.9316	0.9414	0.9512	0.9611	0.9709

Example: For 5.5kgf/cm^2, the intersection of row 5 and the 0.5 column indicates 0.5394MPa.

2. Force

2-1)N→kgf (1N＝0.101972kgf) 〔Unit: kgf〕

N	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.000	0.010	0.020	0.031	0.041	0.051	0.061	0.071	0.082	0.092
1	0.102	0.112	0.122	0.133	0.143	0.153	0.163	0.173	0.184	0.194
2	0.204	0.214	0.224	0.235	0.245	0.255	0.265	0.275	0.286	0.296
3	0.306	0.316	0.326	0.337	0.347	0.357	0.367	0.377	0.387	0.398
4	0.408	0.418	0.428	0.438	0.449	0.459	0.469	0.479	0.489	0.500
5	0.510	0.520	0.530	0.540	0.551	0.561	0.571	0.581	0.591	0.602
6	0.612	0.622	0.632	0.642	0.653	0.663	0.673	0.683	0.693	0.704
7	0.714	0.724	0.734	0.744	0.755	0.765	0.775	0.785	0.795	0.806
8	0.816	0.826	0.836	0.846	0.857	0.867	0.877	0.887	0.897	0.908
9	0.918	0.928	0.938	0.948	0.959	0.969	0.979	0.989	0.999	1.010

Example: For 4.5N, the intersection of row 4 and the 0.5 column indicates 0.459kgf.

2-2)kgf→N(1kgf＝9.80665N) 〔Unit: N〕

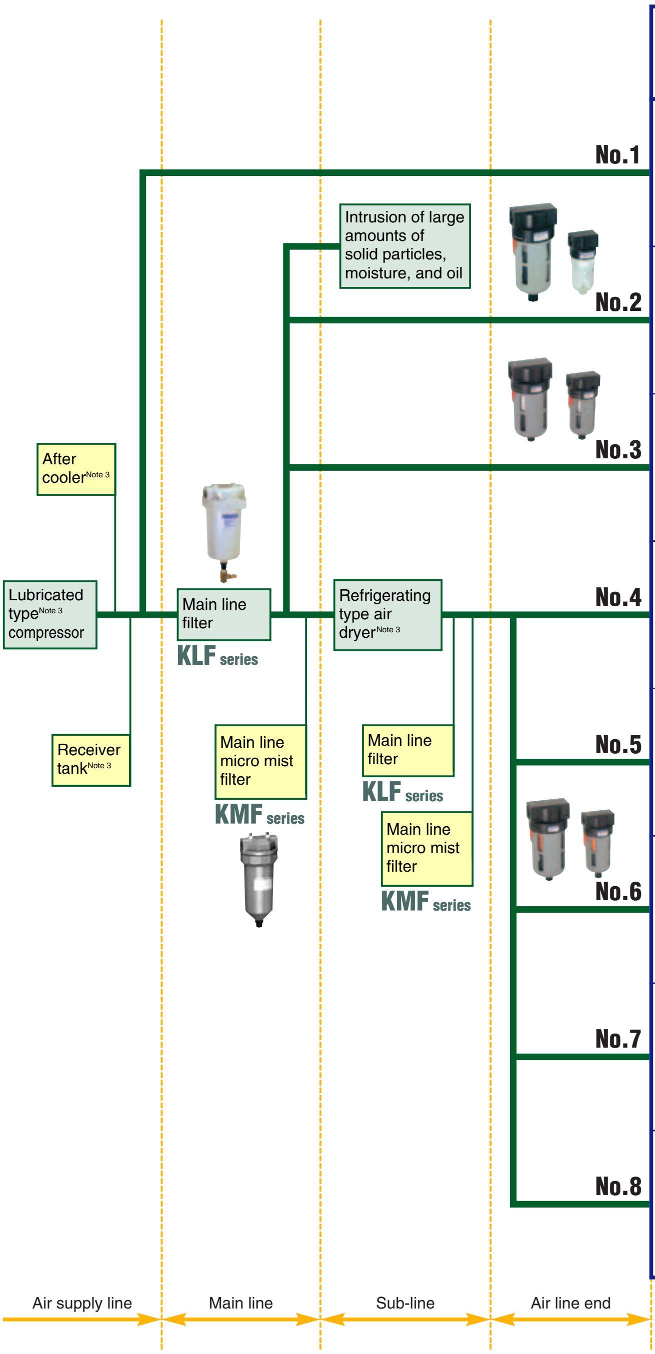
kgf	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.000	0.981	1.961	2.942	3.923	4.903	5.884	6.865	7.845	8.826
1	9.807	10.787	11.768	12.749	13.729	14.710	15.691	16.671	17.652	18.633
2	19.613	20.594	21.575	22.555	23.536	24.517	25.497	26.478	27.459	28.439
3	29.420	30.401	31.381	32.362	33.343	34.323	35.304	36.285	37.265	38.246
4	39.227	40.207	41.188	42.169	43.149	44.130	45.111	46.091	47.072	48.053
5	49.033	50.014	50.995	51.975	52.956	53.937	54.917	55.898	56.879	57.859
6	58.840	59.821	60.801	61.782	62.763	63.743	64.724	65.705	66.685	67.666
7	68.647	69.627	70.608	71.589	72.569	73.550	74.531	75.511	76.492	77.473
8	78.543	79.434	80.415	81.395	82.376	83.357	84.337	85.318	86.299	87.279
9	88.260	89.241	90.221	91.202	92.183	93.163	94.144	95.125	96.105	97.086

Example: For 1.5kgf, the intersection of row 1 and the 0.5 column indicates 14.710N.

REFERENCE

1. Koganei Clean Air System
2. Piping Size and Flow Rate
3. Explanation of Conversion of the International System of Units (SI units)
4. Explanation of Terms Used in the Catalog
5. Application Example of Quick Fittings Standard Type

1.Koganei Clean Air System



Basic system	Quality of compressed air	Moisture content	Oil content	Solid particles	Odor	Suitable application
—	Intrusion of large amounts of solid particles, moisture, and oil	Humidity 100%	34mg/m^3 (ANR) (28ppm$^{W}/_{W}$)	—	Yes	No general application
F	Intrusion of some amounts of solid particles, moisture, and oil ● **General industrial air**	Humidity 100% water vapor separation 80%	(10mg/m^3) (ANR) (8ppm$^{W}/_{W}$)	5 μm 100%	Yes	General industrial labor saving equipment, pneumatic equipment, general industrial fixtures, pneumatic tools, construction, civil engineering equipment, general cleaning
F+MF	Some amounts of moisture, but solid particles and oil removed ● **General industrial air**	Humidity 100%	1mg/m^3 (ANR) (0.8ppm$^{W}/_{W}$)	0.3 μm 99.9%	Yes	General industrial equipment
F	Some amounts of oil and solid particles, but moisture removed ● **Clean air**	Dew point −17°C or below	(6mg/m^3) (ANR) (5ppm$^{W}/_{W}$)	5 μm 100%	Yes	General industrial labor saving equipment, pneumatic equipment, general industrial fixtures, pneumatic tools, general cleaning
F+MF	Solid particles, moisture, and oil removed ● **Precision clean air**	Dew point −17°C or below	0.1mg/m^3 (ANR) (0.08ppm$^{W}/_{W}$)	0.3 μm 99.9%	Yes	Instrumentation, general coating, cooling, general drying equipment
F+MF+ MMF	Virtually all solid particles, moisture, and oil removed ● **Ultra-precision clean air**	Dew point −17°C or below	0.01mg/m^3 (ANR) (0.008ppm$^{W}/_{W}$)	0.01 μm 99.9999%	Yes	Pneumatic measuring devices, drying, precision cleaning, high-quality coating
KLF+ KMF+ KKF+ KMF	Virtually all solid particles, moisture, oil, and odors removed ● **Medical clean air**	Dew point −17°C or below	0.1mg/m^3 (ANR) (0.08ppm$^{W}/_{W}$)	0.3 μm 99.9999%	No	Medical and pharmaceutical products, medical equipment, respirators, foodstuffs
F+MF (+MMF)+ absorbent air dryer +MMF	Virtually all solid particles, moisture, and oil removed, and dew point lowered ● **Super dry air**	Dew point −50°C or below (and possibly as low as −70°C)	0.01mg/m^3 (ANR) (0.008ppm$^{W}/_{W}$)	0.01 μm 99.9999%	Yes	Semiconductor-related, electrical and electronic parts drying, charging tank drying, powder conveying

Notes: 1. Install equipment shown in framed boxes ▭, as required.
2. For situations where oil in the lines is a particular problem, use of a non-lubricated compressor is recommended.
3. Not in the Koganei product line.

When air coming from the compressor is degraded, use the equipment shown below to obtain clean air suited to your application.

Air Cleaning Step (Items shown in framed boxes 🟨 are additional equipment)				**Moisture content**	**Oil content**	**Solid particles**		**Suitable application (features)**
Air conditioning equipment	Step **1**	Drain filter **DF** series or Cool separator **KAE-7**		●**Drain filter** Humidity 100% Separation rate 99% ●**Cool separator** Dew point drops by 3°C	34mg/m³ (ANR) (28ppm$^{w}/_{w}$) Note	———	Air quality improvement at time of end-use	● Drain filter: Filter with little clogging, water vapor removed ● Cool separator: Effective for lowering dew point by 3°C ● General industrial use air
	Step **2**	Drain filter **DF** series Filter **F, FN** series		Humidity 100% Separation rate 99%	10mg/m³ (ANR) (8ppm$^{w}/_{w}$) Note	5 μm 100%		● Solid particles and water vapor removed ● General industrial use air
	Step **3**	Drain filter **DF** series Filter **F, FN** series Mist filter **MF** series		Humidity 100% Separation rate 99%	1mg/m³ (ANR) (0.8ppm$^{w}/_{w}$)	0.3 μm 99.9%		● Oil removed ● General industrial use air
	Step **4**	Drain filter **DF** series Filter **F, FN** series Mist filter **MF** series Micro mist filter **MMF** series		Humidity 100% Separation rate 99%	0.1mg/m³ (ANR) (0.08ppm$^{w}/_{w}$)	0.01 μm 99.9999%		● General industrial use clean air
	Step **5**	Drain filter **DF** series Filter **F, FN** series Mist filter **MF** series Micro mist filter **MMF** series Membrane air dryer **KRM** series		Dew point −26〜−10°C	0.1mg/m³ (0.08ppm$^{w}/_{w}$)	0.01 μm 99.9999%		● When dry air is required ● Freon-free air dryer, power supply not required ● Dry clean air
Final filter series	Step **6**	Drain filter **DF** series Filter **F, FN** series Mist filter **MF** series Micro mist filter **MMF** series Membrane air dryer **KRM** series In-line filter **PLF** series		Dew point −26〜−10°C	0.1mg/m³ (0.08ppm$^{w}/_{w}$)	0.01 μm 99.9%	Precision filtration of blow, charge, and vacuum lines	● Small straight-type porous hollow fiber membrane component, easily handled at end line (no module connection) ● For blow air lines ● For IC chip manufacturing equipment, vacuum breaking air
	Step **7**	Clean line filter **CLF050**				0.01 μm 100%		● SUS body and PTFE (membrane + non-woven cloth) dual-layer general gas filter (no module connection) ● For precision filters on various types of general gas and vacuum lines used in semiconductor industry and liquid crystal manufacturing equipment

Note :Drain filters, cool separators, and filters shown in Steps 1 and 2 cannot remove oil.

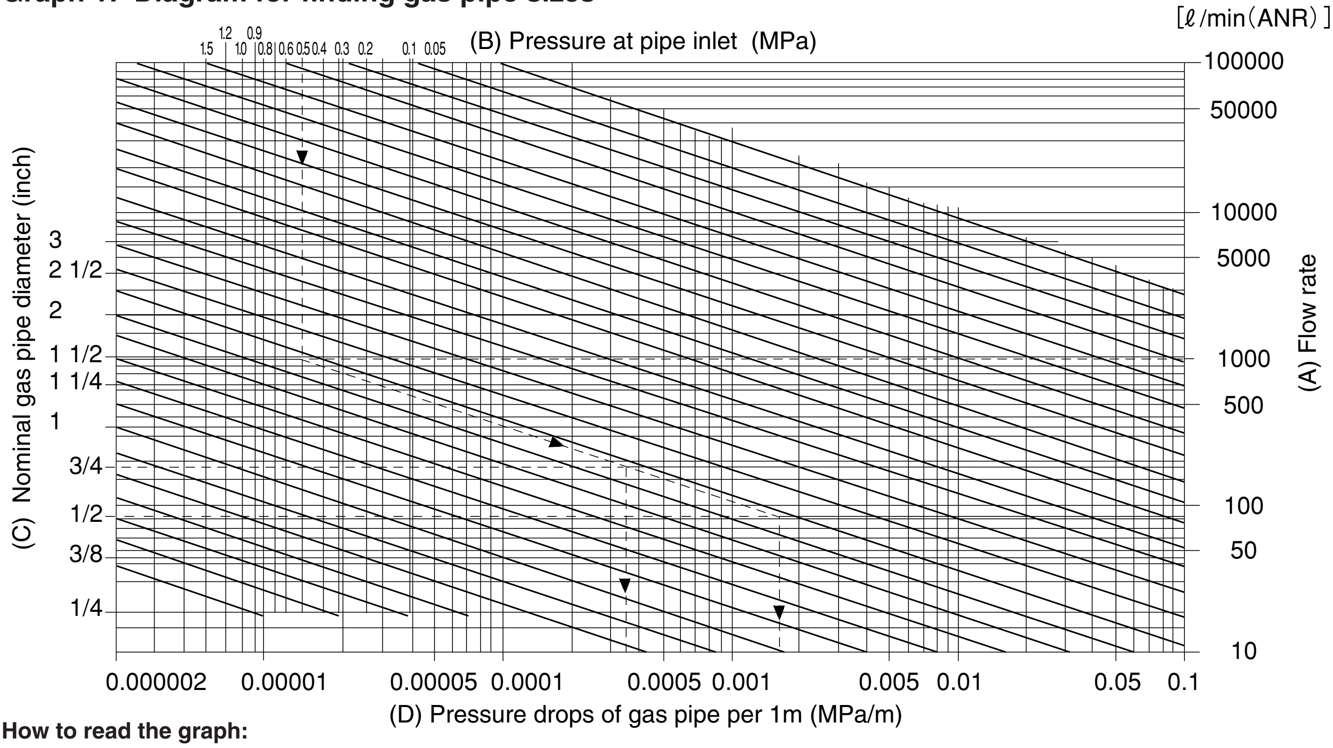
Caution: At humidity 100%, the chilled air inside the piping generates liquid.

2. Piping Size and Flow Rate

Using a Flow Chart to Find Pressure Drops in Pipe Line

When pressure, flow rate and piping size are decided, a pressure drop per approximately 1m can be easily determined by using a flow chart as shown in Graph 1. When using elbow or tee or similar fittings, the flow chart can be used to determine the pressure drop by converting the fittings to a directly corresponding pipe length, which is similar to the method used for determining the effective area of the fittings.

Graph 1: Diagram for finding gas pipe sizes



How to read the graph:

Example: What is the approximate pressure drop in a gas pipe measuring 1/2″ in diameter and 10m in length, when the air pressure is 0.5MPa and the flow rate is 1000 ℓ /min (ANR).

Answer: Following the diagram, find the point where the line at 0.5MPa on pressure scale (B) and the line indicating 1000 ℓ /min (ANR) on the flow rate scale (A) meet. Then, following along the diagonal line to find the point where the line from 1/2″ on the pipe diameter scale (C) meets the diagonal line. Then, go downward from the point to find the pressure drop point on the scale (D). It will show a reading of 0.0016MPa/m pressure drop for pipes approximately 1m long. Therefore, in the case of a pipe 10m long, the pressure drop will be 0.0016×10=0.016MPa. To make pressure drops smaller, pick a gas pipe with a larger diameter. For example, a pipe with a 3/4″ diameter will have the value 3.4×10^{-4} MPa/m.

Chart showing recommended maximum flow rate for gas pipes

Nominal dimensions	1/8 B	1/4 B	3/8 B	1/2 B	3/4 B	1 B	1 1/4 B	1 1/2 B
Pressure drop [MPa/10m]	0.125	0.073	0.059	0.044	0.029	0.021	0.014	0.011
Inlet pressure [MPa]	Maximum flow rate [ℓ /min (ANR)]							
0.05	127	244	518	838	1465	2460	3870	5150
0.10	146	283	598	965	1690	2828	4460	5950
0.15	163	314	668	1076	1885	3150	4960	6630
0.20	179	344	730	1180	2060	3450	5430	7280
0.30	206	395	840	1360	2375	3900	6300	8400
0.40	230	442	940	1520	2660	4450	7000	9360
0.50	252	485	1030	1660	2920	4875	7700	10250
0.60	272	523	1110	1800	3140	5250	8300	11050
0.70	292	558	1185	1920	3350	5620	8870	11800
0.80	308	592	1260	2035	3560	5970	9430	12570
0.90	324	623	1325	2140	3745	6290	9900	13220
1.00	340	654	1395	2250	3930	6600	10400	13880
1.20	370	717	1510	2450	4280	7150	11250	15040
1.40	398	763	1625	2624	4590	7700	12100	16200
1.50	410	790	1680	2710	4740	7930	12550	16780

1MPa = 145psi.   1 ℓ /min = 0.0353ft^3/min   1m = 3.28ft

Pipe designations and dimensions

Designation		Outer diameter mm	Inner diameter mm
6A	**1/8B**	10.5	6.5
8A	**1/4B**	13.8	9.2
10A	**3/8B**	17.3	12.7
15A	**1/2B**	21.7	16.1
20A	**3/4B**	27.2	21.6
25A	**1B**	34.0	27.6
32A	**1 1/4B**	42.7	35.7
40A	**1 1/2B**	48.6	41.6
50A	**2B**	60.5	52.9
65A	**2 1/2B**	76.3	67.9
80A	**3B**	89.1	80.7
90A	**3 1/2B**	101.6	93.2
100A	**4B**	114.3	105.3
125A	**5B**	139.8	130.8
150A	**6B**	165.2	155.2
175A	**7B**	190.7	180.1
200A	**8B**	216.3	204.7
225A	**9B**	241.8	229.4
250A	**10B**	267.4	254.2
300A	**12B**	318.5	304.7
350A	**14B**	355.6	339.8
400A	**16B**	406.4	390.6
450A	**18B**	457.2	441.4
500A	**20B**	508.0	492.2

- There are two ways to designate sizes of steel pipes.
- The “A” and the “B” marks can be deleted and the abbreviated terms are then used in writing and in speech.
- The “B” mark is quite often eliminated for abbreviation. In such cases, 1/4B pipe would be referred to as “1/4” pipe.

3. Explanation of Conversion of the International System of Units (SI units)

This Catalog uses SI units for specifications and other data. The following figures are used when converting from old unit measurements.

Pressure	1MPa	＝10.1972kgf/cm^2	＝145psi.
Force, load	1N	＝0.101972kgf	＝0.2248lbf.
Torque, moment	1N・m	＝0.101972kgf・m	＝0.7376ft・lbf
Vacuum pressure	－1kPa	＝－7.5006mmHg	＝－0.145psi.
Acceleration	1m/s^2	＝0.101972G	＝3.281ft./sec.^{2}

Unit Conversion Table

1. Pressure

1-1）MPa→kgf/cm^2 (1MPa＝10.1972kgf/cm^2) 〔Unit: kgf/cm^2〕

MPa	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.00	1.02	2.04	3.06	4.08	5.10	6.12	7.14	8.16	9.18
1	10.20	11.22	12.24	13.26	14.28	15.30	16.32	17.34	18.35	19.37
2	20.39	21.41	22.43	23.45	24.47	25.49	26.51	27.53	28.55	29.57

Example: For 1.5MPa, the intersection of row 1 and the 0.5 column indicates 15.30kgf/cm^2.

1-2) kgf/cm^2→MPa (1kgf/cm^2＝0.0980665MPa) 〔Unit: MPa〕

kgf/cm^2	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.0000	0.0098	0.0196	0.0294	0.0392	0.0490	0.0588	0.0686	0.0785	0.0883
1	0.0981	0.1079	0.1177	0.1275	0.1373	0.1471	0.1569	0.1667	0.1765	0.1863
2	0.1961	0.2059	0.2157	0.2256	0.2354	0.2452	0.2550	0.2648	0.2746	0.2844
3	0.2942	0.3040	0.3138	0.3236	0.3334	0.3432	0.3530	0.3628	0.3727	0.3825
4	0.3923	0.4021	0.4119	0.4217	0.4315	0.4413	0.4511	0.4609	0.4707	0.4805
5	0.4903	0.5001	0.5099	0.5198	0.5296	0.5394	0.5492	0.5590	0.5688	0.5786
6	0.5884	0.5982	0.6080	0.6178	0.6276	0.6374	0.6472	0.6570	0.6669	0.6767
7	0.6865	0.6963	0.7061	0.7159	0.7257	0.7355	0.7453	0.7551	0.7649	0.7747
8	0.7845	0.7943	0.8041	0.8140	0.8238	0.8336	0.8434	0.8532	0.8630	0.8728
9	0.8826	0.8924	0.9022	0.9120	0.9218	0.9316	0.9414	0.9512	0.9611	0.9709

Example: For 5.5kgf/cm^2, the intersection of row 5 and the 0.5 column indicates 0.5394MPa.

2. Force

2-1)N→kgf (1N＝0.101972kgf) 〔Unit: kgf〕

N	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.000	0.010	0.020	0.031	0.041	0.051	0.061	0.071	0.082	0.092
1	0.102	0.112	0.122	0.133	0.143	0.153	0.163	0.173	0.184	0.194
2	0.204	0.214	0.224	0.235	0.245	0.255	0.265	0.275	0.286	0.296
3	0.306	0.316	0.326	0.337	0.347	0.357	0.367	0.377	0.387	0.398
4	0.408	0.418	0.428	0.438	0.449	0.459	0.469	0.479	0.489	0.500
5	0.510	0.520	0.530	0.540	0.551	0.561	0.571	0.581	0.591	0.602
6	0.612	0.622	0.632	0.642	0.653	0.663	0.673	0.683	0.693	0.704
7	0.714	0.724	0.734	0.744	0.755	0.765	0.775	0.785	0.795	0.806
8	0.816	0.826	0.836	0.846	0.857	0.867	0.877	0.887	0.897	0.908
9	0.918	0.928	0.938	0.948	0.959	0.969	0.979	0.989	0.999	1.010

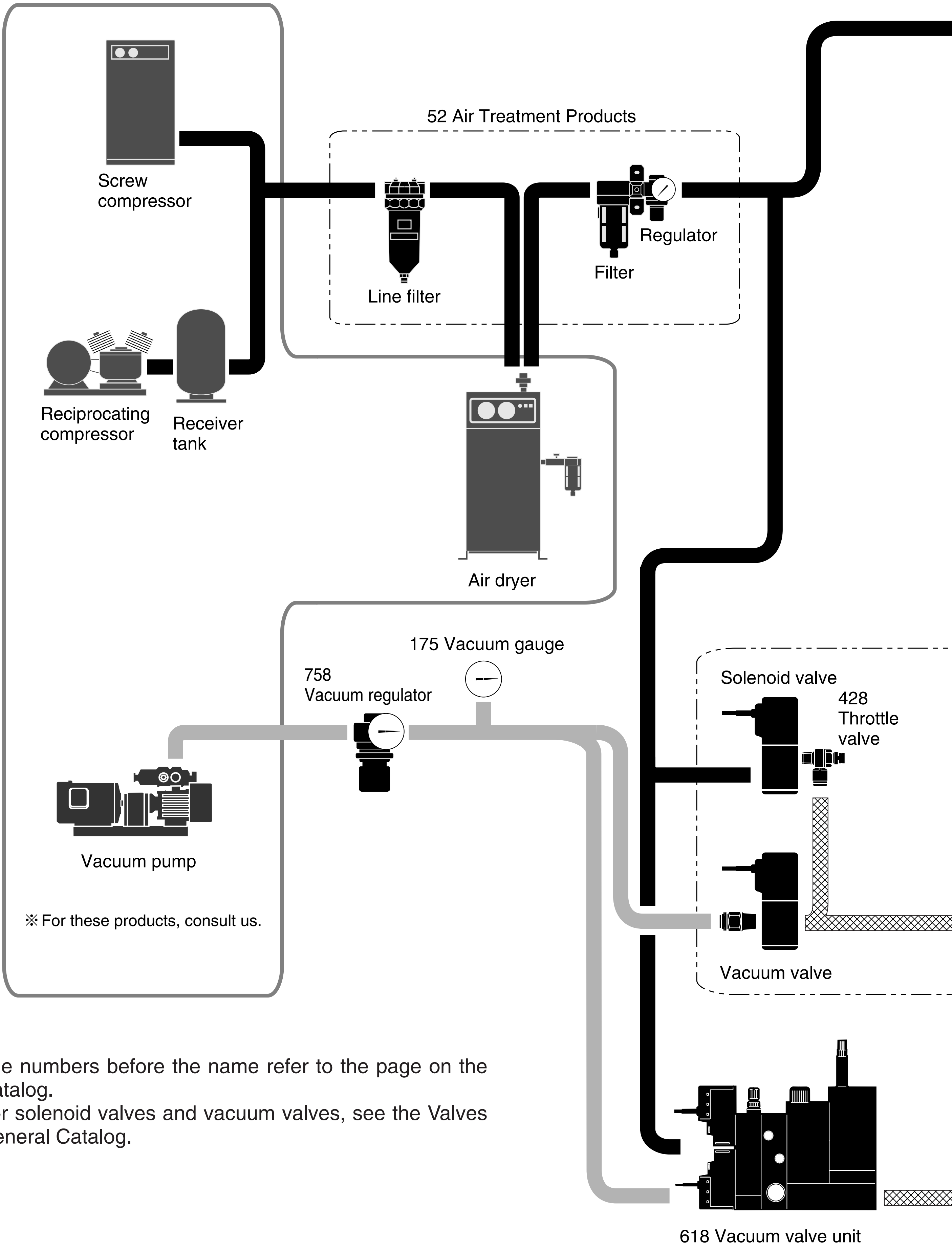
Example: For 4.5N, the intersection of row 4 and the 0.5 column indicates 0.459kgf.

2-2)kgf→N(1kgf＝9.80665N) 〔Unit: N〕

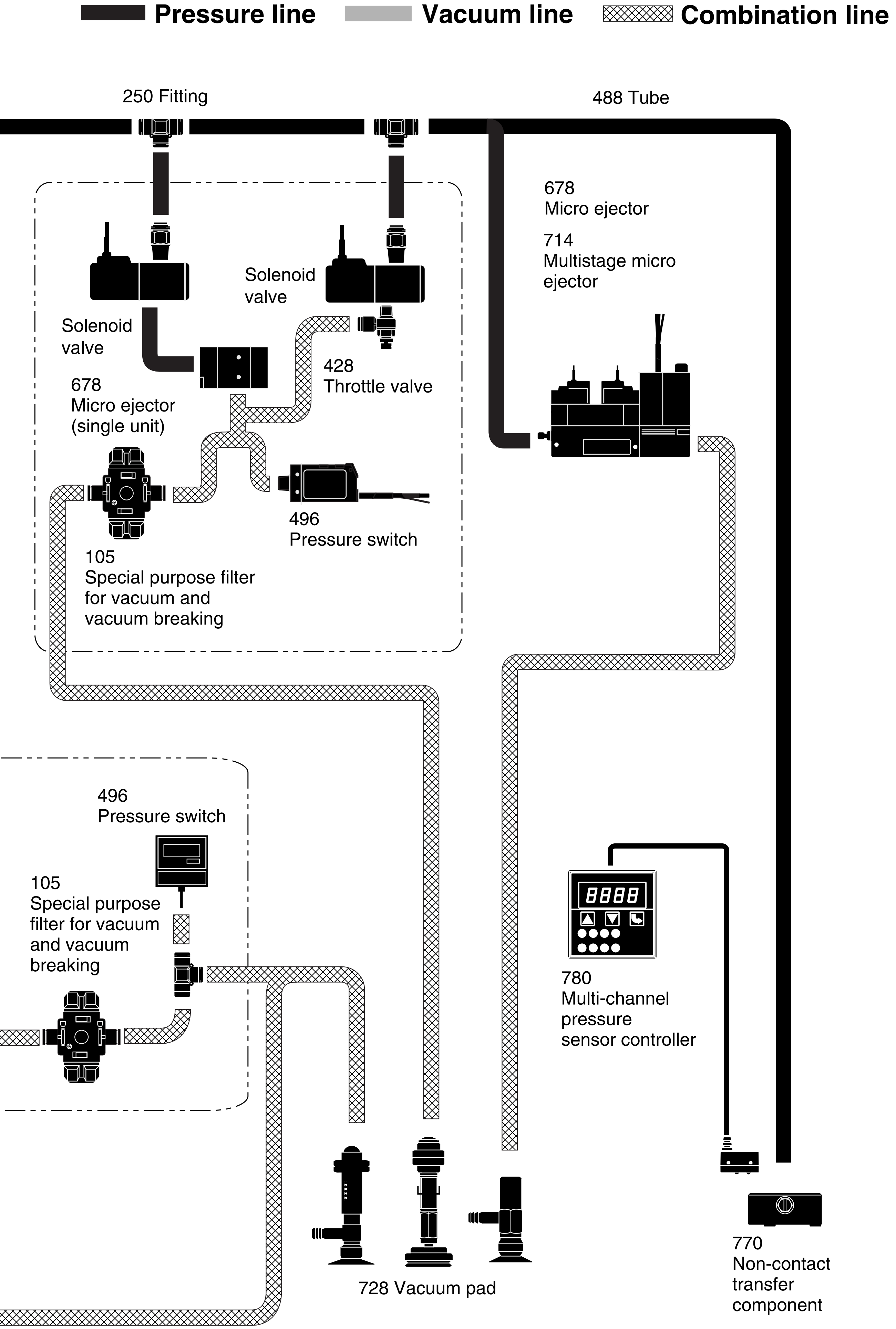
kgf	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.000	0.981	1.961	2.942	3.923	4.903	5.884	6.865	7.845	8.826
1	9.807	10.787	11.768	12.749	13.729	14.710	15.691	16.671	17.652	18.633
2	19.613	20.594	21.575	22.555	23.536	24.517	25.497	26.478	27.459	28.439
3	29.420	30.401	31.381	32.362	33.343	34.323	35.304	36.285	37.265	38.246
4	39.227	40.207	41.188	42.169	43.149	44.130	45.111	46.091	47.072	48.053
5	49.033	50.014	50.995	51.975	52.956	53.937	54.917	55.898	56.879	57.859
6	58.840	59.821	60.801	61.782	62.763	63.743	64.724	65.705	66.685	67.666
7	68.647	69.627	70.608	71.589	72.569	73.550	74.531	75.511	76.492	77.473
8	78.543	79.434	80.415	81.395	82.376	83.357	84.337	85.318	86.299	87.279
9	88.260	89.241	90.221	91.202	92.183	93.163	94.144	95.125	96.105	97.086

Example: For 1.5kgf, the intersection of row 1 and the 0.5 column indicates 14.710N.

Vacuum Products

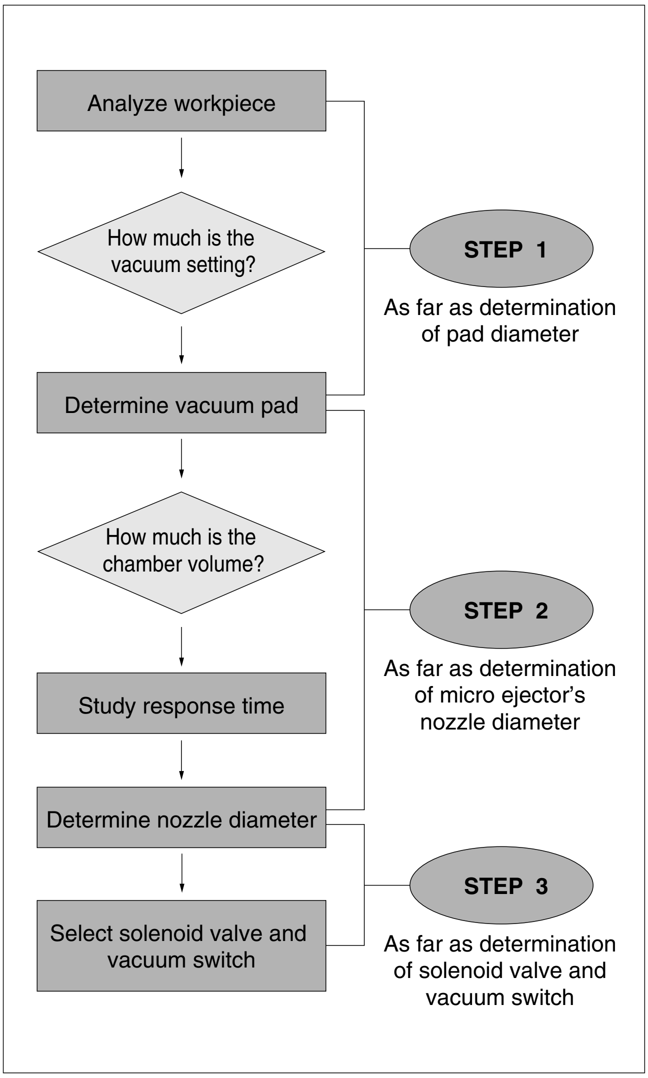


- The numbers before the name refer to the page on the Catalog.
  For solenoid valves and vacuum valves, see the Valves General Catalog.

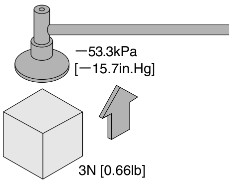

▬ Pressure line
▬ Vacuum line
▨ Combination line
250 Fitting
488 Tube
678
Micro ejector
714
Multistage micro
ejector
Solenoid
valve
Solenoid
valve
428
Throttle valve
678
Micro ejector
(single unit)
496
Pressure switch
105
Special purpose filter
for vacuum and
vacuum breaking
496
Pressure switch
105
Special purpose
filter for vacuum
and vacuum
breaking
8888
780
Multi-channel
pressure
sensor controller
728 Vacuum pad
770
Non-contact
transfer
component

Configuration and Selection of Vacuum Products (Micro Ejectors and Vacuum Pads)

When using Koganei micro ejectors and vacuum pads, etc., to configure vacuum systems, use the following sequence to analyze and study the operations and workpieces.
For the selection method, see the explanations at each step.



[Example]
Perform horizontal lifting transfer of a 300g workpiece by a standard type fixed pad. Calculate the pad diameter assuming no leaks from the pad contact surface and vacuum setting of −53.3kPa [−15.7in.Hg].



$$3=-53.3\times A\times 0.1\times \frac{1}{2}$$

$$A=1.125\text{cm}^2$$

$$\text{Pad diameter}=\sqrt{1.125\times\frac{4}{\pi}}\fallingdotseq 1.19\text{cm}$$

→ Based on the above, use a pad diameter of standard size ϕ 15 or more.

$$\left[\begin{array}{l}0.66=\frac{15.7}{29.9}\times A\times 14.7\times\frac{1}{2}\\ A=0.1710\text{in}^2\\ \text{Pad diameter}=\sqrt{0.1710\times\frac{4}{\pi}}\fallingdotseq 0.467\text{in.}\end{array}\right]$$

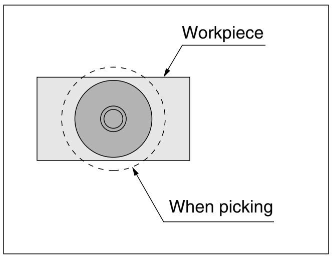
STEP 1 As far as determination of pad diameter

Use the following sequence and method to determine the vacuum pad diameter to be used.

1. Determine the mass of the workpiece.
2. Study the contact area of the workpiece.

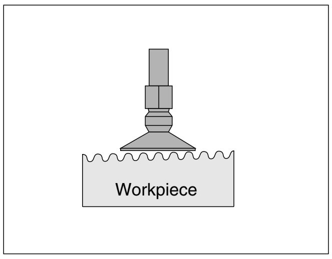
(1) How much of the pad diameter can be used?

When picking up the workpiece, the pad diameter spreads out about 10%, as shown in the figure. If the pad spreads beyond the edge of the workpiece contact area, air leaks could occur.



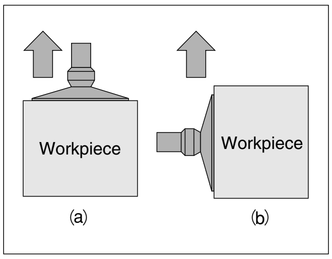
(2) Could a rough surface cause air leakages?

When it appears that leakages from the pad contact surface may occur, be sure to set the vacuum flow rate at a higher level.



3. Study the workpiece transfer direction and the pad mounting direction.

In general, the picking up direction includes horizontal lifting (a), with the workpiece picked up horizontally, and vertical lifting (b), with it picked up vertically.



To ensure safety margins in the lifting force calculations, consider the following multiples when setting the values.

Horizontal lifting······ Standard type: two times or more
Swivel type, or Non-rotating type: four times or more
Vertical lifting·········· Standard type: four times or more
Swivel type, or Non-rotating type: eight times or more

(Vacuum pads with built-in springs require even larger safety margins than the values noted above.)

4. Calculation of lifting force.

The lifting force W is calculated using the following formula.

$$\boxed{W = P \times A \times 0.1 \times \frac{1}{S}}$$

W: Lifting force (N)
P: Vacuum (−kPa)
A: Pad area (cm^2)
S: Safety margin

$$\boxed{W' = \frac{P'}{29.9} \times A \times 14.7 \times \frac{1}{S}}$$

W': Lifting force [lbf]
P': Vacuum [−in.Hg]
A: Pad area [in^2]
S: Safety margin

Remark: For the theoretical lifting force of Koganei vacuum pads, by size, see the table on p.731.

STEP 2

As far as determination of micro ejector's nozzle diameter

Based on the response time to the chamber volume, which is listed in the specifications of all micro ejector models, find the nozzle diameter (micro ejector type) to be used. The method to be used is as follows.
Response time is the general term consisting of the vacuum reaching time, from the time of contact by the pad with the workpiece until the setting of vacuum level is reached, and the vacuum breaking time, from the time of vacuum breaking until the pad releases the workpiece. Response time is the key to the efficiency of automated systems that are based on vacuum for repetitive lift and release of workpiece.

1. Calculate the piping volume.

◆ Calculate the volume of the piping between the vacuum generation port and the vacuum pad. Since a larger piping volume lengthens the response time, shortening the response time requires piping that is as short and straight as possible.

2. Based on the desired response time, and the piping volume, select the nozzle diameter.

Using the method for calculating the micro ejector response time (p.692), and the micro ejector response time tables (p.702, 712, 720, and 726), study the micro ejector response times by model type and by chamber volume, and then select the micro ejector with the nozzle diameter (type) that fits the required response time.

Example: $\phi 8 \times \phi 6$ (O.D×I.D) tube with length of 70cm, select for a desired response time of 0.3 s.

Piping volume: $\phi 6 \times 70cm = 19.8cm^3 \fallingdotseq 20cm^3$
From the response time table: Select **ME07**.

Note: The response time table lists data only for air pressure of 0.5MPa [73psi.] and vacuum level setting of − 73.3kPa [−21.6in.Hg].
For air pressure, while the response time shows little change for values exceeding the above level, it tends to become delayed at pressures below 0.5MPa [73psi.]. In such cases, use the values in the table as a general guideline.

STEP 3

As far as determination of solenoid valve and vacuum switch

Use the micro ejector selection procedure in STEP 2 to specify the type with solenoid valve or with vacuum switch, or to specify otherwise suitable solenoid valve and vacuum switch.

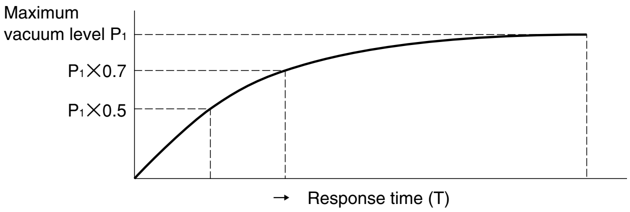
Precautions for Vacuum System Configurations

One pad, one ejector

If a multiple number of vacuum pads are connected to a single micro ejector, then if a leak occurs at even one pad, causing it to lose lifting of the workpieces, the vacuum level will drop for all of the other vacuum pads connected to that micro ejector, as well, and all lifting capacity would be lost. To avoid this kind of problem, always use a configuration of one vacuum pad for one micro ejector.

Selection of an 80% vacuum level for higher operating efficiency

The response time becomes longer when the vacuum level setting is higher than it needs to be for lifting a workpiece. We recommend a vacuum level setting that is at about 70～80% of the attainable degree of vacuum derived from the micro ejector's air pressure setting.



Use specified tubes for piping in the vacuum generation port side

Use of small tubes at the vacuum generation port, with piping that goes through many curves, can result in piping resistance that requires a higher vacuum level between the micro ejector and the vacuum pad, causing the vacuum switch to detect the set vacuum level and activate before the vacuum in the vacuum pad reaches the set vacuum level. Be sure to use the predetermined specified tubes for piping at the vacuum generation port.
If use of a large-volume micro ejector with high-resistance piping is unavoidable, separately install the vacuum switch so that it is as close to the vacuum pad as possible.

Use stable pressure to supply compressed air

Always use a regulator to adjust the pressure for compressed air supplied to the micro ejector.
In addition, if piping connecting the air supply to the micro ejector extends too far, or if the tube diameter is too small, increase the setting for the regulator pressure.

Use a filter in the vacuum line

If using a micro ejector without filter type in a vacuum line, separately install a filter partway along the piping.
For micro ejectors (**ME03/05/07, MED07/10**) where their built-in filters can be replaced, replace the filters at regular intervals.
[Replacement filter: **ME☐MA-F, MED-F]**

For preservation of a clean, quiet environment

●Multistage ejector: Make use of **-02** port exhaust specification.
Connect a tube to the exhaust port (Rc1/4), and direct the exhaust to a different location.(Mountable up to **TS10-02** fitting.) Use tubes with inner diameter of at least $\phi 6$ [0.236in.], to reduce exhaust resistance as low as possible.

Lifting workpieces containing moisture

The **MED** series micro ejector has a vacuum switch next to the exhaust port that may malfunction if moisture is emitted from the exhaust port. Always direct moisture containing exhaust to a different location.