● This catalog provides detailed information on hydraulic pumps, motors, integrated HSTs, cylinders, and valves for vehicles such as excavators, mini-excavators, loaders, forklift trucks, and agricultural machines. As for information on some products not included in this catalog, please contact KYB Hydraulic Sales Department.

● Some products require prototype tests based on the specifications of customer machines so as to secure their on-site fine tuning. In some cases, new functions need to be added to our products to meet customer requirements.

● The catalog makes general suggestions for product selection, handling precautions, and basic dimensions. Confirmation on detailed specifications may be necessary for actual use. Please contact KYB Sales Department for clarification of details. (Refer to Page 66 and to the back cover of the catalog for the contact details of Sales Department.)

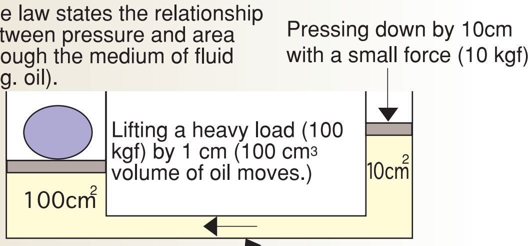
Basics of Oil Hydraulics

【What is oil hydraulics?】

Oil hydraulics refer to a group of devices or a system that drives a hydraulic pump with power sources, such as engines and electric motors, to transform mechanical energy to fluid energy in order to produce mechanical movement using an actuator like a cylinder while controlling energy output.

<Pascal's Law>

The law states the relationship between pressure and area through the medium of fluid (e.g. oil).



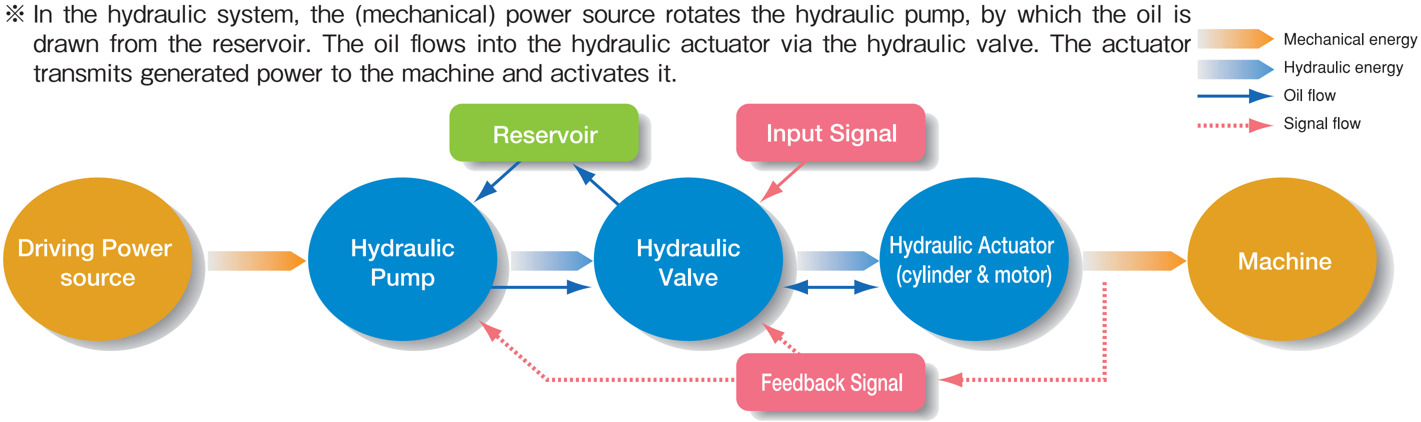
With a pipe connecting the two parts, the system is easily remotely controlled.

◇ Flexibility is enhanced in vehicle designing.

【Unit conversion table】

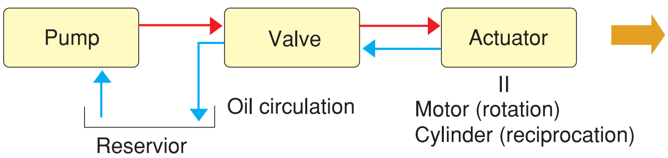
	Gravitational Unit	→ × → / ← ÷ ←	SI Unit (Symbol)	SI Unit (Name)
Force	kgf	9.807	N	Newton
	lbf	4.448	N	Newton
Torque (Moment of force)	kgf•cm	0.0981	N•m	Newton meter
	lbf•ft	1.356	N•m	Newton meter
	lbt•in	0.113	N•m	Newton meter
Pressure	kgf/cm^2	0.0981	MPa	Mega Pascal
	atm	0.1013	MPa	Mega Pascal
	psi(lbf/in^2)	0.0069	MPa	Mega Pascal
	bar	0.1	MPa	Mega Pascal
	mmHg	133.3	Pa	Pascal
Power	kgf•m/s	0.00981	kW	Kilowatt
	lbf•ft/s	0.00136	kW	Kilowatt
	PS	0.7355	kW	Kilowatt
	HP	0.746	kW	Kilowatt
Energy	kgf•m	9.807	J	Joule
	kcal	4186	J	Joule
Viscosity	kgf•s/cm^2	98067	Pa•s	Pascal second
	cP	0.001	Pa•s	Pascal second
	P (poise)	0.1	Pa•s	Pascal second
Kinetic viscosity	cSt	1×10^{-6}	m^2/s	Square meter per second
		1	mm^2/s	Square millimeter per second
	St	1×10^{-4}	m^2/s	Square meter per second

※ In the hydraulic system, the (mechanical) power source rotates the hydraulic pump, by which the oil is drawn from the reservoir. The oil flows into the hydraulic actuator via the hydraulic valve. The actuator transmits generated power to the machine and activates it.



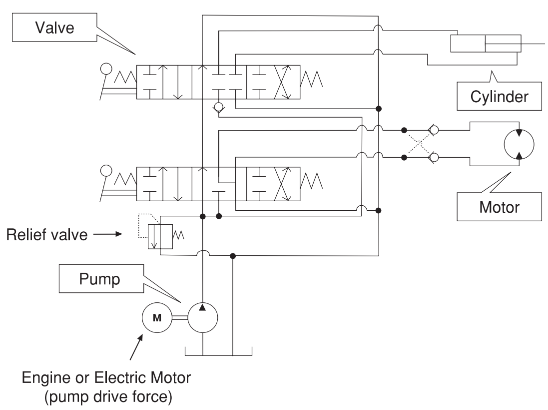
【Basic Configuration of Hydraulic Circuit】

【Hydraulic Equipment Configuration】
An open circuit model



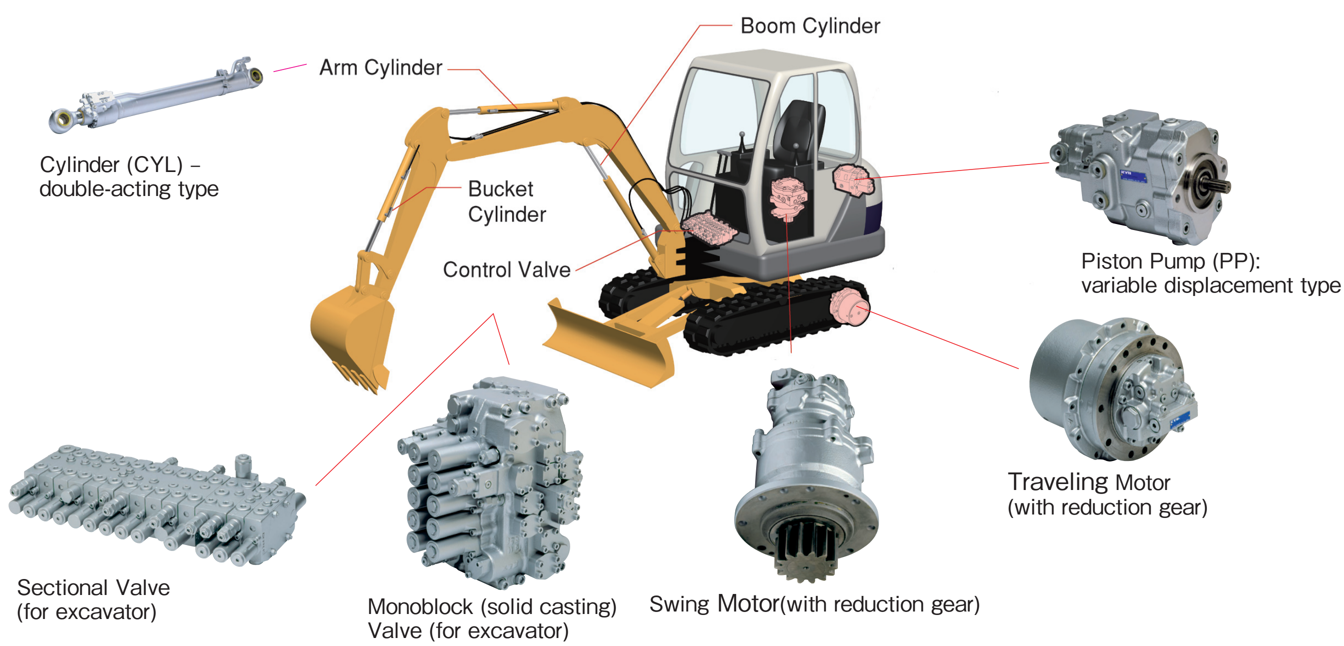
※ When the tip of the actuator is loaded, the oil pressure between the pump and actuator rises.

【Hydraulic Circuit Example】

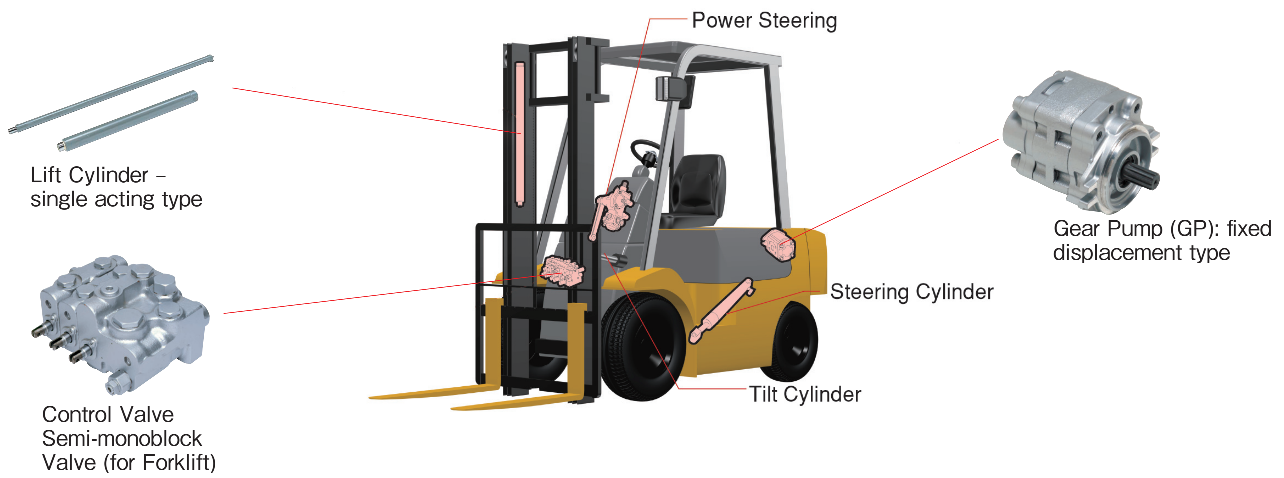


Products for Each Machine (examples)

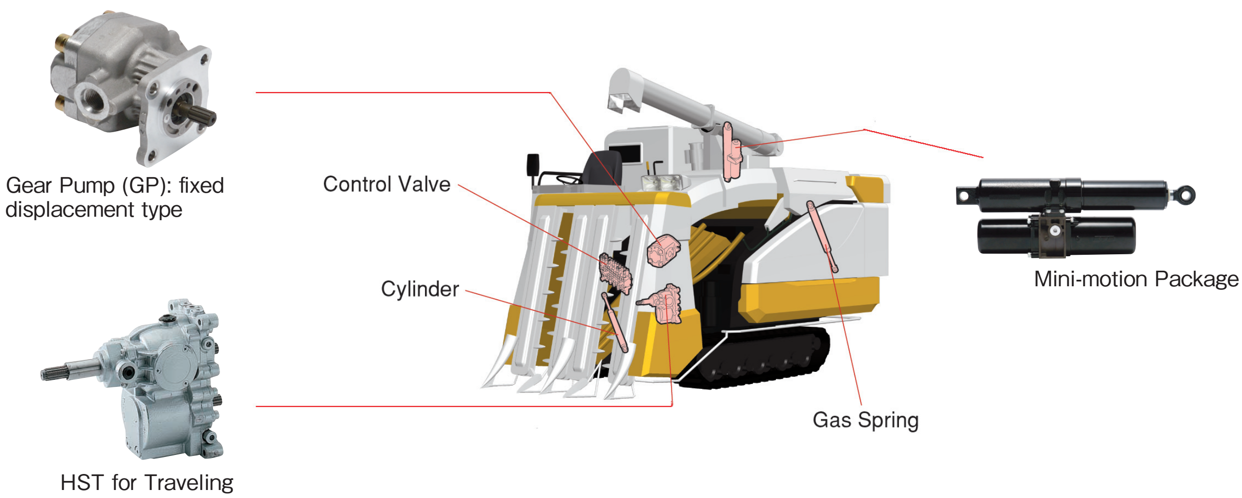
Hydraulic Equipment for Excavators and Mini-excavators



Hydraulic Equipment for Forklift Truck



Hydraulic Equipment for Combines



Caution regarding this Product Brochure

Definition of Alert Marks

In this brochure, the "Danger", "Warning", and "Caution" signs are defined as follows.

※ These warning signs are very important for the operator's safety. Understand them before using the products.

⚠Danger Improper handling will result in an imminently dangerous situation such as death or serious injury.
⚠Warning Improper handling may potentially risk death or serious injury.
⚠Caution Improper handling may result in slight to moderate injury or damage.

Instruction Manual

The cautions and notices described in this manual are intended to help select products. Please read the manuals of the selected products and fully understand the properties of the selected products before using them.

Regulations and Standards

Please observe the warnings and cautions described in this manual and the following regulations and standards for the safe use of products.
[Safety related regulations and standards]
① High Pressure Gas Safety Law, ② Industrial Safety and Health Law, ③ Fire Service Law, ④ Explosion Protection Classes,
⑤ Construction of Pressure Vessels (JIS B 8243), and ⑥ General Rules for Hydraulic Systems (JIS B 8361)

Safety Precautions

(1) On Product Handling

① ⚠Caution Wear necessary protective equipment when handling the product so as to prevent any injury.
② ⚠Caution Always be alert to avoid getting your hand pinched or suffering a backache from an unnatural operating posture or overload when handling the product.
③ ⚠Caution Do not step on, strike, drop, or apply stress to the product. Such an act may cause malfunction, damage, or oil leakage.
④ ⚠Caution Oil on a product or the floor makes it slippery and dangerous. When you find the hydraulic fluid on the product or the floor, wipe it off immediately.

(2) On Mounting and Dismounting products

① ⚠Caution Mounting, dismounting, piping, and wiring should be performed only by a qualified engineer (preferably one who has been trained by KYB) with the required knowledge.
② ⚠Warning Before starting such work, make sure that the machine is turned off, the motor or engine is not in motion, and pressure inside the hydraulic piping is zero.
③ ⚠Warning Turn off the power supply before doing wiring work. A failure to do so may cause an electric shock.
④ ⚠Caution Keep the mounting holes and surfaces of the product clean. A loose bolt or broken seal may cause damages or oil leakage.
⑤ ⚠Caution When mounting the product, use specified bolts only and tighten them with the specified torque. A failure to do so may cause malfunction, damage, or oil leakage.

(3) On Operation

① ⚠Danger Use only explosion- or combustion-proofed products in a explosive or combustible state.
② ⚠Warning Apply a protection cover on the rotation shaft of the pump and motor to avoid your hand or clothing being caught in the machine.
③ ⚠Caution If you find something wrong, such as strange sound, oil leakage and smoke, stop the operation immediately and take necessary action. A failure to do so may cause damage, fire, or injuries.
④ ⚠Caution Make sure that the hydraulic circuits and wiring are properly connected with no loose connections before the initial operation.
⑤ ⚠Caution Use the product only according to the specifications described in the catalog and drawings, and the specifications provided by KYB.
⑥ ⚠Caution The product becomes very hot during operation because of a rise in the temperature at the circuit oil and the solenoid valve. Make sure that the operator's hand or another part of his body does not touch such heated parts. A failure to do so may cause burns.
⑦ ⚠Caution Use the specified or proper hydraulic fluid and keep the contamination level within the recommended range. A failure to do so may cause malfunction or damage.

(4) On Maintenance and Storage

① ⚠Caution Any alteration or modification of the product by a customer is strictly prohibited.
② ⚠Caution Do not disassemble and reassemble the product without permission of KYB or its authorized agency. A violation may cause poor performance, damage, or an accident.
③ ⚠Caution Transport or store the product in a proper environment at a proper temperature and humidity with proper dust- and rust-preventative measures in place.
④ ⚠Caution Replacing seals may be necessary after storing the product for a long period.

Precautions on the Use of Hydraulic Equipment

All Hydraulic Circuits

※ When selecting hydraulic components, contact each manufacturer for the characteristics of hydraulic equipment such as piping, joints, filters, and oil reserviors manufactured by other manufacturers.

① Pressure drop: Pressure drop is proportional to the square of the flow rate. Because the loss may increase depending on the specific equipment and the size and/or length of joints, the normal flow rate and the maximum flow rate being used also should be taken into account.

② Circuit temperature control: The temperature of the hydraulic fluid in the entire circuit may rise because of the operation frequency and/or pressure drop. Consult the component manufacturer to make sure the reservoir and cooler capacity is sufficient.

Hydraulic Fluids

● Applicable hydraulic fluids

Cold regions	Warm regions
ISO VG32	ISO VG46
Outside air temperature −10 ~ 25℃	Outside air temperature 0 ~ 35℃

● Applicable hydraulic fluids

	Kinetic viscosity mm^2/s	Oil temperature	
		ISO VG32	ISO VG46
Proper range	25 ~ 100	17 ~ 45℃	23 ~ 55℃
Practical range	15 ~ 500	−7 ~ 60℃	0 ~ 70℃

● Strainers and Filters

Apply a 150 mesh strainer to the suction line from a reservoir and a 10μm filter to the return line to the reservoir. Determine the capacity based on the pump flow rate on the maximum input rotation and maintain the pressure drop below 0.03 MPa.

<Hydraulic fluid contamination level control>

It is recommended to maintain hydraulic fluid contamination within the NAS 9 class range.

● Circuit Oil Temperature

Permissible oil temperature range: -20℃ (starting temperature) up to 100℃ (total 100 hours), and between 20℃ and 80℃ for a continuous operation.

Please contact us when you plan to use the equipment outside the permissible oil temperature range.

Precautions on Handling Pump/Motor

Mounting

① In general, the pump/motor can be mounted in any direction. But the drain piping should be connected to the reservoir at a point lower than the oil level after it is taken out from the upper surface of the pump/motor housing. This is to lubricate the reduction gears. Please note that the travel motor and the swing motor are to be mounted in the specified direction.

② Make sure that the rotating direction is correct for both pump and motor.

③ Make sure there is some allowance between the pump shaft and driving shaft (with a motor or engine), and between the motor shaft and driven shaft (on the load side), in either case in the radial direction. Avoid applying thrust load to the pump or motor shaft.

④ Maintain the center dislocation between the pump and driving shafts, and between the motor and driving shafts within 0.1 mm on FIR (full indicator reading).

Selecting Shaft End Configuration

Select a shaft end configuration appropriate for the driving system based on the following pump and motor requirements.

① Direct driving: When it is difficult to give some allowance in the radial direction, use a spline shaft. Make sure to apply lubricant and dust-protection to the spline. Selecting a counterpart spline with the surface hardness over HRC 50 and the surface roughness below 32a is recommended.

② Coupling driving: When using a flexible coupling, select one with a straight shaft and assemble it in such a way that no thrust load is applied to the pump motor shaft. (See Fig. 2 below.)

③ Applicable shaft configurations vary depending on the product. Please contact us for details.

【Pump/Motor Shaft Driving System】

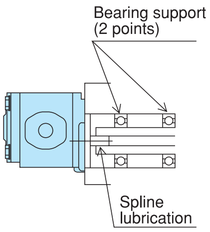


Fig. 1 Example of Direct Driving
※ Spline shaft

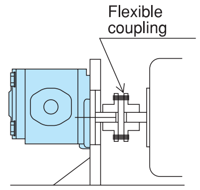


Fig. 2 Example of Coupling Driving
※ Straight shaft

Pump Suction Pressure and Piping

During a normal pump operation, maintain pressure on the pump suction port (less than 30 mm from the port surface) above -0.02 MPa. Pressure may come down as low as -0.05 MPa for a short while on a cold start, but air suction from the piping should be strictly avoided. For the suction side piping, use pipes with a diameter equal to or larger than the diameter of the pump suction port and try to keep the length as straight and short as possible.

Piston Pump Motor Drain Piping and Case Internal Pressure

◇ Drain piping is to be connected to the reservoir at the point lower than the reservoir oil level after being taken out from the point higher than the pump/motor housing. This is necessary for lubrication in reduction gears.
Always keep the motor housing filled with oil. Otherwise, it will result in poor lubrication in the housing and cause the seizure of parts.
◇ Maintain the case internal pressure below 0.1 MPa.
Higher drain pressure will shorten the life of internal parts. Smaller or longer piping will raise the internal pressure.
◇ Contact us about the proper drain flow, which varies depending on the condition.
◇ Operating the product without drain piping will raise the pressure in housing and may cause internal damage or oil leakage. If you have done so, inspect and repair damage or replace the housing. (This will not apply to some pumps that do not need drain piping.)
◇ Fill the housing with oil before starting an operation. Otherwise, it may cause an initial seizure.

Closed Circuit Pump and Motor Boost Pressure

A closed circuit pump requires boost pressure of 0.3 to 0.5 MPa at the suction port.
Lower boost pressure may cause cavitation, noise, poor braking, or damage to the pump.

Piston Motor Back Pressure

If the output port of a motor in a series- or meter-out circuit is pressurized highly and constantly, the product life shortens and excessive back pressure may damage the motor at an early stage of its life. Contact us for permissible maximum back pressure for each product.

Piston Motor Cavitation Prevention

With a motor used in an open circuit, cavitation may occur at a low-pressure area when the motor stops running. Install a cavitation preventive function in the circuit to avoid such damage.

Precautionary Cylinder Handling

● **Initial Unpacking**

Do not remove the plug placed on the cylinder port until you start assembling the unit. Mount the cylinder on the prepared equipment right after unplugging it, and fill the cylinder with oil.

● **Rust Protection**

When leaving the rod extended after the cylinder is mounted on the equipment, apply grease to the exposed rod surface once a month.

Precautions on Valve Handling

● **On Assembly**

◇ Do not remove the plug placed on each port until it is connected to the piping.
◇ When mounting a valve, use bolts of the right size and work on the provided flat mounting plate so as to protect the valve from the tightening torque.
◇ Use an operation link that does not apply a horizontal load to the spool. (Manual lever, etc.)

● **On Operation**

◇ Set the valve lever at the neutral position when starting an operation. Otherwise, it may cause the actuator to start running unexpectedly.
◇ Allowable maximum backpressure: The figure in the specifications includes a peak value at the tank port of the valve. A careful attention is also required when viscosity is high at a low temperature.
※ Please read the precautions described in each chapter after page 7.

Definition of terms frequently used with hydraulic circuit trouble

Entire circuit		Hydraulic equipment	
Oil hammer	Pressure increase generated by a rapid decrease in the flow rate of oil in the system.	Chattering	A self-induced high-frequency vibration of the check valve or relief valve generated by the oscillation of the valve seat.
Aeration	Process in which air is entrained in hydraulic fluid	Hunting	A phenomenon in which the movement of the motor and cylinder fluctuates due to the oscillation of the flow control valve (the piston, etc.) and pressure variance resulting from the air bubbles in a circuit.
Cavitation	A phenomenon in which tiny gas bubbles in oil inflate with pressure from the oil flow partially reduced.	Hydraulic lock	Undesirable locking of a piston or a spool attributed to a trapped liquid prevents movement.
Erosion	Loss of material from mechanical elements caused by the impingement of fluid or fluid-suspended particulate matter, micro-jets or a combination thereof	Flow force	Force on a movable element in components caused by the flow or fluid passing by.
Contamination	A state in which hydraulic fluid in the circuit is mixed with various contaminants, such as casting sand, chips, rust, welding beads, seal scrapings, dust, and dirt.	External leak	Oil leakage outside the hydraulic equipment that contaminates the equipment and surrounding objects.
Flushing	A cleaning method in which the cleaning operation is conducted to remove foreign objects that have been on the piping from the beginning. (This has nothing to do with a flushing valve system in a closed circuit.)	Internal leak	Oil leakage from the high-pressure side to the low-pressure side in the hydraulic equipment. Serious leakage lowers performance and may cause an excessive lowering of a cylinder.
Heat shock	A phenomenon in which very hot oil flows into the low temperature parts of the equipment and entire circuit that has not quite warmed up yet, resulting in a sudden inflation of parts causing malfunction.	Crack (Burst)	Cracking of the equipment body or its parts caused by excessive high pressure, fatigue, drop, or external force.

Additional Data

1.Main Formulas (Source: Extracted from the Practical Hydraulic System Pocket Book) published by the Japan Fluid Power Association)

<Formulas for Pump and Motor Characteristics (The International System of Units)>

Definition	Symbol	Unit	Pump	Motor
Displacement	Vg	cm3		
Pressure difference	ΔP	MPa	Pout − Pin	Pin − Pout
Revolution speed	n	min^{-1} (rpm)	n	$\frac{q_v \cdot 10^3 \cdot \eta_v}{V_g}$
Flow rate	qv	L/min	$\frac{V_g \cdot n \cdot \eta_v}{10^3}$	$\frac{V_g \cdot n}{10^3 \cdot \eta_v}$
Torque	T	N・m	$\frac{V_g \cdot \Delta P}{2 \cdot \pi \cdot \eta_{hm}}$	$\frac{V_g \cdot \Delta P \cdot \eta_{hm}}{2 \cdot \pi}$
Volumetric efficiency	η_v	−	$\frac{q_v \cdot 10^3}{V_g \cdot n}$	$\frac{V_g \cdot n \cdot 10^{-3}}{q_v}$
Mechanical efficiency	η_{hm}	−	$\frac{V_g \cdot \Delta P}{2\pi \cdot T}$	$\frac{2\pi \cdot T}{V_g \cdot \Delta P}$
Total efficiency	η_t	−	$\frac{q_v \cdot \Delta P \cdot 10^3}{2\pi \cdot T \cdot n}$	$\frac{2\pi \cdot T \cdot n \cdot 10^{-3}}{q_v \cdot \Delta P}$
Driving power source (pump input) (motor output)	Ph	k W	$\frac{2\pi \cdot T \cdot n}{60{,}000}$ or $\frac{q_v \cdot \Delta P}{60 \cdot \eta_t}$	$\frac{2\pi \cdot T \cdot n}{60{,}000}$ or $\frac{q_v \cdot \Delta P \cdot \eta_t}{60}$

Reference: 1kW = 10^3 N・m/s = 102kgf・m/s
1PS = 735.5 N・m/s = 75kgf・m/s

<Motor related formulas>

■ Revolution load and hydraulic motor selection

Rotation is considered to generate the following loads.

Static friction torque

Breakaway torque $T_1 = \mu_S \cdot m \cdot g \cdot R$ [N・m]

Dynamic friction torque $T_2 = \mu_D \cdot m \cdot g \cdot R$ [N・m]

Inertia torque $T_3 = I \cdot \frac{d\omega}{dt} = \frac{GD^2}{4} \cdot \frac{2\pi \cdot N}{60t} = \frac{N \cdot GD^2}{38t}$ [N・m]

Where,

R: Bearing radius of rotating object (m)

I: Inertia moment of rotating object [kg・m^2]

GD^2: Flywheel effect

ω : Revolution angular velocity $\omega = \frac{2\pi \cdot N}{60}$ [rad/s^2]

$\frac{\omega}{t}$: Revolution angular acceleration $\frac{\omega}{t} = \frac{2\pi \cdot N}{60t}$ [rad/s^2]

N: Revolution velocity (min-1)

t: Acceleration time (s)

Sum of GD2 in multi-axis rotation:

$GD^2 = GD_1^2 + GD_2^2 \cdot \left(\frac{N_2}{N_1}\right)^2 + GD_3^2 \cdot \left(\frac{N_3}{N_1}\right)^2$

Where,

GD^2: Whole GD2 on one axis

GD^2_1 and N_1: GD^2 on the first axis and revolution velocity

GD^2_2 and N_2: GD^2 on the second axis and revolution velocity

GD^2_3 and N_3: GD^2 on the third axis and revolution velocity

Select a hydraulic motor considering the magnitude of the load torque. The output torque of a hydraulic motor varies at operation start and during operation, and the former is more important.

$T = \frac{P \cdot D \cdot \eta_T}{2\pi}$ [N*m] Consequently $D = \frac{2\pi \cdot T}{P \cdot \eta_T}$ [cm^3]

$P = \frac{2\pi \cdot T}{D \cdot \eta_T}$ [MPa]

$Q = \frac{D \cdot N}{1000\,\eta_V}$ [L/min]

Where,

D: displacement volume of a hydraulic motor [cm^3]

T: Output torque of a hydraulic motor [N・m]

P: Effective pressure of a hydraulic motor [MPa]

N: Revolution velocity of a hydraulic motor [min^{-1}]

η_TT: Torque efficiency of a hydraulic motor

η_Tv: Volumetric efficiency of a hydraulic motor

<Cylinder related formulas>

■ Reciprocation load and cylinder selection

A double acting movement is considered to generate the following loads.

Static friction resistance $F_1 = \mu_S \cdot m \cdot g$ [N]

Dynamic friction resistance $F_2 = \mu_D \cdot m \cdot g$ [N]

Inertia load $F_3 = m \cdot a = m \cdot \frac{dV}{dt}$ [N]

Elasticity load $F_4 = k \cdot x$ [N]

Where,

μ_S: Moving angle static friction coefficient

μ_D: Moving surface dynamic friction coefficient

M: Load mass [kg]

g: Gravitational acceleration [m/s^2]

a: Acceleration [m/s^2]

V: Cylinder velocity [m/s]

t: Acceleration time [s]

k: Spring constant [N/mm]

x: Spring displacement [mm]

Select a cylinder considering the load magnitude. When the compression force is great, consider the rod buckling strength.

Determine standard dimensions of the hydraulic cylinder to satisfy the calculated dimensions.

Piston rod diameter $d = \sqrt{\frac{4 \times F \cdot S}{\pi \cdot \sigma}}$ [mm]

Cylinder bore $D = \sqrt{\frac{4(A_1 + A_2)}{\pi}}$ [mm]

Where,

F: Cylinder load [N]

S: Safety factor

σ : Tensile strength [N/mm^2]

A_1: Piston rod area $A_1 = \frac{\pi}{4} \cdot d^2$ [mm^2]

A_2: Cylinder effective area $A_2 = \frac{F}{P_R}$ [mm^2]

P_R: Pressure on cylinder [MPa]

Determine the cylinder size and obtain the required pressure and flow.

$P_1 = \frac{F}{A_1}$ [MPa]

$Q = A_1 \cdot V \times 10^{-3}$ [L/min]

Where P_1: Pressure required of a cylinder [MPa]

Q: Flow rate required of a cylinder [L/min]

F: Cylinder thrust [N]

A_1: Inlet side pressure receiving area [mm^2]

V: Cylinder velocity [m/min]

<Valve related formulas>

(1) Pressure and flow rate Q before and after throttle

$Q = 60\,cA\sqrt{\frac{2\Delta P}{\rho}}$

Q: Flow rate [L/min]

c: Flow coefficient [0.6 ~ 0.7]

A: Throttle area (opening) [mm^2]

Δ P: Pressure difference before and after throttle [MPa]

ρ : Hydraulic oil density [kg/m^3]

(2) Spool leak amount q

$q = \frac{\pi d b^3}{12\mu l}(1 + 1.5\varepsilon^2)\Delta P$

q: Leak amount [cm^3/s]

d: Spool diameter [mm]

l: Lap length (clearance length) [mm]

b: Clearance (hole dia. - shaft dia.) / [μm (10^{-3}mm)]

ε : Eccentricity (spool eccentric distance) / b

μ : Viscosity (Pa*S)

△ P: Front and rear pressure difference [MPa]

2. Tightening Torque for Piping (Reference data)

Note: The tightening torque may vary depending on various conditions such as material, specifications, tightening methods, etc. The following figures represent hypothetical conditions:

(1) Metric screw

Coarse pitch strength grade II Unit : N・m (kgf・m)

Strength grade	M5 × 0.8	M6 × 1	M8 × 1.25	M10 × 1.5	M12 × 1.75	M14 × 2	M16 × 2	M18 × 2.5	M20 × 2.5	M22 × 2.5
6 T	3.3 ± 0.2 (0.34 ± 0.02)	5.6 ± 0.3 (0.57 ± 0.03)	13.7 ± 0.7 (1.40 ± 0.07)	27.17 ± 1.37 (2.77 ± 0.14)	47.5 ± 2.4 (4.84 ± 0.24)	75.9 ± 3.8 (7.74 ± 0.39)	118.7 ± 5.9 (12.1 ± 0.6)	162.8 ± 7.85 (16.6 ± 0.8)	231.5 ± 11.8 (23.6 ± 1.2)	315.8 ± 15.7 (32.2 ± 1.6)
8 T	5.4 ± 0.3 (0.55 ± 0.03)	9.1 ± 0.5 (0.93 ± 0.05)	22.3 ± 1.1 (2.27 ± 0.11)	44.13 ± 2.26 (4.50 ± 0.23)	77.1 ± 3.8 (7.86 ± 0.39)	123.6 ± 5.9 (12.6 ± 0.6)	192.2 ± 9.8 (19.6 ± 1.0)	264.8 ± 13.7 (27.0 ± 1.4)	375.6 ± 18.6 (38.3 ± 1.9)	513.9 ± 25.5 (52.4 ± 2.6)
1 0 T	7.5 ± 0.4 (0.76 ± 0.04)	12.7 ± 0.6 (1.29 ± 0.06)	30.8 ± 1.6 (3.14 ± 0.16)	61.10 ± 3.04 (6.23 ± 0.31)	106.9 ± 5.9 (10.9 ± 0.6)	170.6 ± 8.8 (17.4 ± 0.9)	266.8 ± 13.7 (27.2 ± 1.4)	366.8 ± 18.6 (37.4 ± 1.9)	519.8 ± 26.5 (53.0 ± 2.7)	711.0 ± 35.3 (72.5 ± 3.6)

Fine pitch strength grade II Unit : N・m (kgf・m)

Strength grade	M5 × 0.5	M6 × 0.75	M8 × 1	M10 × 1.25	M12 × 1.25	M14 × 1.5	M16 × 1.5	M18 × 1.5	M20 × 1.5	M22 × 1.5
6 T	3.8 ± 0.2 (0.39 ± 0.02)	6.3 ± 0.3 (0.64 ± 0.03)	14.8 ± 0.8 (1.51 ± 0.08)	28.93 ± 1.47 (2.95 ± 0.15)	52.5 ± 2.7 (5.35 ± 0.27)	82.7 ± 4.1 (8.43 ± 0.42)	127.5 ± 6.9 (13.0 ± 0.7)	185.4 ± 9.8 (18.9 ± 1.0)	258.9 ± 12.8 (26.4 ± 1.3)	350.1 ± 17.7 (35.7 ± 1.8)
8 T	6.2 ± 0.3 (0.63 ± 0.03)	10.1 ± 0.5 (1.03 ± 0.05)	24.0 ± 1.2 (2.45 ± 0.12)	46.98 ± 2.35 (4.79 ± 0.24)	85.2 ± 4.2 (8.69 ± 0.43)	134.4 ± 6.9 (13.7 ± 0.7)	206.9 ± 10.8 (21.1 ± 1.1)	301.1 ± 14.7 (30.7 ± 1.5)	420.7 ± 20.6 (42.9 ± 2.1)	568.8 ± 28.4 (58.0 ± 2.9)
1 0 T	8.6 ± 0.4 (0.88 ± 0.04)	14.0 ± 0.7 (1.43 ± 0.07)	33.3 ± 1.7 (3.39 ± 0.17)	65.02 ± 3.24 (6.63 ± 0.33)	117.7 ± 5.9 (12.0 ± 0.6)	186.3 ± 9.8 (19.0 ± 1.0)	286.4 ± 14.7 (29.2 ± 1.5)	416.8 ± 20.6 (42.5 ± 2.1)	582.5 ± 29.4 (59.4 ± 3.0)	787.5 ± 39.2 (80.3 ± 4.0)

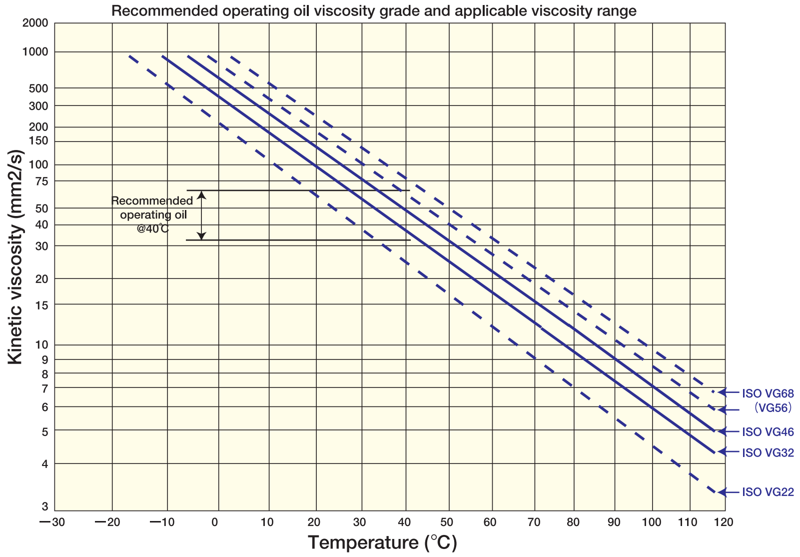
(2) G O-ring boss joint Unit: N・m (kgf・m)

Size	Working pressure	
	20.6MPa	27.5MPa
G1/8	9.0 ± 0.4 (0.92 ± 0.04)	11.8 ± 0.6 (1.2 ± 0.06)
G1/4	22.6 ± 1.0 (2.3 ± 0.1)	29.4 ± 1.0 (3.0 ± 0.1)
G3/8	39.2 ± 2.0 (4.0 ± 0.2)	57.0 ± 2.0 (5.2 ± 0.2)
G1/2	70.6 ± 2.9 (7.2 ± 0.3)	92.2 ± 3.9 (9.4 ± 0.4)
G3/4	157 ± 8 (16.0 ± 0.8)	216 ± 11 (22.0 ± 1.1)

(3) Unified O-ring boss joint Unit: N・m (kgf・m)

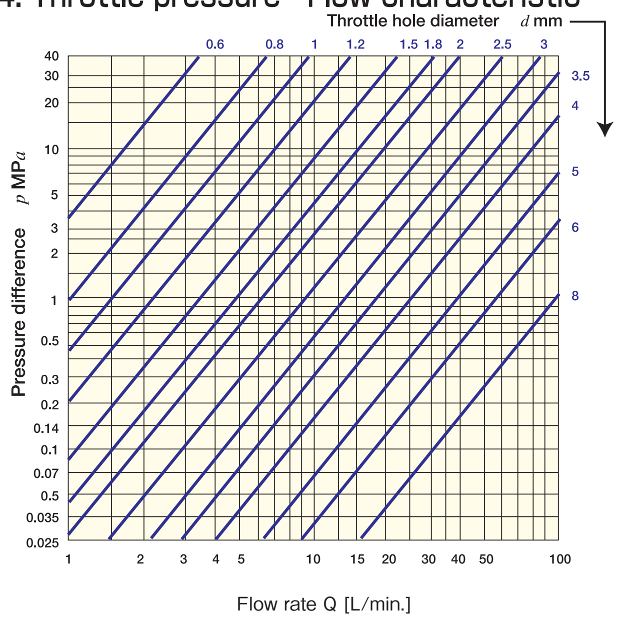
Size	Working pressure	
	20.6MPa	27.5MPa
7/16-20UNF	11.8 ± 0.6 (1.2 ± 0.06)	15.7 ± 0.8 (1.6 ± 0.08)
9/16-18UNF	23.5 ± 1.0 (2.4 ± 0.1)	31.4 ± 1.0 (3.2 ± 0.1)
3/4-16UNF	53.0 ± 2.0 (5.4 ± 0.2)	70.6 ± 2.9 (7.2 ± 0.3)
7/8-14UNF	80.4 ± 3.9 (8.2 ± 0.4)	107.9 ± 4.9 (11.0 ± 0.5)

3. Working oil viscosity - Temperature graphs



Use hydraulic oil ISO VG32 in cold areas and ISO VG46 in warm areas.

4. Throttle pressure - Flow characteristic



Typical Applications and Products

Pumps, valves, motors, and cylinders for excavators and mini-excavators

Pumps, valves, and motors for wheel loaders and skid-steer loaders

Pumps, valves, HSTs, and MMPs for agricultural equipment

Pumps, valves, and cylinders for forklift trucks