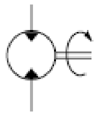
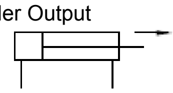
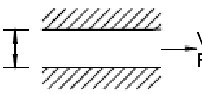
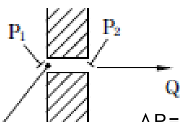
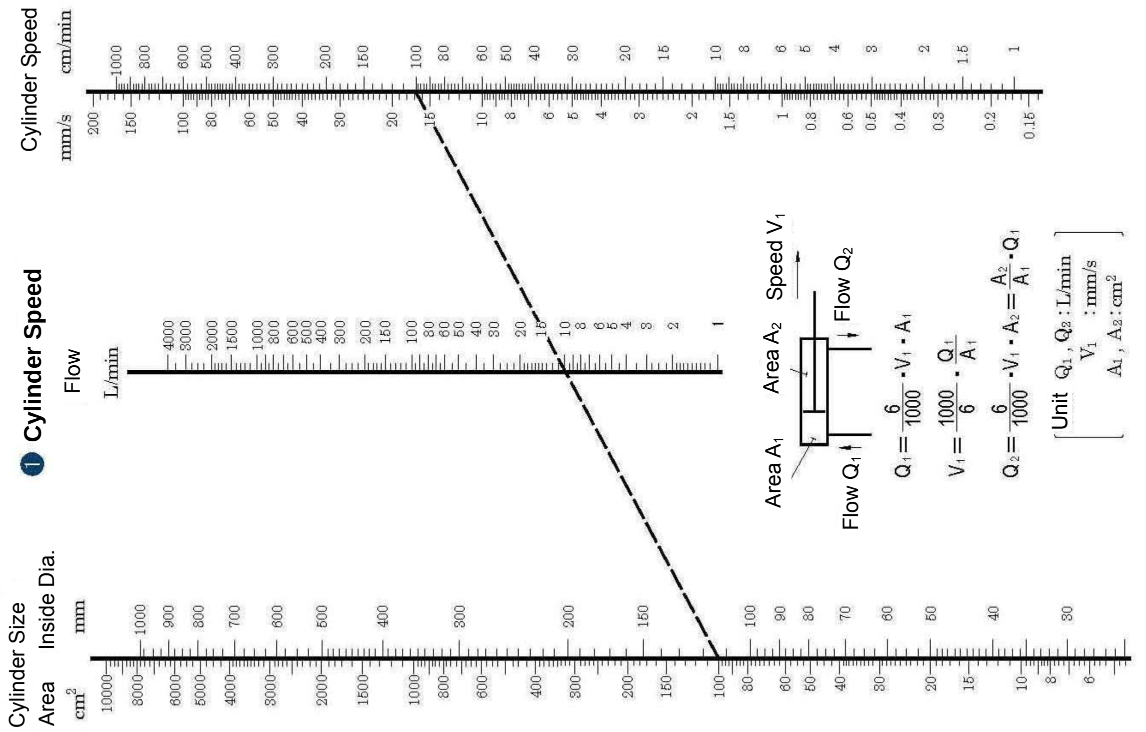
	SI Unit	Engineering Unit (Reference)
Hydraulic Pump ● Hydraulic Power (Pump Output)	$L_O = \frac{P \cdot Q}{60}$ L_O: Hydraulic Power kW P: Pressure MPa Q: Flow L/min * 1 kW = 1 kN•m/s = 60 kN•m/min	$L_O = \frac{P \cdot Q}{612}$ L_O: Hydraulic Power kW P: Pressure kgf/cm^2 Q: Flow L/min * 1 kW = 102 kgf•m/s = 6120 kgf•m/min
Hydraulic Pump ● Shaft Input	$L_i = \frac{2\pi TN}{60000}$ L_i: Shaft Input kW T: Shaft Torque N•m N: Shaft Speed r/min	$L_i = \frac{2\pi TN}{6120}$ L_i: Shaft Input kW T: Shaft Torque kgf•m N: Shaft Speed rpm
Hydraulic Pump ● Volumetric Efficiency	$\eta_V = \frac{Q_P}{Q_O} \times 100$ η_V: Volumetric Efficiency % Q_P: Flow at Pressure P L/min Q_O: Flow at No Load L/min * Q_O - Q_P = Pump's Total Internal Leakage	
Hydraulic Pump ● Overall Efficiency	$\eta = \frac{L_O}{L_i} \times 100 = \frac{P \cdot Q}{60 L_i} \times 100$ η: Overall Efficiency % L_O: Hydraulic Power kW L_i: Shaft Input kW P: Discharge Pressure MPa Q: Flow L/min	$\eta = \frac{L_O}{L_i} \times 100 = \frac{P \cdot Q}{612 L_i} \times 100$ η: Overall Efficiency % L_O: Hydraulic Power kW L_i: Shaft Input kW P: Discharge Pressure kgf/cm^2
● Hydraulic Motor Output 	$L = \frac{2\pi T \cdot N}{60\ 000}$ L: Output kW T: Torque Nm N: Speed r/min	$L = \frac{2\pi T \cdot N}{6120}$ L: Output kW T: Torque kgf•m N: Speed rpm
● Cylinder Output 	$L = \frac{F \cdot V}{60}$ L: Output kW F: Force kN V: Speed m/min	$L = \frac{F \cdot V}{6120}$ L: Output kW F: Force kgf V: Speed m/min
● Valve Power Loss Flow Q Pressure P_1 [Valve] Pressure P_2 Pressure Loss: $\Delta P = P_1 - P_2$ Power Loss between Valve Inlet and Outlet: L	$L = \frac{\Delta P \cdot Q}{60}$ L : kW ΔP : MPa Q : L/min	$L = \frac{\Delta P \cdot Q}{612}$ L : kW ΔP : kgf/cm^2 Q : L/min
● Viscosity (Absolute) and Kinematic Viscosity	$\mu = \rho \cdot \nu_1 = \rho \cdot \nu_2 \times 10^{-6}$ μ : Viscosity (Absolute) Pa•s (= N•s/m^2) ρ : Density kg/m^3 ν_1: Kinematic Viscosity m^2/s ν_2: Kinematic Viscosity mm^2/s	$\mu = \rho \cdot \nu_1 = \frac{\gamma}{g} \cdot \nu_1 = \frac{\gamma \cdot \nu_2}{100 g}$ μ : Viscosity (Absolute) kgf·s/cm^2 ρ : Density kgf·s^2/cm^4 ν_1: Kinematic Viscosity cm^2/s ν_2: Kinematic Viscosity cSt γ : Specific Gravity kgf/cm^3 g: Gravitational Acceleration 980 cm/s^2 * 1 cSt = 0.01 cm^2/s
● Reynolds Number Diameter d  Velocity V, Flow Q R: Reynolds Number ν : Kinematic Viscosity	$R = \frac{V \cdot d}{\nu_1} = \frac{4000Q}{60\pi d \cdot \nu_1} = \frac{2120Q}{d \cdot \nu_2}$ R : Dimensionless Quantity V : cm/s d : cm ν_1 : cm^2/s ν_2 : mm^2/s{cSt} Q : L/min * R < 2300: Laminar Flow R > 2300: Turbulent Flow	
● Orifice Flow  A: Opening Area $\Delta P = P_1 - P_2$ C = Discharge Coefficient γ = Specific Gravity ρ = Density	$Q = C \cdot A \sqrt{\frac{2\Delta P}{\rho} \times 10^6} \times 6$ Q: L/min ρ : kg/m^3 C: Dimensionless Discharge Coefficient ΔP: MPa A: cm^2	$Q = C \cdot A \sqrt{\frac{2g}{\gamma} \cdot \Delta P} \times \frac{60}{1000} = 2.66 C \cdot A \sqrt{\frac{\Delta P}{\gamma}}$ Q: L/min g: 980 cm/s^2 C: Dimensionless Discharge Coefficient γ: kgf/cm^3 A: cm^2 ΔP: kgf/cm^2

Note) The value of discharge coefficient depends on the flow channel geometry and the Reynolds number; it generally ranges from 0.6 to 0.9.

1 Cylinder Speed



$$Q_1 = \frac{6}{1000} \cdot V_1 \cdot A_1$$

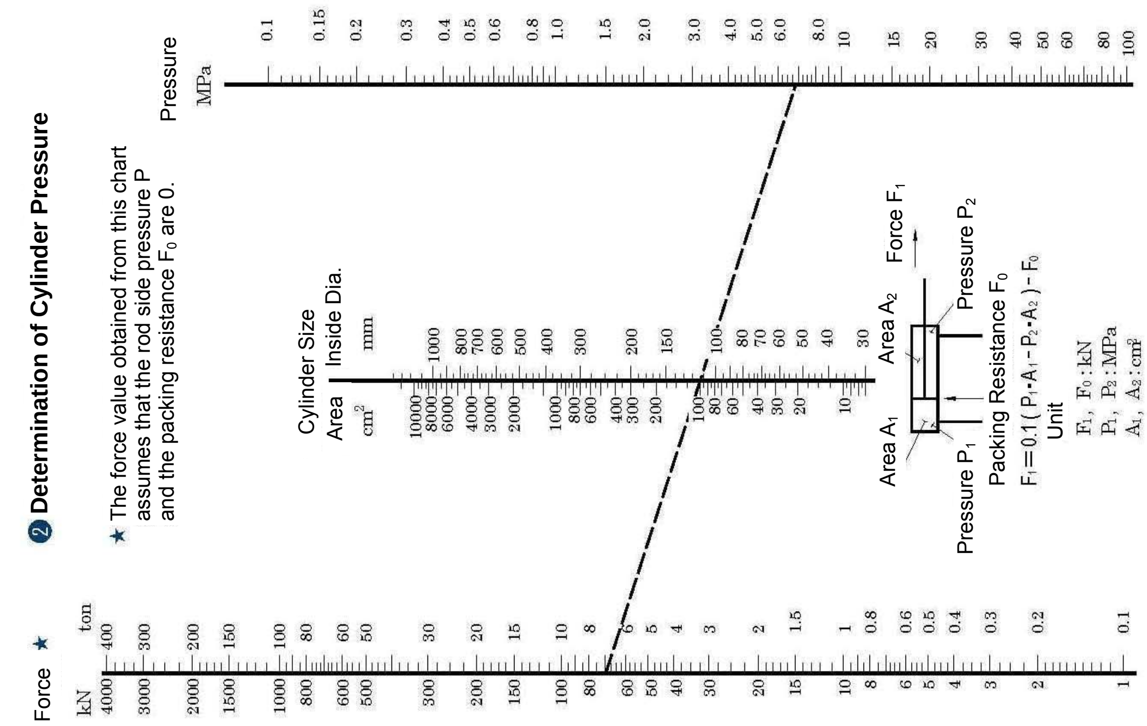
$$V_1 = \frac{1000}{6} \cdot \frac{Q_1}{A_1}$$

$$Q_2 = \frac{6}{1000} \cdot V_1 \cdot A_2 = \frac{A_2}{A_1} \cdot Q_1$$

Unit [Q_1, Q_2 : L/min; V_1 : mm/s; A_1, A_2 : cm²]

2 Determination of Cylinder Pressure

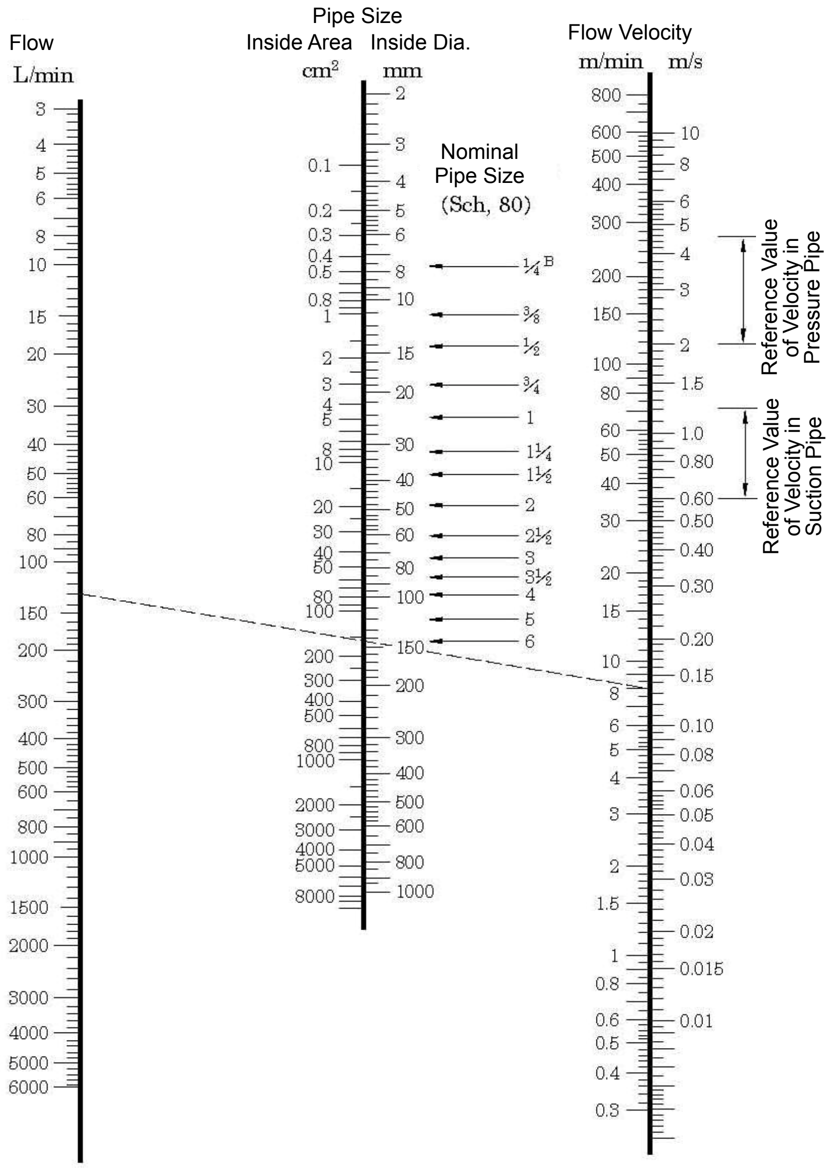
★ The force value obtained from this chart assumes that the rod side pressure P and the packing resistance F_0 are 0.



$$F_1 = 0.1 (P_1 \cdot A_1 - P_2 \cdot A_2) - F_0$$

Unit
F_1, F_0 : kN
P_1, P_2 : MPa
A_1, A_2 : cm²

1 Pipe Size/Flow Velocity



2 Steel Tubes/Pipes SGP. STS370. STPS2

Carbon Steel Pipes

Pipe Type ->			SGP (JIS G 3452)	STS370 (JIS G 3455)											
Nominal Pres. MPa ->			2	4		6		10		16		25		35	
Safety Factor ->			8 or more					6 or more		5 or more		4 or more			
Nominal Dia. (A)	Nominal Dia. (B)	Outside mm	Thickness mm	Thick mm	Sch. No.	Thick mm	Sch. No.	Thick mm	Sch. No.	Thick mm	Sch. No.	Thick mm	Sch. No.	Thick mm	Sch. No.
8	1/4	13.8												3.0	80
10	3/8	17.3												3.2	80
15	1/2	21.7				2.8	40					3.7	80	4.7	160
20	3/4	27.2				2.9	40					3.9	80	5.5	160
25	1	34.0				3.4	40	4.5	80					6.4	160
32	1 1/4	42.7				3.6	40	4.9	80			6.4	160	8.0	★
40	1 1/2	48.6				3.7	40	5.1	80			7.1	160	9.0	★
50	2	60.5		3.9	40			5.5	80			8.7	160	11.2	★
65	2 1/2	76.3	4.2	5.2	40			7.0	80	9.5	160			14.2	★
80	3	89.1	4.2	5.2	40			7.6	80	11.1	160			16.5	★
90	3 1/2	101.6	4.2	5.7	40	8.1	80			12.7	160			20.0	★
100	4	114.3	4.5	6.0	40	8.6	80			13.5	160			20.0	★
125	5	139.8	4.5	9.5	80			15.9	160						
150	6	165.2	5.0	11.0	80			18.2	160						

Note)

1. The selection of steel pipes based on the operating pressure may be difficult, since the pressure fluctuation, pipe vibration, pipe connection type, and other factors must be considered. Refer to the nominal pressure values and their corresponding safety factors in the left table for pipe selection.
2. "Sch. No." is an abbreviation for schedule number. Note that "★" indicates special thick wall steel pipes with no schedule number.
   <Reference>
   JIS G 3452, 3454 to 64
   Description
   Schedule number = 10 × P/S
   where
   P: Operating pressure MPa
   S: Allowable stress MPa
3. Designation (-B Series of Yuken)
   (Example 1)
   SGP pipe: SGP-2 1/2B
   (Example 2)
   STS370 with Sch. No.:
   STS370-3/4B × Sch. 80
   (Example 3)
   STS370 special thick wall steel pipe:
   STS370-1 1/4B × 8.0 t

Precision Carbon Steel Tubes for Compression Type Tube Fittings

・Thickness (mm)

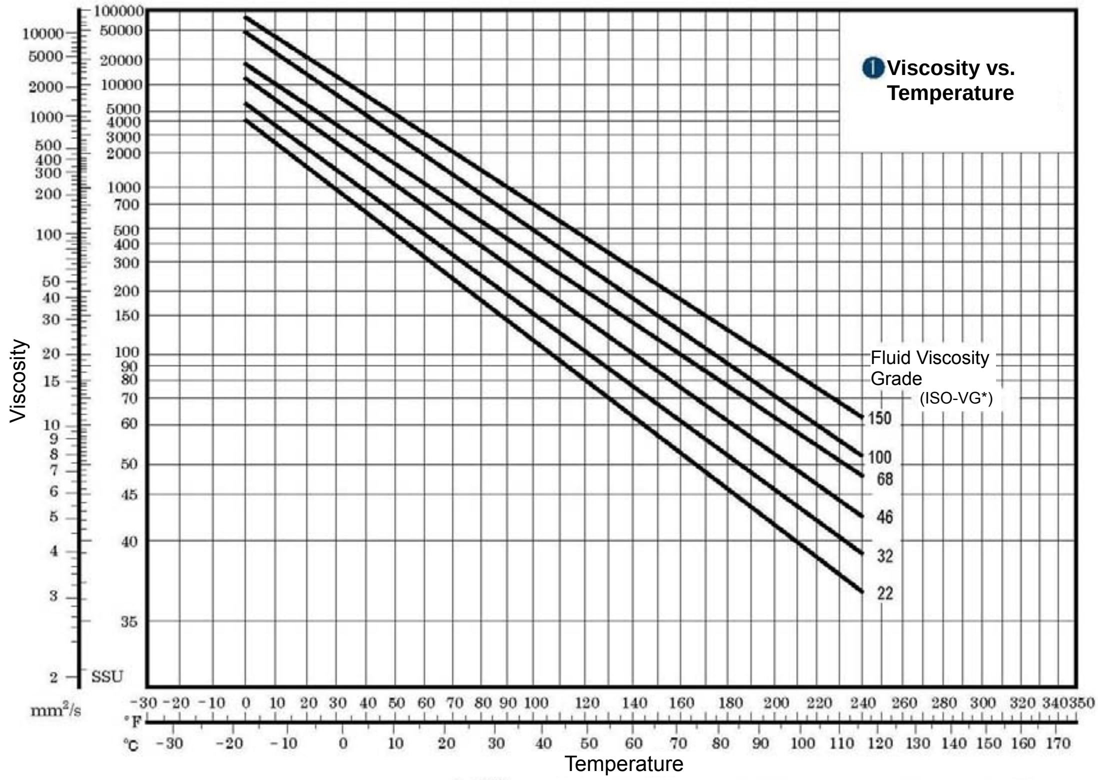
Outside mm \ Nominal Pres. MPa / Safety Factor	10	16	25	35
	6 or more		4 or more	
6				1.5
10			1.5	2.0
12			2.0	2.5
16	2.0		3.0	
20	2.0	2.5	3.0	
25	2.5		4.0	

Note)

1. STPS2 defined in JIS B 2351-1 Annex 2.
2. For selection considerations, refer to Note 1 in the "Carbon Steel Pipes" section.
3. Designation
   (Example) STPS2-12 × 2.5

Data Sheet
Formulas/Nomograms

Formulas/Nomograms [Part 4]
(1) Viscosity vs. Temperature,
(2) Viscosity Conversion Chart



❷ **Viscosity Conversion Chart**

Use the following equations when the viscosity is 100 mm²/s or more.

SSU × 0.220 ＝ mm²/s
RSS × 0.2435 ＝ mm²/s
°E × 7.6 ＝ mm²/s