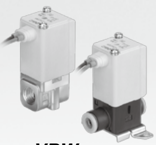
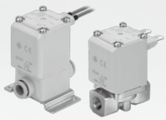
Process Valves
Model Selection 1

For product specifications such as maximum operating pressure differentials and operating temperature ranges, refer to the relevent pages of each product.

Air

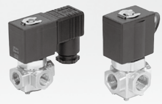
Fluid	Action	Series	Remarks	Applicable port size				
				One-touch fittings	—	6	8	
					M5	1/8	1/4	
Air	Direct operated	**VDW**		ø3.2, ø4, ø6	●	●	●	
		VX2		ø6, ø8, ø10, ø12		●	●	
		VXK2				●	●	
		VXE	Only low wattage, DC type			●	●	
		VX3				●	●	
	Pilot operated	**VXD**		ø10, ø3/8", ø12			●	
		VXZ	Zero pressure differential operation	ø10, ø3/8", ø12			●	
		VXP					●	
		VQ20/30	For dry air	ø6, ø8, ø10, ø12				
	External pilot piston	**VNA**				●	●	
		VNB				●	●	


***VDW* Series**


***VX2* Series**

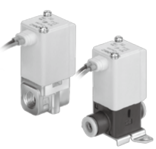

***VXK2* Series**

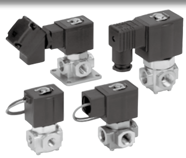

***VXE* Series**


***VX3* Series**

Vacuum

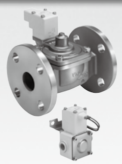
Fluid		Action	Series	Remarks				
					—	6	8	
					M5	1/8	1/4	
Vacuum	**Low vacuum**	Direct operated	**VDW**		●	●	●	
			VX2			●	●	
			VXK2			●	●	
			VX3/VXV3			●	●	
		External pilot piston	**VNB**			●	●	
	Medium vacuum	Direct operated	**VDW**		●	●		
			VX2			●	●	
			VX3	Option: V, M		●	●	
	High vacuum	External pilot piston	**XL**					
			XM/XY					
			XVD	Flow rate adjustment				

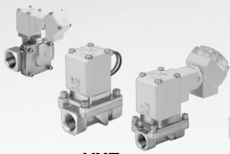

***VDW* Series**

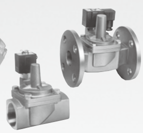

***VXV3* Series**

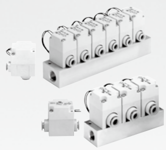
Model Selection

Applicable port size										Page
Thread type fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)							Flange fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)			
10	15	20	25	32	40	50	32	40	50	
3/8	1/2	3/4	1	1 1/4	1 1/2	2	1 1/4	1 1/2	2	
										P.453
●	●									P.27
●										P.81
●	●									P.257
●	●									P.377
●	●	●	●				●	●	●	P.113
●	●	●	●							P.171
●	●	●	●	●	●	●	●	●	●	P.311
										P.513
●	●	●	●	●	●	●				P.559
●	●	●	●	●	●	●	●	●	●	P.567

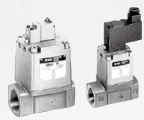

VXD **Series**


VXZ **Series**


VXP **Series**


VQ20/30 **Series**


VNA **Series**


VNB **Series**

Applicable port size										Page
Thread type fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)							Flange fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)			
10	15	20	25	32	40	50	32	40	50	
3/8	1/2	3/4	1	1 1/4	1 1/2	2	1 1/4	1 1/2	2	
										P.453
●	●									P.27
●										P.81
●										P.377
●	●	●	●	●	●	●	●	●	●	P.567
										P.453
●	●									P.27
●										P.377
Vacuum KF: 16, 25, 40, 50, 63, 80, 100, 160; K63, 80, 100, 160										Best Pneumatics No. 10
Vacuum KF: 16, 25, 40, 50, 63, 80; K63, 80										
For VCR 1/4; For swage lock: 1/4										


XL **Series**


XM/XY **Series**


XVD **Series**

VX2
VXK
VXD
VXZ
VXS
VXB
VXE
VXP
VXR
VXH
VXF
VX3
VXA

Process Valves
Model Selection 2

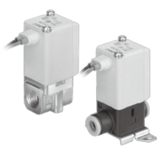
For product specifications such as maximum operating pressure differentials and operating temperature ranges, refer to the relevent pages of each product.

Water

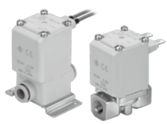
Fluid	Action	Series	Remarks	Applicable port size			
				One-touch fittings	—	6	8
					M5	1/8	1/4
Water	Direct operated	**VDW**		ø3.2, ø4, ø6	●	●	●
		VX2				●	●
		VXK2				●	●
		VXE	Only low wattage, DC type			●	●
		VX3				●	●
	Pilot operated	**VXD**					●
		VXZ	Zero pressure differential operation				●
		VXP					●
		VXR	Water hammer relief				
		VXH	Only AC type, 2 MPa or less				●
	External pilot piston	**VNB**				●	●

Heated water

Fluid	Action	Series	Remarks			
				—	6	8
				M5	1/8	1/4
Heated water	Direct operated	**VX2**			●	●
		VXK2			●	●
		VX3	Option: E, P		●	●
	Pilot operated	**VXD**				●
		VXZ	Zero pressure differential operation, Option			●
		VXP	Option: E, P			●
		VXR	Water hammer relief, Option: D			
	External pilot piston	**VNB**			●	●



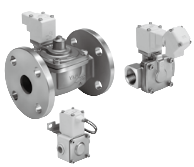
***VDW** Series*



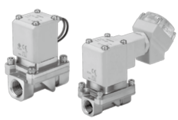
***VX2** Series*

***VXK2** Series*

***VXE** Series*



***VXD** Series*



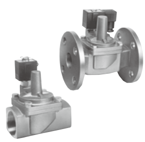
***VXZ** Series*

Model Selection

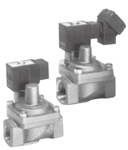
	Applicable port size										Page
	Thread type fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)							Flange fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)			
	10	15	20	25	32	40	50	32	40	50	
	3/8	1/2	3/4	1	1 1/4	1 1/2	2	1 1/4	1 1/2	2	
											P.453
	●	●									P.27
	●										P.81
	●	●									P.257
	●										P.377
	●	●	●	●				●	●	●	P.113
	●	●	●	●							P.171
	●	●	●	●	●	●	●	●	●	●	P.311
	●	●	●	●	●	●	●				P.323
	●	●									P.333
	●	●	●	●	●	●	●	●	●	●	P.567

	Applicable port size										Page
	Thread type fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)							Flange fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)			
	10	15	20	25	32	40	50	32	40	50	
	3/8	1/2	3/4	1	1 1/4	1 1/2	2	1 1/4	1 1/2	2	
	●	●									P.27
	●										P.81
	●										P.377
	●	●	●	●				●	●	●	P.113
	●	●	●	●							P.171
	●	●	●	●	●	●	●	●	●	●	P.311
		●	●	●	●	●	●				P.323
	●	●	●	●	●	●	●	●	●	●	P.567

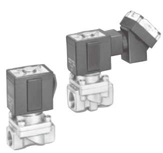
VX3 **Series**



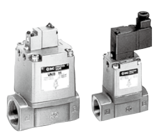
VXP **Series**



VXR **Series**



VXH **Series**



VNB **Series**

Process Valves
Model Selection 3

For product specifications such as maximum operating pressure differentials and operating temperature ranges, refer to the relevent pages of each product.

Oil

Fluid	Action	Series	Remarks	— M5	6 1/8	8 1/4
Oil	Direct operated	**VX2**			●	●
		VXK2			●	●
		VXE	Only low wattage, DC type, Option: A, H		●	●
		VX3	Option: A, D, H, N		●	●
	Pilot operated	**VXH**	Only AC type, 1.5 MPa or less			●
		VXD				●
		VXZ	Zero pressure differential operation			●
		VXP	Option: A, D, H, N			●
		VXR	Water hammer relief, Option: A, D			
	External pilot piston	**VNA**			●	●
		VNB			●	●

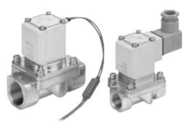
Steam

Fluid	Action	Series	Remarks	— M5	6 1/8	8 1/4
Steam	Direct operated	**VX2**			●	●
		VXK2			●	●
		VX3	Option: S, Q		●	●
		VXS				●
	External pilot piston	**VXB**				
	Pilot operated	**VXP**	Option: S			●
	External pilot piston	**VND**				●

***VX2* Series**

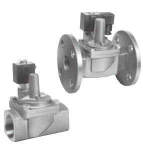
***VXK2* Series**

***VXE* Series**

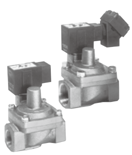


***VXS* Series**

***VXB* Series**



***VXP* Series**



***VXR* Series**

***VNA* Series**

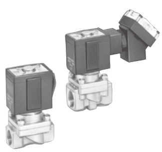
Model Selection

VX2
VXK
VXD
VXZ
VXS
VXB
VXE
VXP
VXR
VXH
VXF
VX3
VXA

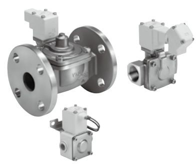
Applicable port size										Page
Thread type fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)							Flange fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)			
10	15	20	25	32	40	50	32	40	50	
3/8	1/2	3/4	1	1 1/4	1 1/2	2	1 1/4	1 1/2	2	
●	●									P.27
●										P.81
●	●									P.257
●										P.377
●	●									P.333
●	●	●	●				●	●	●	P.113
●	●	●	●							P.171
●	●	●	●	●	●	●	●	●	●	P.311
●	●	●	●	●	●	●				P.323
●	●	●	●	●	●	●				P.559
●	●	●	●	●	●	●	●	●	●	P.567

Applicable port size										Page
Thread type fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)							Flange fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)			
10	15	20	25	32	40	50	32	40	50	
3/8	1/2	3/4	1	1 1/4	1 1/2	2	1 1/4	1 1/2	2	
●	●									P.27
●										P.81
●										P.377
●	●	●	●							P.215
●	●	●								P.239
●	●	●	●	●	●	●	●	●	●	P.311
●	●	●	●	●	●	●	●	●	●	P.633

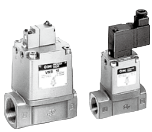
VX3 Series



VXH Series



VXD Series



VNB Series

VND Series

Process Valves
Model Selection 4

For product specifications such as maximum operating pressure differentials and operating temperature ranges, refer to the relevent pages of each product.

High pressure compressed air

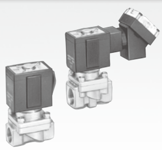
Fluid	Action	Series	Remarks	— M5	6 1/8	8 1/4	10 3/8
High pressure compressed air	Direct operated	**VXE**	Only low wattage, DC type, 3 MPa or less		●		
	Pilot operated	**VXH**	Only AC type, 2 MPa or less			●	●
		VCH40	Only G thread type, 5 MPa or less				
		VCH400					

∗ Only G thread type

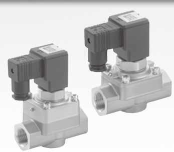
Coolant

Fluid	Action	Series	Remarks	— M5	6 1/8	8 1/4	10 3/8
Coolant	External pilot piston	**SGC**					●
		SGH					●
		VNC			●	●	●
		VNH					●

***VXE** Series*



***VXH** Series*



***VCH40** Series*

***VCH400** Series*

Chemical liquids, Pure water

Fluid	Action	Series	Remarks	— M5	6 1/8	8 1/4	10 3/8
Chemical liquids, Pure water	Pilot operated	**LV**	Female thread type, with fittings type available		●	●	●
	Direct operated	**LVM**	With fittings type, female thread type available	●*			

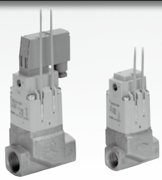
∗ Body ported: M5; Base mounted: M6

Dust collector

Fluid	Action	Series	Remarks	20 3/4	25 1	40 1 1/2	50 2
Dust collector	Pilot operated	**VXF2**	Dedicated for dust collector	●	●	●	●

Applicable port size									Page
Thread type fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)						Flange fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)			
15	20	25	32	40	50	32	40	50	
1/2	3/4	1	1 1/4	1 1/2	2	1 1/4	1 1/2	2	
									P.257
●									P.333
	●*	●*							P.431
●*	●*	●*							P.436

Applicable port size											Page
Thread type fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)						Flange fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)					
15	20	25	32	40	50	32	40	50	65	80	
1/2	3/4	1	1 1/4	1 1/2	2	1 1/4	1 1/2	2	2 1/2	3	
●	●	●	●	●	●						P.575
●	●	●									P.597
●	●	●	●	●	●	●	●	●	●	●	P.617
●	●	●									P.627



***SGC* Series**

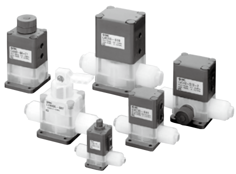
***SGH* Series**

***VNC* Series**

***VNH* Series**

Applicable port size									Page
Thread type fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)						Flange fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)			
15	20	25	32	40	50	32	40	50	
1/2	3/4	1	1 1/4	1 1/2	2	1 1/4	1 1/2	2	
●	●	●							P.683
									P.527

Applicable port size				Page
Thread type fitting (Nominal dia. A/Upper, Nominal dia. B/Lower)				
65	80	90	100	
2 1/2	3	3 1/2	4	
●	●	●	●	P.335



***LV* Series**

***LVM* Series**

***VXF2* Series**

VX2
VXK
VXD
VXZ
VXS
VXB
VXE
VXP
VXR
VXH
VXF
VX3
VXA

Solenoid Valve Flow Rate Characteristics
(How to indicate flow rate characteristics)

1. Indication of flow rate characteristics

The flow rate characteristics in equipment such as a solenoid valve, etc. are indicated in their specifications as shown in Table (1).

Table (1) Indication of Flow Rate Characteristics

Corresponding equipment	Indication by international standard	Other indications	Conformed standard
Pneumatic equipment	*C*, *b*	—	ISO 6358: 1989 JIS B 8390: 2000
	—	*S*	JIS B 8390: 2000 Equipment: JIS B 8379, 8381-1, 8381-2
		Cv	ANSI/(NFPA)T3.21.3 R1-2008
Process fluid control equipment	*Kv*	—	IEC60534-1: 2005 IEC60534-2-3: 1997 JIS B 2005-1: 2012 JIS B 2005-2-3: 2004 Equipment: JIS B 8471, 8472, 8473
	—	*Cv*	

2. Pneumatic equipment

2.1 Indication according to the international standards

(1) Conformed standard

ISO 6358: 1989 : Pneumatic fluid power—Components using compressible fluids—Determination of flow rate characteristics

JIS B 8390: 2000 : Pneumatic fluid power—Components using compressible fluids—How to test flow rate characteristics

(2) Definition of flow rate characteristics

The flow rate characteristics are indicated as a result of a comparison between sonic conductance $\boldsymbol{C}$ and critical pressure ratio $\boldsymbol{b}$.

Sonic conductance $\boldsymbol{C}$: Value which divides the passing mass flow rate of an equipment in a choked flow condition by the product of the upstream absolute pressure and the density in a standard condition.

Critical pressure ratio $\boldsymbol{b}$: Pressure ratio (downstream pressure/upstream pressure) which will turn to a choked flow when the value is smaller than this ratio.

Choked flow : The flow in which the upstream pressure is higher than the downstream pressure and where sonic speed in a certain part of an equipment is reached.
Gaseous mass flow rate is in proportion to the upstream pressure and not dependent on the downstream pressure.

Subsonic flow : Flow greater than the critical pressure ratio

Standard condition : Air in a temperature state of 20°C, absolute pressure 0.1 MPa (= 100 kPa = 1 bar), relative humidity 65%.
It is stipulated by adding the "(ANR)" after the unit depicting air volume.
(standard reference atmosphere)
Conformed standard: ISO 8778: 1990 Pneumatic fluid power—Standard reference atmosphere, JIS B 8393: 2000: Pneumatic fluid power—Standard reference atmosphere

(3) Formula for flow rate

It is described by the practical units as following.

When

$$\frac{\boldsymbol{P_2} + 0.1}{\boldsymbol{P_1} + 0.1} \leq \boldsymbol{b}\text{, choked flow}$$

$$\boldsymbol{Q} = 600 \times \boldsymbol{C}\,(\boldsymbol{P_1} + 0.1)\sqrt{\frac{293}{273 + \boldsymbol{T}}} \quad \cdots\cdots (1)$$

When

$$\frac{\boldsymbol{P_2} + 0.1}{\boldsymbol{P_1} + 0.1} > \boldsymbol{b}\text{, subsonic flow}$$

$$\boldsymbol{Q} = 600 \times \boldsymbol{C}\,(\boldsymbol{P_1} + 0.1)\sqrt{1 - \left[\frac{\dfrac{\boldsymbol{P_2} + 0.1}{\boldsymbol{P_1} + 0.1} - \boldsymbol{b}}{1 - \boldsymbol{b}}\right]^2}\sqrt{\frac{293}{273 + \boldsymbol{T}}} \quad \cdots\cdots (2)$$

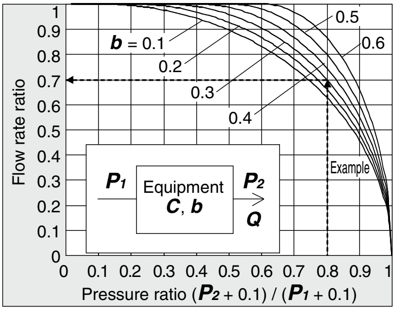
Q : Air flow rate [L/min (ANR)]
C : Sonic conductance [$dm^3/(s{\cdot}bar)$], dm^3 (Cubic decimeter) of SI = L (liter).
b : Critical pressure ratio [—]
P_1 : Upstream pressure [MPa]
P_2 : Downstream pressure [MPa]
T : Temperature [°C]
Note) Formula of subsonic flow is the elliptic analogous curve.
Flow rate characteristics are shown in Graph (1) For details, please use the calculation software available from SMC website.

Example)
Obtain the air flow rate for P_1 = 0.4 [MPa], P_2 = 0.3 [MPa], ***T*** = 20 [°C] when a solenoid valve is performed in ***C*** = 2 [$dm^3/(s{\cdot}bar)$] and ***b*** = 0.3.

According to formula 1, the maximum flow rate $= 600 \times 2 \times (0.4 + 0.1) \times \sqrt{\frac{293}{273 + 20}} = 600$ [L/min (ANR)]

$$\text{Pressure ratio} = \frac{0.3 + 0.1}{0.4 + 0.1} = 0.8$$

Based on Graph (1), it is going to be 0.7 if it is read by the pressure ratio as 0.8 and the flow ratio to be ***b*** = 0.3.
Hence, flow rate = Max. flow x flow ratio = 600 x 0.7 = 420 [L/min (ANR)]



Graph (1) Flow rate characteristics

(4) Test method
Attach a test equipment with the test circuit shown in Fig. (1) while maintaining the upstream pressure to a certain level which does not go below 0.3 MPa. Next, measure the maximum flow to be saturated in the first place, then measure this flow rate at 80%, 60%, 40%, 20% and the upstream and downstream pressure. And then, obtain the sonic conductance ***C*** from this maximum flow rate. In addition, calculate ***b*** using each data of others and the subsonic flow formula, and then obtain the critical pressure ratio ***b*** from that average.

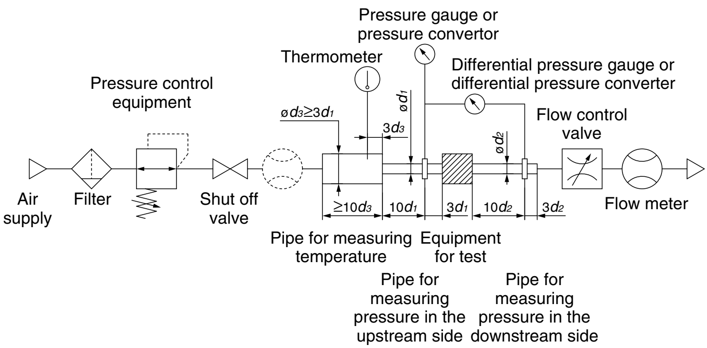


Fig. (1) Test circuit based on ISO 6358: 1989, JIS B 8390: 2000

Solenoid Valve Flow Rate Characteristics

2.2 Effective area *S*

(1) Conformed standard

JIS B 8390: 2000: Pneumatic fluid power—Components using compressible fluids—Determination of flow rate characteristics

Equipment standards: **JIS B 8373: Solenoid valve for pneumatics**
JIS B 8379: Silencer for pneumatics
JIS B 8381-1: Fittings for pneumatics—Part 1: Push-in fittings for thermoplastic resin tubing
JIS B 8381-2: Fittings for pneumatics—Part 2: Compression fittings for thermoplastic resin tubing

(2) Definition of flow rate characteristics

Effective area *S*: The cross-sectional area having an ideal throttle without friction deduced from the calculation of the pressure changes inside an air tank or without reduced flow when discharging the compressed air in a choked flow, from an equipment attached to the air tank. This is the same concept representing the "easy to run through" as sonic conductance *C*.

(3) Formula for flow rate

When

$\frac{P_2 + 0.1}{P_1 + 0.1}$ 0.5, **choked flow**

$$Q = 120 \times S\,(P_1 + 0.1)\sqrt{\frac{293}{273 + T}} \quad \cdots\cdots(3)$$

When

$\frac{P_2 + 0.1}{P_1 + 0.1} > 0.5$, **subsonic flow**

$$Q = 240 \times S\,\sqrt{(P_2 + 0.1)\,(P_1 - P_2)}\,\sqrt{\frac{293}{273 + T}} \quad \cdots\cdots(4)$$

Conversion with sonic conductance *C*:

$$S = 5.0 \times C \quad \cdots\cdots(5)$$

Q : Air flow rate[L/min(ANR)]
S : Effective area [mm^2]
P_1 : Upstream pressure [MPa]
P_2 : Downstream pressure [MPa]
T : Temperature [°C]

Note) Formula for subsonic flow (4) is only applicable when the critical pressure ratio b is the unknown equipment. In the formula (2) by the sonic conductance C, it is the same formula as when $b = 0.5$.

(4) Test method

Attach a test equipment with the test circuit shown in Fig. (2) in order to discharge air into the atmosphere until the pressure inside the air tank goes down to 0.25 MPa (0.2 MPa) from an air tank filled with the compressed air at a certain pressure level (0.5 MPa) which does not go below 0.6 MPa. At this time, measure the discharging time and the residual pressure inside the air tank which had been left until it turned to be the normal values to determine the effective area *S*, using the following formula. The volume of an air tank should be selected within the specified range by corresponding to the effective area of an equipment for test. In the case of JIS B 8379, the pressure values are in parentheses and the coefficient of the formula is 12.9.

$$S = 12.1\,\frac{V}{t}\,\log_{10}\left(\frac{P_s + 0.1}{P + 0.1}\right)\sqrt{\frac{293}{T}} \quad \cdots\cdots(6)$$

S : Effective area [mm^2]
V : Air tank capacity [L]
t : Discharging time [s]
P_s : Pressure inside air tank before discharging [MPa]
P : Residual pressure inside air tank after discharging [MPa]
T : Temperature inside air tank before discharging [K]

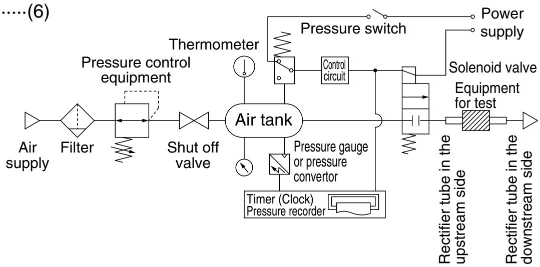


Fig. (2) Test circuit based on JIS B 8390: 2000

VX2
VXK
VXD
VXZ
VXS
VXB
VXE
VXP
VXR
VXH
VXF
VX3
VXA

2.3 Flow coefficient *Cv* factor

The United States Standard ANSI/(NFPA)T3.21.3: R1-2008R: Pneumatic fluid power—Flow rating test procedure and reporting method for fixed orifice components

This standard defines the ***Cv*** factor of the flow coefficient by the following formula that is based on the test conducted by the test circuit analogous to ISO 6358.

$$Cv = \frac{Q}{114.5\sqrt{\dfrac{\Delta P\,(P_2 + P_a)}{T_1}}} \quad \cdots\cdots (7)$$

ΔP : Pressure drop between the static pressure tapping ports [bar]
P_1 : Pressure of the upstream tapping port [bar gauge]
P_2 : Pressure of the downstream tapping port [bar gauge]: $P_2 = P_1 - \Delta P$
Q : Flow rate [L/s standard condition]
P_a : Atmospheric pressure [bar absolute]
T_1 : Upstream absolute temperature [K]

Test conditions are < $P_1 + P_a$ = 6.5 ± 0.2 bar absolute, T_1 = 297 ± 5K, 0.07 bar ≤ ΔP 0.14 bar.

This is the same concept as effective area ***A*** which ISO 6358 stipulates as being applicable only when the pressure drop is smaller than the upstream pressure and the compression of air does not become a problem.

3. Process fluid control equipment

(1) Conformed standard

IEC60534-1: 2005: Industrial-process control valves. Part 1: control valve terminology and general considerations
IEC60534-2-3: 1997: Industrial-process control valves. Part 2: Flow capacity, Section Three-Test procedures
JIS B 2005-1: 2012: Industrial-process control valves – Part 1: Control valve terminology and general considerations
JIS B 2005-2-3: 2004: Industrial-process control valves – Part 2: Flow capacity – Section 3: Test procedures
Equipment standards: JIS B 8471: Solenoid valve for water
JIS B 8472: Solenoid valve for steam
JIS B 8473: Solenoid valve for fuel oil

(2) Definition of flow rate characteristics

Kv factor: Value of the clean water flow rate represented by m³/h that runs through the valve (equipment for test) at 5 to 40°C, when the pressure difference is 1 x 105 Pa (1 bar). It is calculated using the following formula:

$$Kv = Q\sqrt{\frac{1 \times 10^5}{\Delta P} \cdot \frac{\rho}{1000}} \quad \cdots\cdots (8)$$

Kv : Flow coefficient [m³/h]
Q : Flow rate [m³/h]
ΔP : Pressure difference [Pa]
ρ : Density of fluid [kg/m³]

(3) Formula of flow rate

It is described by the practical units. Also, the flow rate characteristics are shown in Graph (2).

In the case of liquid:

$$Q = 53Kv\sqrt{\frac{\Delta P}{G}} \quad \cdots\cdots (9)$$

Q : Flow rate [L/min]
Kv : Flow coefficient [m³/h]
ΔP : Pressure difference [MPa]
G : Relative density [water = 1]

In the case of saturated aqueous vapor:

$$Q = 232Kv\sqrt{\Delta P(P_2 + 0.1)} \quad \cdots\cdots (10)$$

Q : Flow rate [kg/h]
Kv : Flow coefficient [m³/h]
ΔP : Pressure difference [MPa]
P_1 : Upstream pressure [MPa]: $\Delta P = P_1 - P_2$
P_2 : Downstream pressure [MPa]

Solenoid Valve Flow Rate Characteristics

Conversion of flow coefficient:

$Kv = 0.865\ Cv$ ....(11)

Here,

Cv factor: Value of the clean water flow rate represented by US gal/min that runs through the valve at 40 to 100°F, when the pressure difference is 1 lbf/in^2 (psi)

Value is different from Kv and Cv factors for pneumatic purpose due to different test method.

(4) Test method

Connect the equipment for the test to the test circuit shown in Fig. (3), and run water at 5 to 40°C. Then, measure the flow rate with a pressure difference where vaporization does not occur in a turbulent flow (pressure difference of 0.035 MPa to 0.075 MPa when the inlet pressure is within 0.15 MPa to 0.6 MPa). However, as the turbulent flow is definitely caused, the pressure difference needs to be set with a large enough difference so that the Reynolds number does not fall below 1 x 105, and the inlet pressure needs to be set slightly higher to prevent vaporization of the liquid. Substitute the measurement results in formula (8) to calculate Kv.

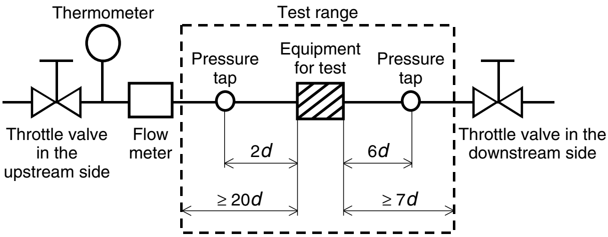
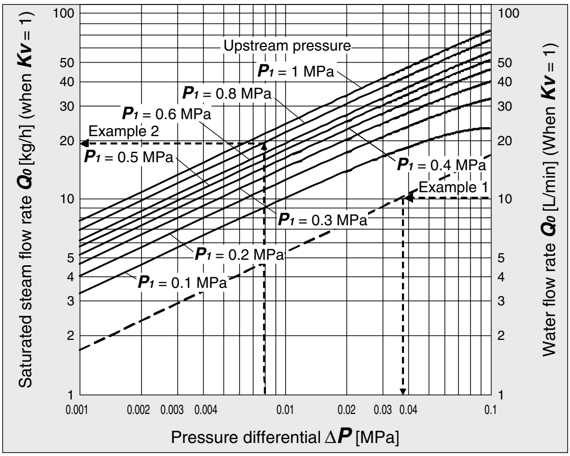


Fig. (3) Test circuit based on IEC60534-2-3, JIS B 2005-2-3



Graph (2) Flow rate characteristics

Example 1)

Obtain the pressure difference when water [15 L/min] runs through the solenoid valve with a Kv = 1.5 m^3/h.

As the flow rate when Kv = 1 is calculated as the formula: $Q_0 = 15 \times 1/1.5 = 10$ [L/min], read off ΔP when Q_0 is 10 [L/min] in Graph (2). The reading is 0.036 [MPa].

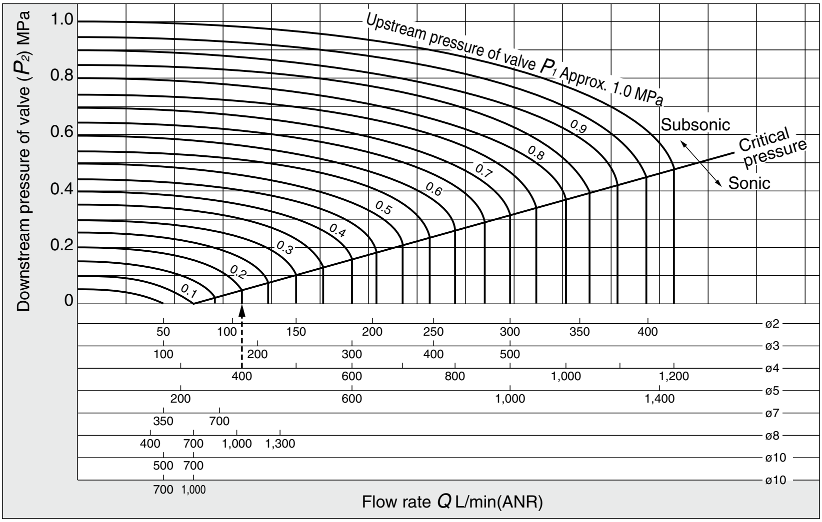
Example 2)

Obtain the saturated steam flow rate when P_1 = 0.8 [MPa] and ΔP = 0.008 [MPa] with a solenoid valve with a Kv = 0.05 [m^3/h]. Read off Q_0 when P_1 is 0.8 and ΔP is 0.008 in Graph (2), the reading is 20 kg/h. Therefore, the flow rate is calculated as the formula: $Q = 0.05/1 \times 20 = 1$ [kg/h].

Flow Rate Characteristics

Note) Use this graph as a guide. In the case of obtaining an accurate flow rate, refer to pages 10 through to 14.

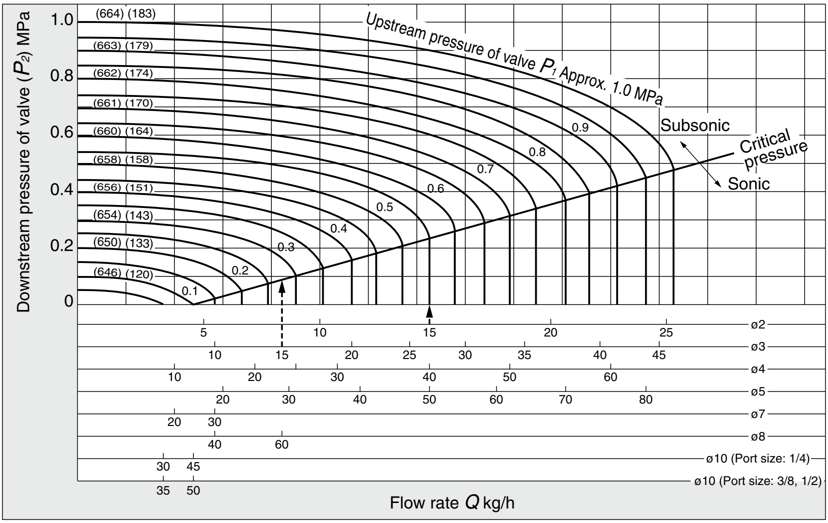
For Air



How to read the graph

The sonic range pressure to generate a flow rate of 400 L/min (ANR) is
P_1 Approx. 0.2 MPa for a ø4 orifice and
P_1 Approx. 0.58 MPa for a ø3 orifice.

For Saturated Steam

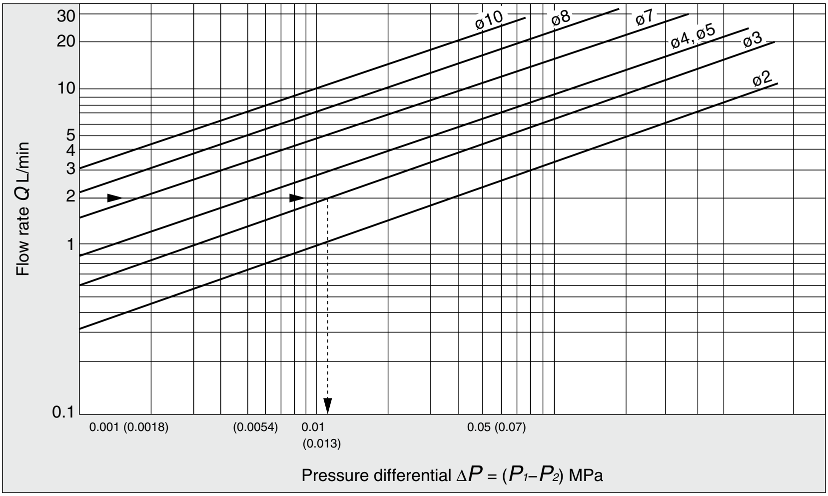


How to read the graph

The sonic range pressure to generate a flow rate of 15 kg/h is
P_1 Approx. 0.55 MPa for ø2 orifice and P_1 Approx. 0.28 MPa for ø3 orifice.
The holding heat slightly differs depending on the pressure P_1, but at 15 kg/h it is approximately 9700 kcal/h.

Flow Rate Characteristics

For Water



How to read the graph

When a water flow of 2 L/min is generated, ΔP Approx. 0.013 MPa for a valve with ø3 orifice.