Working fluid check list

For multi-fluid control 2, 3-port solenoid valves

⚠ Caution

This check list displays guidelines for typical corrosion resistance, and does not guarantee the solenoid valve performance. During actual use, there are unpredictable elements. Thus, there may be cases when general specifications do not apply. Therefore, before use, check the compatibility as needed and take the necessary safety measures on the equipment side.

[Indicates the compatibility of sealant material, body material and working fluid.]

Acrylic/nitriles to　# Ethyl ether

●: Usable ▲: Usable with conditions ×: Not Usable

	Fluid name	Fluid properties (Indicators the state of the raw material even if the fluid indicates water solubility)	Material combination [Body material] Brass/Bronze [Sealant material] Nitrile rubber	Fluororubber	Ethylene propylene	Tetrafluoroethylene resin	[Body material] Stainless Steel [Sealant material] Nitrile rubber	Fluororubber	Ethylene propylene	Tetrafluoroethylene resin	Selection Precautions
#	Acrylic/nitriles	Liquid	×	×	×	×	×	×	●	●	Highly flammable liquid. Toxic substance.
	Acetylene	Gas	×	×	×	×	▲	▲	×	▲	Highly explosive gas. Contact CKD during model selection. If explosion proof (d3G2) is specified, CKD solenoid valves cannot be used. Instead use an air operated type.
	Acetaldehyde	Liquid	×	×	×	●	×	×	×	●	Flammable liquid. If explosion-proof types are specified by the surrounding environment, select explosion-proof (d2G4).
	Acetone	Liquid	×	×	●	●	×	×	●	●	Flammable liquid. If explosion-proof types are specified by the surrounding environment, select explosion-proof (d2G4).
	Aniline	Liquid	×	×	×	×	×	●	●	●	Organic solvents used in paints or dyes.
	Linseed oil		×	×	×	×	●	●	×	●	Take note of viscosity. For direct acting 2-port valves, the fluid viscosity must be 50 mm²/s or less. Pilot operated solenoid valves cannot be used.
	Amyl alcohols	Liquid	×	●	●	●	×	●	●	●	Ethylene propylene rubber is more suitable than fluoro rubber.
	Argon	Gas	●	●	●	●	●	●	●	●	This is an inert gas so there is no corrosion. Specify oil-prohibited specifications. Select Multi-fit valve FFB.
	Ammonia	Gas	×	×	×	×	×	×	▲	▲	Specify a coil with a diode or the DC voltage model. (*1)
	Aqueous ammonia	Liquid	×	×	×	×	×	×	▲	▲	Same as above. AKA: Ammonium hydroxide.
#	Isopropyl alcohol	Liquid	●	●	●	●	●	●	●	●	AKA: IPA. Used in semiconductor washers.
#	Ethyl alcohol (pure)	Liquid	×	●	●	●	×	●	●	●	AKA: Ethanol. If explosion-proof types are specified by the surrounding environment, select explosion-proof (d2G2) or (d2G4).
	Ethyl alcohol (industrial)	Liquid	×	×	●	●	×	×	●	●	
	Ethyl ether	Liquid	×	×	×	●	×	×	×	●	In general, these are known as ethers.

*1: AG, AB42, AP12, AP22, AD12, AD22, explosion-proof types (excluding ADK) and PVS cannot be used even with a coil with diode or DC voltage.

[Indicates the compatibility of sealant material, body material and working fluid.]

Ethylene oxide gas to # Gasoline

●: Usable ▲: Usable with conditions ×: Not Usable

	Fluid name	Fluid properties (Indicators the state of the raw material even if the fluid indicates water solubility)	Material combination [Body material] Brass/Bronze [Sealant material] Nitrile rubber	Fluororubber	Ethylene propylene	Tetrafluoroethylene resin	[Body material] Stainless Steel [Sealant material] Nitrile rubber	Fluororubber	Ethylene propylene	Tetrafluoroethylene resin	Selection Precautions
#	Ethylene oxide gas	Gas	×	×	×	×	×	×	×	×	AKA: Also called E.O.G or ethylene oxide. Boils into gas at 10.4°C. Explosive gas.
	Ethylene glycol	Liquid	●	●	●	●	●	●	●	●	Used as anti-freeze.
	Aqueous ammonium chloride	(Crystal)	×	×	×	×	×	×	×	×	Solenoid valves not suitable. Select a completely resin air operated valve.
	Ethylene chloride	Gas	×	×	×	×	×	×	×	●	AKA: Ethyl chloride. Requires dry conditions. Air Operated Valves for Chemicals Select CKD's oil mist if moisture is present. Flammable gas.
	Methyl chloride	Gas	×	×	×	×	×	×	×	●	AKA: also called methyl chloride or chloromethane. Boils into gas at -23°C. Requires dry conditions. Air Operated Valves for Chemicals Select CKD's oil mist if moisture is present.
	Methylene chloride	Liquid	×	×	×	×	×	×	×	●	AKA: Dichloromethane.
	Aqueous potassium chloride	(Crystal)	×	×	×	×	×	×	×	×	Cannot be used with metal.
	Aqueous magnesium chloride	(Crystal)	×	×	×	×	×	×	×	×	Cannot be used with metal.
	AE solvent	Liquid (powder)	×	×	×	×	×	×	×	×	Cement hardener.
#	Ozone (several ppm or less)	Gas	×	×	×	×	×	▲	▲	▲	Specify a coil with a diode or the DC voltage model. (*1)
#	Sodium perchlorate	Liquid	×	×	×	×	×	×	×	●	AKA: Perchlorate soda. Cannot be used with rubber.
	Hydrogen peroxide solution	Liquid	×	×	×	×	×	×	×	▲	Oxidant. Used in disinfectants and sterilization agents. Usually 30 to 50% water soluble. Specify a coil with a diode or the DC voltage model. (*1)
	Caustic soda	(Solid)	×	×	×	×	●	×	●	●	Take care when using as crystals may form when fluid dries out. (Crystals may adhere to the OUT side of the valve, causing it to lock)
	Aqueous potassium permanganate	(Crystal)	×	×	×	×	×	×	×	●	Used for analysis. Strong oxidant. Take care when using as crystals may form as it dries out.
	Gasoline	Liquid	×	▲	×	●	×	▲	×	●	Fluoro rubber may not always be usable.

*1: AG, AB42, AP12, AP22, AD12, AD22, explosion-proof types (excluding ADK) and PVS cannot be used even with a coil withdiode or DC voltage.

Working fluid check list

For multi-fluid control 2, 3-port solenoid valves

⚠ Caution

This check list displays guidelines for typical corrosion resistance, and does not guarantee the solenoid valve performance. During actual use, there are unpredictable elements. Thus, there may be cases when general specifications do not apply. Therefore, before use, check the compatibility as needed and take the necessary safety measures on the equipment side.

[Indicates the compatibility of sealant material, body material and working fluid.]

Glycerin to # Heavy oil A

●: Usable ▲: Usable with conditions ×: Not Usable

Fluid name	Fluid properties (Indicators the state of the raw material even if the fluid indicates water solubility)	Material combination: [Body material] Brass/Bronze [Sealant material] Nitrile rubber	Fluororubber	Ethylene propylene	Tetrafluoroethylene resin	[Body material] Stainless Steel [Sealant material] Nitrile rubber	Fluororubber	Ethylene propylene	Tetrafluoroethylene resin	Selection Precautions
# Glycerin	Liquid	●	●	●	●	●	●	●	●	Take note of viscosity. For direct acting 2-port valves, the fluid viscosity must be 50mm²/s or less. Pilot operated solenoid valves cannot be used.
Cresol	Solid (liquid)	×	×	×	×	×	●	×	●	Disinfectant. AKA: Methyl phenol.
Chloroform	Liquid	×	×	×	●	×	×	×	●	AKA: Trichloromethane. Acute toxic substance.
# Light oil	Liquid	●	●	×	●	●	●	×	●	–
Aqueous sodium silicate	(Crystal)	●	●	●	●	●	●	●	●	AKA: Water glass. Used in phosphate-free detergents. Take note of viscosity and concentration. Select stainless steel for high concentrations, as it is classified as an alkaline aqueous solution.
# Isopropyl acetate	Liquid	×	×	×	●	×	×	×	●	Flammable liquid. Acute toxic substance. Paint solvent.
Ethyl acetate	Liquid	×	×	×	●	×	×	×	●	A solvent for paint. If explosion proof types are specified by the surrounding environment, select explosion-proof (d2G2) or (d2G4).
Sodium acetate	(Solid)	●	●	×	●	●	●	×	●	Dye.
Butyl acetate	Liquid	×	×	×	●	×	×	×	●	Flammable liquid. Acute toxic substance.
Methyl acetate	Liquid	×	×	×	●	×	×	×	●	Flammable liquid. Acute toxic substance.
Oxygen	Gas	×	●	●	●	×	●	●	●	Oil-prohibited treatment is required as it may spontaneously ignite when exposed to oil.
# Aqueous potassium cyanide		×	×	×	×	●	●	●	●	AKA: Cyanide potash. A poisonous chemical used in plating solutions.
Carbon tetrachloride	Liquid	×	×	×	●	×	×	×	●	Flame retardant. A solvent for dry cleaning. Acute toxic substance.
Aqueous potassium dichromate	(Solid)	×	×	×	×	×	●	●	●	–
Aqueous sodium bicarbonate	(Solid)	×	×	×	×	●	●	●	●	AKA: a baking soda Used as a food additive.
Heavy oil A	Liquid	▲	●	×	●	▲	●	×	●	Take care when selecting the sealant if an additive is present. *2

*2 : High calorie "heavy oil A" is increasingly used for small boilers, etc. Nitrile rubber cannot be used with "high-calorie heavy oil A".

[Indicates the compatibility of sealant material, body material and working fluid.]

Heavy oil B to # Toluene

●: Usable ▲: Usable with conditions ×: Not Usable

	Fluid name	Fluid properties (Indicators the state of the raw material even if the fluid indicates water solubility)	Material combination [Body material] Brass/Bronze [Sealant material] Nitrile rubber	Fluororubber	Ethylene propylene	Tetrafluoroethylene resin	[Body material] Stainless Steel [Sealant material] Nitrile rubber	Fluororubber	Ethylene propylene	Tetrafluoroethylene resin	Selection Precautions
#	Heavy oil B	Liquid	●	●	×	●	●	●	×	●	–
	Heavy oil C	Liquid	×	●	×	●	×	●	×	●	Take note of viscosity. We recommend the LLO solenoid for heavy oil.
	Nitric acid 30%	Liquid	×	×	×	×	×	×	×	×	Solenoid valves cannot be used. CKD recommends Air operated valve for chemical liquids.
	Table vinegar	Liquid	×	×	×	×	×	×	×	×	AKA: vinegar. This falls under the same conditions as "acetic acid".
	Dimethyl silicone oil	Liquid	●	●	●	●	●	●	●	●	In general, this is known as silicone oil.
	Vacuum (medium vacuum)	–	●	●	×	×	●	●	×	×	We recommend the medium Multi-fit valve option (FFB).
	Vacuum (high vacuum)	–	×	×	×	×	×	×	×	×	We recommend a valve for high vacuum (HVB).
	Aqueous silver nitrate	(Solid)	×	×	×	×	▲	▲	▲	▲	Used for analysis or as a photosensitive developing agent. Specify a coil with a diode or the DC voltage model. (*1)
#	Aqueous calcium hydroxide	(Solid)	×	×	×	×	●	●	●	●	AKA: slaked lime Used as a neutralizing agent for wastewater treatment. Take note of viscosity. Strong alkali. This resists dissolving in water, so may not be appropriate for solenoid use if it leaves grains behind.
	Sodium hydroxide (below 30%) (AKA: Caustic soda)	(Solid)	×	×	×	×	●	×	●	●	Take care when using as crystals may form when fluid dries out. (Crystals may adhere to the OUT side of the valve, causing it to lock)
	Sodium hydroxide (30% or more)	(Solid)	×	×	×	×	×	×	●	●	Same as above. Same conditions.
	Hydrogen	Gas	●	●	●	●	●	●	●	●	This forms an explosive gas combination when mixed with air. Explosion proof (d3G1) specifications are not available.
#	Carbon dioxide	Gas	●	●	●	●	●	●	●	●	–
	Carbonated water	Liquid	●	●	●	●	●	●	●	●	–
	Tannic acid	(powder)	×	×	×	×	●	●	●	●	–
#	Nitrogen	Gas	●	●	●	●	●	●	●	●	Inert gas. Non-corrosive. Oil-prohibited specifications. Multi-fit valve is recommended.
#	Turpentine	Liquid	●	●	×	●	●	●	×	●	Rosin oil. Used in solvents and pharmaceutical products. Ignition point: 35°C.
	Natural gas	Gas	●	●	×	●	●	●	×	●	AKA: LNG. Specific gravity: 0.65. Direct acting valve for gas We recommend Catalog No. [CC-1590]. Refer to "Using ⚠ general purpose valves with fuel gas" on page 52.
#	Kerosene	Liquid	●	●	×	●	●	●	×	●	AKA: Kerosene. Jet fuel is known as kerosene.
	City gas	Gas	●	●	×	●	●	●	×	●	We recommend a gas combustion system. Refer to "Using ⚠ general purpose valves with fuel gas" on page 52.
	Dry air	Gas	●	●	●	●	●	●	●	●	Multi-fit valve is recommended.
	Trichloroethane	Liquid	×	×	×	▲	×	×	×	●	The corrosiveness increases when mixed with water.
	Trichloroethylene	Liquid	×	×	×	▲	×	×	×	●	AKA: Trichlene. Acute toxic substance.
	Toluene	Liquid	×	×	×	●	×	×	×	●	If explosion-proof types are specified by the surrounding environment, select explosion-proof (d2G2) or (d2G4). Note that it is volatile and take care with temperatures. Flammable liquid. Acute toxic substance.

*1: AG, AB42, AP12, AP22, AD12, AD22, explosion-proof types (excluding ADK) and PVS have a shading coil and cannot be used even with a coil with diode or DC voltage.

Working fluid check list

For multi-fluid control 2, 3-port solenoid valves

⚠ Caution

This check list displays guidelines for typical corrosion resistance, and does not guarantee the solenoid valve performance. During actual use, there are unpredictable elements. Thus, there may be cases when general specifications do not apply. Therefore, before use, check the compatibility as needed and take the necessary safety measures on the equipment side.

[Indicates the compatibility of sealant material, body material and working fluid.]

Naphtha to # Freon gas

●: Usable ▲: Usable with conditions ×: Not Usable

Fluid name		Fluid properties (Indicators the state of the raw material even if the fluid indicates water solubility)	Material combination [Body material] Brass/Bronze [Sealant material] Nitrile rubber	Fluororubber	Ethylene propylene	Tetrafluoroethylene resin	[Body material] Stainless Steel [Sealant material] Nitrile rubber	Fluororubber	Ethylene propylene	Tetrafluoroethylene resin	Selection Precautions
#	Naphtha	Liquid	×	×	×	●	×	×	×	●	–
#	Dichloride benzene	Liquid (solid)	×	×	×	●	×	×	×	●	AKA: Dichlorobenzene.
	Lactic acid	Liquid	×	×	×	×	×	●	●	●	Used for brewing or drinking.
#	Perchloroethylene	Liquid	×	×	×	×	×	●	×	●	AKA: Ethylene tetrachloride, acute toxic substances, limited to use in environments with well-equipped exhaust equipment. A volatile solvent for dry cleaning. Contact CKD during model selection.
#	Castor oil	Non-drying	×	×	×	×	●	●	×	●	Used as a laxative. Vegetable oils.
#	Phenols	(Crystal)	×	×	×	×	×	●	×	●	Used as a disinfectant and local anesthetic.
	Butane gas	Gas	●	●	×	●	●	●	×	●	If explosion-proof types are specified by the surrounding environment, select explosion-proof (d2G2) or (d2G4). This is a custom-made product as it generates sticky material. Refer to "Using ⚠ general purpose valves with fuel gas" on page 52.
	Butyl alcohol	Liquid	×	●	●	●	×	●	●	●	AKA: Butanol. If explosion proof types are specified by the surrounding environment, select explosion-proof (d2G2) or (d2G4). Flammable liquid. Contact CKD during model selection.
	Brake fluid	Liquid	×	×	●	●	×	×	●	●	–
	Propyl alcohol	Liquid	×	●	●	●	×	●	●	●	–
	Propane gas	Gas	●	●	×	●	●	●	×	●	This is a custom-made product as it generates sticky material. We recommend a gas combustion system. Refer to "Using ⚠ general purpose valves with fuel gas" on page 52.
	Freon gas R23	Liquid and gas	×	×	×	●	×	×	×	●	AKA: HFC23
	Freon gas R32		×	×	●	●	×	×	●	●	AKA: HFC32
	Freon gas R125		●	×	●	●	●	×	●	●	AKA: HFC125
	Freon gas R134a		×	×	×	●	×	×	×	●	AKA: HFC134a
	Freon gas R143a		●	×	●	●	●	×	●	●	AKA: HFC143a
	Freon gas R404A		×	×	×	●	×	×	×	●	For HFC125/143a/134a mixtures
	Freon gas R407C		×	×	×	●	×	×	×	●	For HFC32/125/134a mixtures
	Freon gas R407E		×	×	×	●	×	×	×	●	For HFC32/125/134a mixtures
	Freon gas R410A		×	×	●	●	×	×	●	●	For HFC32/125 mixtures
	Freon gas R507A		●	×	●	●	●	×	●	●	For HFC125/143a mixtures

[Indicates the compatibility of sealant material, body material and working fluid.]

●: Usable ▲: Usable with conditions ×: Not Usable

Hexanol to # Phosphoric acid

Fluid name	Fluid properties (Indicators the state of the raw material even if the fluid indicates water solubility)	Material combination [Body material] Brass/Bronze [Sealant material] Nitrile rubber	Fluororubber	Ethylene propylene	Tetrafluoroethylene resin	[Body material] Stainless Steel [Sealant material] Nitrile rubber	Fluororubber	Ethylene propylene	Tetrafluoroethylene resin	Selection Precautions
# Hexanol	Liquid	×	●	●	●	×	●	●	●	AKA: Hexyl alcohol.
Heptane	Liquid	●	●	×	●	●	●	×	●	Flammable liquid.
Helium	Gas	●	●	●	●	●	●	●	●	Inert gas. Non-corrosive.
Benzine	Liquid	×	×	×	●	×	×	×	●	Solvent. Volatile. Flammable liquid. This forms an explosive gas when mixed with air.
Benzol	Liquid	×	×	×	●	×	×	×	●	AKA: Benzene. Flammable liquid. Harmful substance. Limited to use in environments with well-equipped exhaust equipment.
# Sodium borate	(Crystal)	×	×	×	×	●	●	●	●	AKA: Borax.
Formalin	(Gas)	×	×	×	×	×	×	●	●	AKA: Formaldehyde.
# Methane gas	Gas	●	●	×	●	●	●	×	●	Refer to "Using ⚠ general purpose valves with fuel gas" below.
Methyl alcohol	Liquid	×	×	●	●	×	×	●	●	AKA: Methanol. Flammable liquid. Acute toxic substance.
Methyl ether	Gas	×	×	×	●	×	×	×	●	–
Methyl ethyl ketone	Liquid	×	×	●	●	×	×	●	●	AKA: MEK. Highly flammable liquid. Limited to use in environments with well-equipped exhaust equipment.
Cottonseed oil	Semi-drying	×	●	×	●	×	●	×	●	For food products.
# Lacquer	Liquid	×	×	×	●	×	×	×	●	If explosion-proof types are specified by the surrounding environment, select explosion-proof (d2G2) or (d2G4).
# Hydrogen sulfide solution	Water + gas	×	×	×	×	×	×	×	×	Select a completely resin air operated valve.
Aqueous ammonium sulfate	(Solid)	×	×	×	×	×	×	×	×	AKA: Ammonium sulfate. Nitrogen fertilizer.
Aqueous sodium sulfate	(Solid)	×	×	×	×	×	×	×	×	AKA: Aqueous sodium sulfide.
Aqueous nickel sulfate	(Solid)	×	×	×	×	×	×	×	×	Used as a nickel plating solution.
Aqueous copper sulfate	(Solid)	×	×	×	×	×	×	×	×	Used in agricultural chemicals, pigments, and copper plating.
Phosphoric acid	Liquid	×	×	×	×	×	×	×	×	–

⚠ Using general purpose valves with fuel gas

When using with fuel gas, install an evaporator or provide drainage measures (raise the piping, install a trap, etc.) so that the liquefied gas does not enter the solenoid valve. Observe the laws and periodic inspections set forth for each gas device. When using city gas or LPG (butane gas, propane gas), Standard Product may not be available depending on the gas properties. Contact CKD to select the optimum model.

Regarding Flow Rate Characteristics Display Method

1. Flow characteristics display

The flow rate display in the catalog specifications column is shown as follows.

Applicable Equipment	Display	Unit	Standard
Pneumatic Equipment	JIS compliant indication	C, b	ISO 6358:1989 "Pneumatic fluid power - components using compressible fluids - Determination of flow-rate characteristics" JIS B 8390:2000 (ISO 6358 translation)
	Conventional Display	S	JIS B 8379:1995 'Pneumatic silencers'
		Cv	ANSI(NFPA)T3. 21. 3 R1-2008
Fluid Control Components	JIS compliant indication	Cv Kv	IEC 60534-2-3: 2015 "Industrial Process Control Valves - Part 2: Flow rate - Part 3: Test Procedures JIS B 2005-2-3: 2004 (IEC 60534-2-3 translation) JIS B 8471: 2004 "Solenoids for water" JIS B 8472: 2008 "Solenoids for steam" JIS B 8473: 2007 "Solenoids for fuel"
	Conventional Display		

2. Pneumatic components description

The flow characteristics of the pneumatic components were conventionally indicated with the effective cross-sectional area S and flow coefficient Cv. However, JIS was revised (JIS B 8390:2000), and these are now indicated with the sonic conductance C and critical pressure ratio b.

● Sonic conductance C : Value obtained by dividing the mass flow rate through the device in a choked flow state by the product of the upstream absolute pressure and the density at standard conditions. (sonic conductance) S ≈ 5.0 C (Conventional sizing is possible with C.)

• Critical Pressure Ratio b: Pressure at which choked flow results if smaller than this value(Downstream pressure Force/upstream pressure)(critical pressure ratio)

● Effective cross-sectional area S (mm^2): When the choked flow is released from the components mounted on the air tank,The value of the ideal restricted cross-sectional area without friction or compressed flow, calculated from the pressure changes inside the air tank.

*Choked flow: Flow where upstream pressure is higher than downstream pressure and velocity reaches sonic speed at a certain point in the equipment. The mass flow rate of gas is proportional to the upstream pressure and does not depend on the downstream pressure. (Choked flow)

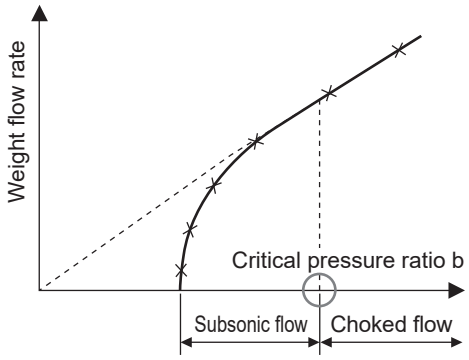


Fig. 1 Weight flow rate characteristics versus upstream pressure

Flow rate calculation formula

Expressed as follows using practical units.

Q : Flow rate L/min (ANR) in standard condition
C : Sonic conductance [$dm^3/(s \cdot bar)$]
b : Critical pressure ratio
S : Effective cross-sectional area mm^2
P1 : Primary side absolute pressure MPa (abs)
P2 : Secondary side absolute pressure MPa (abs)
T : Air temperature °C

• $\frac{P2}{P1}$ When ≤ b, Choked flow

$$Q=600\times C\times P_1\times \sqrt{\frac{293}{273+T}} \quad \text{.....(1)}$$

• $\frac{P2}{P1}$ When > b, subsonic flow

$$Q=600\times C\times P_1\times \sqrt{1-\left[\frac{\frac{P2}{P1}-b}{1-b}\right]^2}\sqrt{\frac{293}{273+T}} \quad \text{.....(2)}$$

When calculating with effective cross-sectional area S, substitute value C obtained with C = S/5 in the above formula. For subsonic flow, substitute b = 0.5 in formula (2).

3. Fluid control components description

The flow characteristics of the fluid control components indicated flow coefficients Cv and Av. However, the Av value was eliminated from the control valve flow coefficient with "JIS B 2005-2-3:2004" revisions, and there are two types o f Kv and C v. Cv and Kv values are listed for the flow characteristics of the fluid control components.

● Flow coefficient Cv: This is a non-SI control valve flow coefficient, but is used commonly throughout the world. US gal value which indicates 40 to 100°F city water flow rate per minute passing through the valve (device under test) at pressure differential of 1 psi.

$$Cv=Q\sqrt{\frac{\rho}{\rho w}\cdot\frac{1}{\triangle P}} \quad \cdots\cdots\cdots \quad (3)$$

Cv : Flow coefficient
Q : Flow rate [U.S.gal/min] (1U.S.gal/min=6,309 ×10^{-5} m^3 /s)
ρ : Fluid density [1b/ft^3] (1b/ft^3=16,018 kg/m^3)
ρw : 40°F to 100°F (4°C to 38°C) water density [1b/ft^3]
△P : Pressure difference [psi] (1 psi= 6.8948 kPa)

● Flow coefficient Kv: Value which indicates 5 to 40°C city water flow rate passing through the valve in m^3/h unit at pressure difference of 1bar. The flow rate (in m^3/h) of fresh water at a temperature of 5 to 40°C that flows through the valve with a pressure differential of 1 bar.

$$Kv=Q\sqrt{\frac{1\times10^5}{\triangle P}\cdot\frac{\rho}{1{,}000}} \quad \cdots \quad (4)$$

Kv : Flow coefficient
Q : Flow rate [m^3/h]
△P :Pressure difference [Pa]
ρ : Fluid density [kg/m^3]

Flow rate calculation formula

Expressed as follows using practical units.

● Flow coefficient Cv

For liquids:

$$Q=45.58\,Cv\sqrt{\frac{\triangle P}{G}} \quad \cdots\cdots\cdots\cdots \quad (5)$$

Cv: Flow coefficient
Q: Flow rate [ℓ/min]
△P: Pressure difference [MPa]
G: Specific gravity [water G = 1]

For steam:

For $P2 \leq \frac{P1}{2}$ $\quad W=\frac{99\,Cv\,P_1}{K}$ ..... (6)

For $P_2 > \frac{P1}{2}$ $\quad W=\frac{198\,Cv\sqrt{(P_1-P_2)\,P_2}}{K}$ ..... (7)

Cv: Flow coefficient
W: Flow rate [kg/h]
P_1 : Primary side absolute pressure [MPa]
P_2 : Secondary side absolute pressure [MPa]
K: (1+0.0013ts) ts: Degree of superheat (Saturation steam K = 1)

Regarding Flow Rate Characteristics Display Method

Flow rate calculation formula

Expressed as follows using practical units.

● Flow coefficient Kv

For liquids:

$$Q = 52.63Kv\sqrt{\frac{\triangle P}{G}} \quad \text{..... (8)}$$

Kv : Flow coefficient
Q : Flow rate [ℓ/min]
△P : Pressure difference [MPa]
G : Specific gravity [water G = 1]

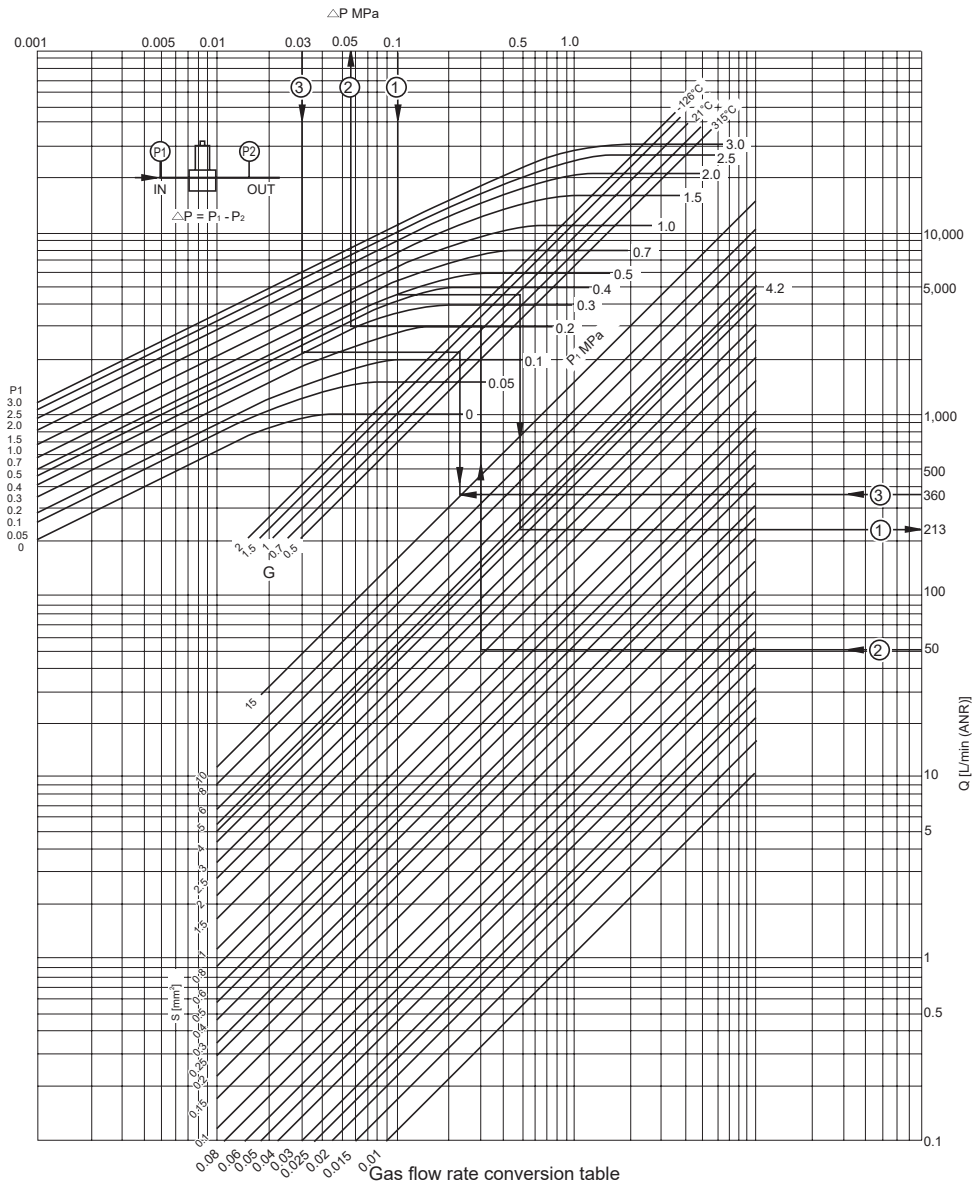
Flow coefficient conversion

Kv≈0.87 Cv

Kv: Value which indicates 5 to 40°C city water flow rate passing through the valve in m^3/h unit at pressure difference 1 bar.
Cv: Value which indicates 60°F city water flow rate passing through the valve in US gal/min. unit at pressure difference 1 lbf/in^2 (psi).
The Kv and Cv for air use different test methods, so the values do not match.

Flow rate conversion table

Air



● Example 1:
The flow rate when air is passed through with (S=4.2 mm²) P1 = 0.5 MPa, P_2 = 0.4 MPa (△P = P_1 - P_2 = 0.1 MPa) is

Q=226 L/min (ANR)

● Example 2:
The pressure loss when air is passed through a S=1.5 mm² valve at 50 L/min (ANR) at P1 = 0.3 MPa is

△P=0.057 MPa

● Example 3:
What should the valve's effective cross-sectional area be to attain a 360 L/min (ANR) flow rate at P1 = 0.3 MPa and △P=0.03 MPa?

S=16.7

*1: The table shows the effective cross-sectional area (S) up to 15. If this value is exceeded, multiply the effective cross-sectional area (S) and flow rate proportionally.
Example:
If the effective cross-sectional area(S) is 20, refer to 2 and calculate the flow rate by 10 times.

*2: Nitrogen Assume that the raw temperature is 20°C.

Flow rate calculation method

When calculating from effective sectional area
SI units

● When $P_2/P_1 \leq 0.5$ (choke flow)

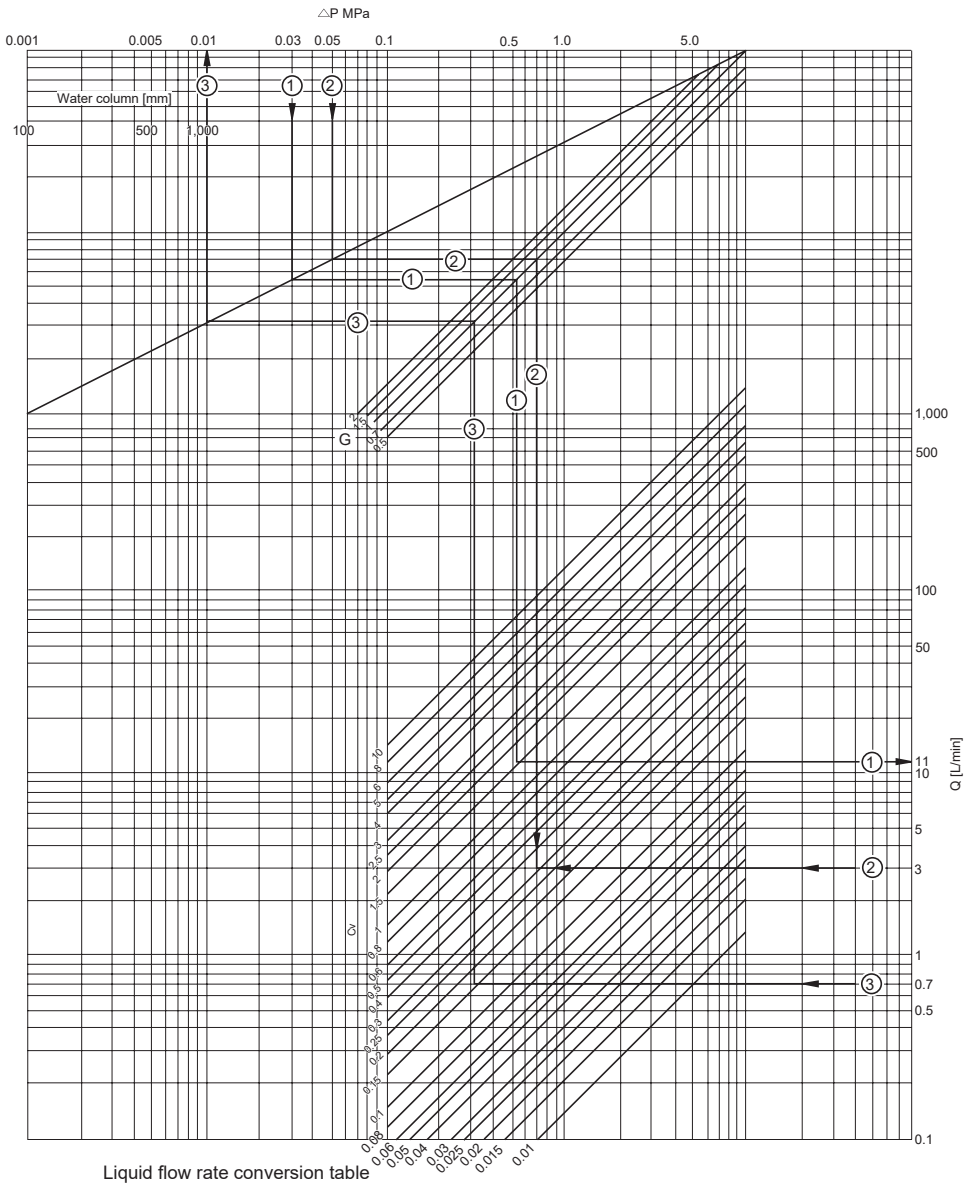
$$Q=120\times S\times P_1\times\sqrt{\frac{293}{273+T}}$$

● P_2/P_1>When 0.5 (subsonic flow)

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

Q: Flow rate L/min (ANR)
P_1: Primary side absolute pressure MPa (abs)
P_2: Secondary side absolute pressure MPa (abs)
S: Effective Area (mm^2)

Water



Liquid flow rate conversion table

● Example 1:
What is the flow rate when water (specific gravity = 1) is passed through a Cv1.5 valve at △P=0.03 MPa (P_1-P_2)?

Q = 11 .8L/min

● Example 2:
Cv required for water (specific gravity = 1) to flow at 3 L/min at △P=0.05 MPa

Cv=0.29

● Example 3:
Pressure loss when water (specific gravity = 1) is passed through a Cv=0.15 valve at 0.7 L/min

△P=0.01 MPa

*1: The table shows Cv up to 10. If this value is exceeded, multiply the Cv and flow rate Q proportionally.
Example:
If Cv is 15, refer to 1.5 and multiply the flow rate by 10.

Flow rate calculation method

Flow coefficient Kv $\sqrt{\frac{\triangle P}{G}}$

Q = 52.63Kv

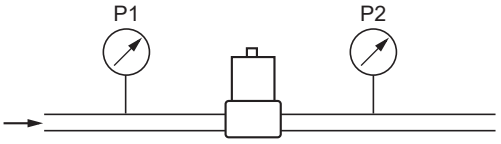
Kv: Flow coefficient
Q: Flow rate [ℓ/min]
△P: Pressure difference [MPa]
G: Specific gravity [water G = 1]

Flow coefficient conversion
Kv≈0.87Cv

Flow coefficient Cv

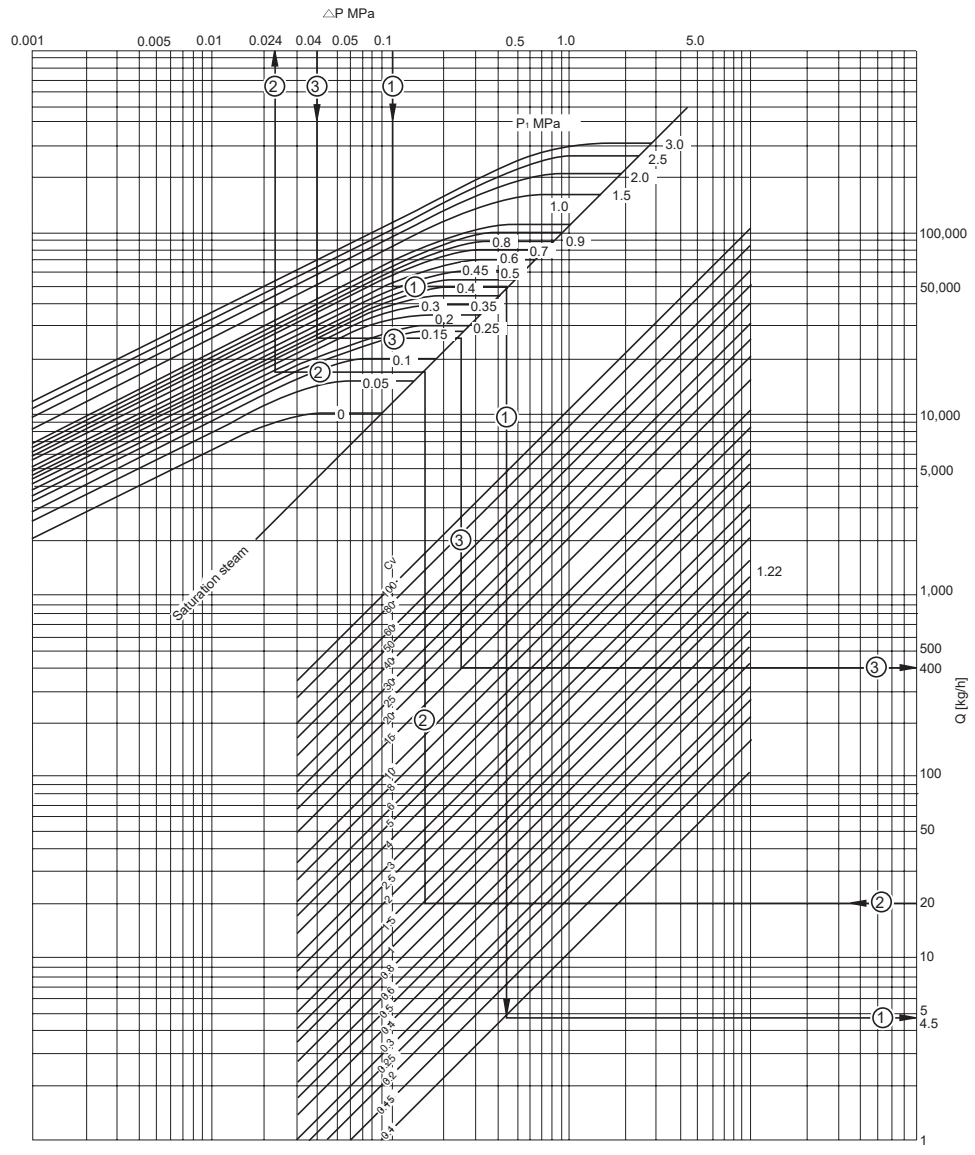
Q = 45.58Cv $\sqrt{\frac{\triangle P}{G}}$

Cv: Flow coefficient
Q: Flow rate [ℓ/min]
△P: Pressure difference [MPa]
G: Specific gravity [water G = 1]



Pressure Loss
△P
$\triangle P = P_1 - P_2$
P1: Upstream pressure [MPa]
P2: Downstream pressure [MPa]

Steam



Steam flow rate conversion table

● Example 1:
For solenoid valves with dissolution coefficient Cv=0.1
P_1 = 0.5 MPa,
P_2 = 0.4 MPa
What is the flow rate when saturated water vapor is passed through a valve ($\triangle P = P_1 - P_2$ = 0.1 MPa)?

Q=4.0 kg/h

● Example 2:
What is the pressure loss when 20 kg/h is passed at P_1 = 0.2 MPa (Cv=1.22)?

P = 0.024 MPa

● Example 3:
P_1= Indicates that a Cv=150 valve is used at 0.3 MPa and P=0.04 MPa What flow rate can be attained?

Q=3618 kg/h

Note: The table shows Cv up to 100. If this value is exceeded, multiply the Cv and flow rate Q proportionally.
Example:
If Cv is 150, refer to 15 and multiply the flow rate by 10.

Flow rate calculation method

$$W = \frac{100CvP_1}{K} \qquad \text{For } P_2 \leq \frac{P1}{2}$$

$$W = \frac{201Cv\sqrt{(P_1-P_2)\,P_2}}{K} \qquad P_2\text{For} > \frac{P1}{2}$$

W : Flow rate kg/h
P_1: Primary side absolute pressure MPa (abs)
P_2: Secondary side absolute pressure MPa (abs)
K: (1+0.0013ts) ts: Degree of superheat
(Saturation steam: K=1)