Contents

Note:- *Performance characteristics shown are based on our laboratory test conditions and these may vary under different operating conditions. Product details are liable to change without prior notice.*

SALIENT DESIGN & CONSTRUCTION FEATURES

DESCRIPTION :

Variable volume, swash plate design axial piston pump for open loop circuits
280 bar continuous operating pressure
Efficient flow & pressure controls

SALIENT FEATURES :

Compact design
Low noise operation
Good suction characteristics
2 separate case drain ports for horizontal & vertical mounting
Easy to maintain
Provision to adjust / set minimum & maximum flow
SAE or ISO flange mounting option
Port flanges with UNC or Metric threads
Option for ports at side or rear
Tapered roller bearings for long life
High efficiency

INDUSTRIAL APPLICATIONS :

Metal working machinery such as presses, tube drawing etc.
Aluminium die casting machinery
Plastic injection and blow molding machinery
Amusement park machinery
Material handling machinery such as conveyors etc.
Mining machinery such as crushers etc.
Simulators
Machine tools

MOBILE APPLICATIONS :

Construction & earth moving machinery such as loaders & back hoes
Rail road machinery such as track laying m/cs.
Refuse trucks
Mining machinery such as tunnel borers etc
Road machinery such as asphalt pavers etc.
Agriculture & forestry machinery such as harvesters & logging m/cs
Material handling machinery such as cranes etc.
Marine equipment such as steering gear etc.

APPLICATION GUIDE LINES

Mounting
The J9V model Piston Pumps are designed for operating in any position so long as the Pump shaft is accurately aligned with its drive shaft. The concentricity of the Pump and Drive shaft is more critical if no flexible coupling is used between them.

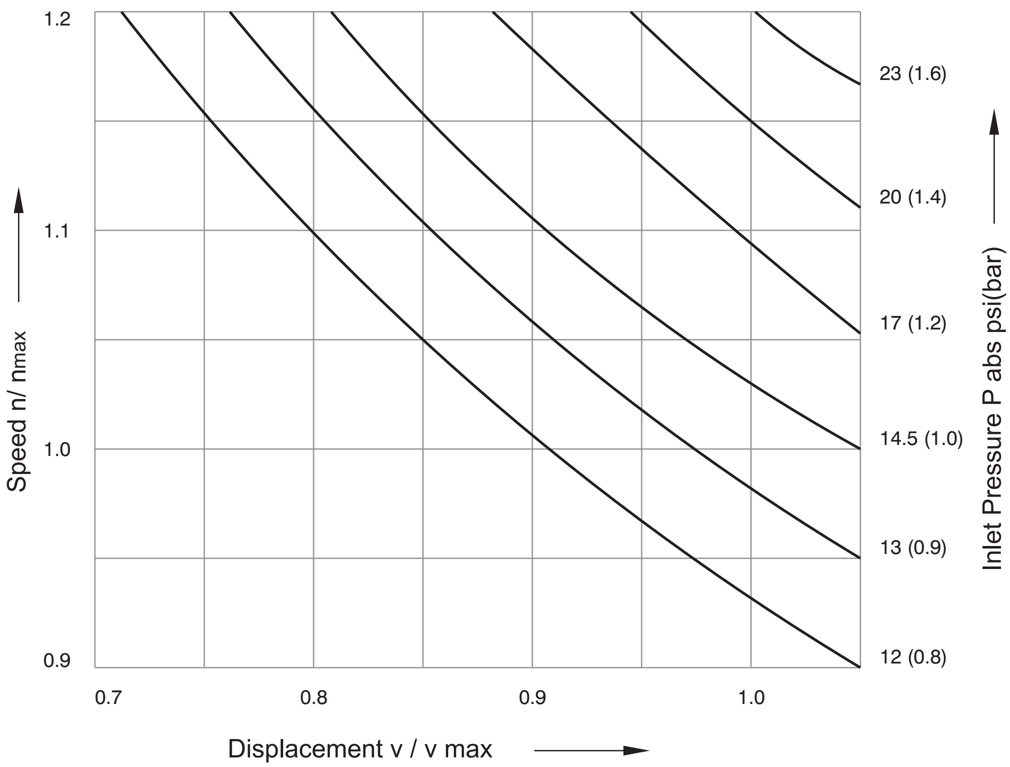
Shaft types
The pumps are designed for in-line-drive only and no side loading on the shaft is permissible beyond the specific limits. Pumps are supplied with either keyed or splined shaft.

Splined : The shaft splines are of flat root side fit type and a coupling confirming to class-5 side root fit as per SAE - J498C with hardness of 27-34 Rc must only be used to drive the pump. The permissible maximum misalignment is 0.06 mm (0.002 in) TIR for foot mounted pump and 0.03 mm (0.001 in) in case of flange mounted pump. The angular misalignment between the shaft splines and the coupling internal splines should be less than +/- 0.002 mm per mm diameter of the pump shaft. The shaft /coupling splines must be coated with a long lasting lubricant such as molybdenum di-sulphide grease.

Keyed : These are supplied with matching Keys and in case replacement becomes necessary, use only high strength heat treated steel keys with hardness of 27-34 Rc. The key corners must be chamfered properly so that it locates snugly in the keyway.

Inlet pressure
Maintain inlet pressure within the limits shown below. Low inlet pressure (vacuum) may limit maximum pump speed and cause cavitation.
Inlet pressure (min) = 0.8 bar(12 psi)
Inlet pressure(max) = 30 bar(435 psi).

VARIATION OF OUTPUT FLOW BASED ON INLET PRESSURE AT VARIOUS RPM



The above graph helps in determining the output flow or the minimum inlet pressure required at the rated RPM.

APPLICATION GUIDE LINES

Case pressure

The maximum permissible case pressure is 2 bar (30 psi) absolute and at the same time it must not exceed the inlet pressure by more than 0.5 bar (7 psi). The case drain piping to the reservoir should be such that the pump casing is full of oil at all times. If necessary use a check valve (0.3 bar / 5 psi spring) in the drain line. The size of the case drain pipe should be of sufficient size to prevent development of back pressure of over 2 bar (30 psi)

Pressure ratings

Refer table, 'General Characteristics' on page 9 for maximum (peak) and continuous pressure ratings against each displacement. While selecting a suitable pump for a specific application, ensure that the connected load never exceeds this pressure. The various pressures that are to be considered while selecting a pump are given below.

System pressure is the pressure developed by the pump measured at it's outlet port which is needed to handle the load connected to it. To achieve longer life for the pump the system pressure should remain at or below the continuous operating pressure specified.

Continuous operating pressure is the pressure at which the pump is operating normally in steady state condition.

Maximum (peak) pressure is the pressure at which the pump can be run for very short periods of time intermittently. At no point of time the pump should be tried to operate above this pressure

Speed ratings

The Minimum, maximum and limiting speeds for each displacement are given in the table on Page 9 and definitions for these various speeds are given below. The minimum recommended speed is 500 rpm for satisfactory performance of the pump.

Maximum speed is that which is permitted when pump is being used at maximum displacement with inlet pressure of 1 bar (abs). It is advisable to operate below this speed limit for obtaining longer service life of the pump.

Limiting speed is the highest speed at which the pump can be run under full power condition. Exceeding this speed limit would call for positive suction pressure and/or reduced pump delivery volume.

Shaft loads

The pumps are provided with tapered roller bearings which can take external radial and thrust loads. But as far as possible all external shaft loads are to be avoided and where this is not feasible try mounting the pump in such a way so that these external loads fall between 150^{o} & 210^{o} position as shown in the sketch on next page. The radial load imposed on the shaft due to an externally applied load is to be calculated using the formula given below and this should not exceed the limits given in the table on page 9.

T = Fr x S

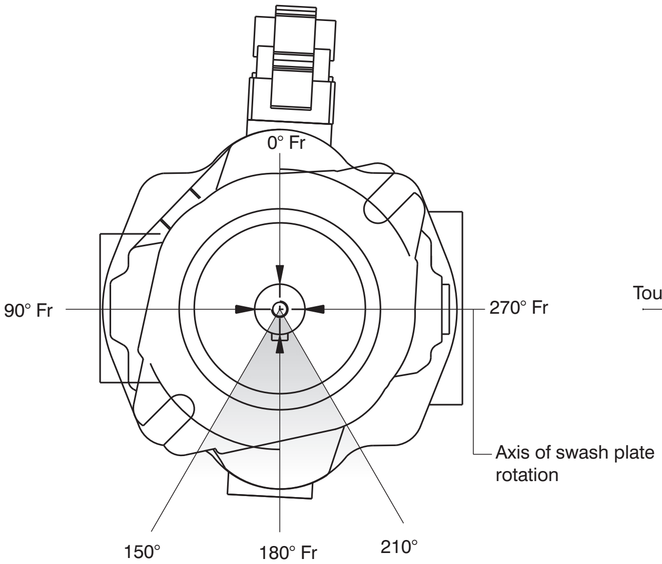
Where S = distance between mounting flange and point of application of load.

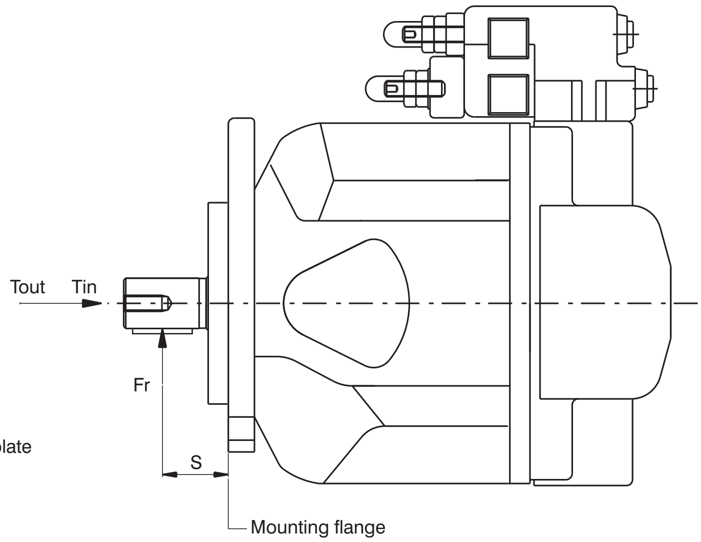
T = Maximum torque.

Fr = Maximum radial load.

APPLICATION GUIDE LINES

Shaft load orientation:





T in, T out = Thrust load

Fluid connections

The hoses / pipes used must be of adequate size matching to the port size on the pump to ensure free flow of oil and also must be of sufficient strength to withstand the possible pressures. A smaller size inlet pipe will not allow sufficient flow of oil into the pump at higher operating speeds. A smaller size outlet pipe will create back pressure and result in heat generation. Flexible hoses are preferred and when rigid piping is used it must be ensured that it does not impose any strain on the pump port block / fluid connections. Galvanised coating for the steel pipes is to be avoided, as in use the coating can flake off and contaminate the oil.

Hydraulic Fluid

Oil in a hydraulic system performs the dual function of lubrication and transmission of power. It constitutes a vital factor in a hydraulic system and due care should be taken in choosing the right oil that assures satisfactory life and operation of all the system components with particular emphasis on hydraulic pumps.

Use a high quality, anti-wear, mineral based hydraulic fluid when the pressure exceeds 3000psi (207 bar). The optimum viscosity must be between 16 and 36 mm^2/s.

Recommended fluids

Petroleum base mineral oils containing additives for anti-foaming; anti-rusting, anti-oxidation and de-aeration are recommended. New generation synthetic oils with similar characteristics can also be used after ensuring their compatibility with material of seals (Buna-N / Nitrile).

The seals and o-rings may need to be changed, if necessary, to ensure their compatibility with the fluid. The chart below illustrates the effects on pump life when using non standard fluids.

Fluid type>>		Mineral Oil	Phosphate ester	Polyol ester	Water glycol
MAX Pressure	bar	350	210	210	210
Temperature Range	°C	20~60			10~50
Cavitation resistance		●	Ø	Ø	Ø
Percentage pump life compared to mineral oil		100	60	50	20

● = Optimum Ø = acceptable but with reduced pump life

APPLICATION GUIDE LINES

Viscosity limits

The following values apply in respect of viscosity limits:

Vmin = 10 mm²/s (60 SUS)
Short-term at maximum permissible drain temperature of 90° c.

Vmax = 1000 mm²/s. (4600 SUS).

Maintain fluid viscosity within the recommended range for maximum efficiency and bearing life. Minimum viscosity should only occur during brief occasions of maximum ambient temperature and severe duty cycle operation. Maximum viscosity should only occur at cold start. Limit speed at which the pump is run until the system warms up.

Temperature range

t min = -25 ° C (-13° F)

t max = 90° C (194° F)

Maintain fluid temperature with in the limits shown above. Minimum temperature relates to the physical properties of the component materials. Cold oil will not affect the durability of the pump components. However, it may affect the ability of the pump to provide flow and transmit power. Maximum temperature is based on material properties and it should not be exceeded. Measure maximum temperature at the hottest point in the system which is usually the case drain.

Filtration

The operating fluid entering in to the inlet port of the pump must be confirming to the cleanliness level of NAS-1638 Class 9 or SAE - Class 6 or ISO-4406 class 18/15.Oils contaminated with foreign matter will result in wear out of the pump internals leading to it's premature failure.

Suction line filtration is not advisable as it can cause high inlet vacuum that limits the pump operating speed. It is recommended to place a 125 micron (150 mesh) screen at the oil entry point(inside the reservoir) into the pipe that is connected to the pump inlet.

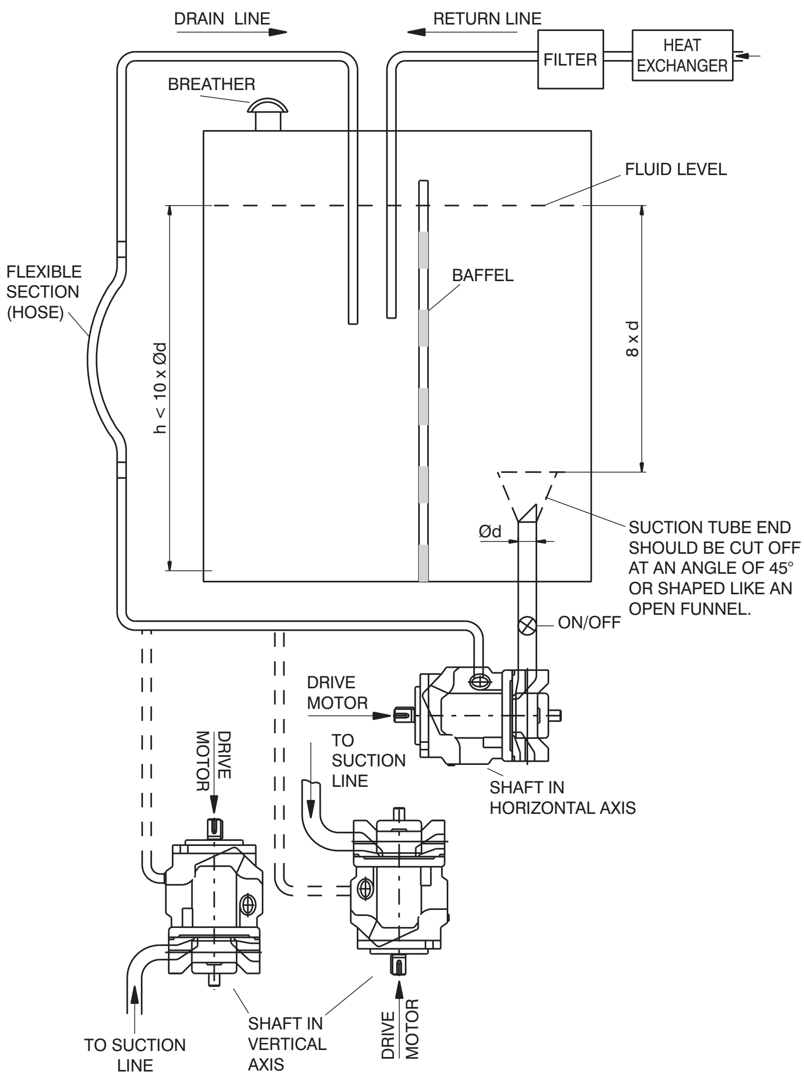
Filtration of oil in the return line is recommended and generally a filter with beta ratio of 20 ≥100 will be sufficient. But as each system is unique, selection of an appropriate return line filter is to be made considering the cleanliness level of the oil required, flow capacity of the pump, maintenance periodicity and ambient conditions for promoting contamination.

Installation

The installation position shown is optional .It is recommended to position the pump at a level below the minimum oil level of the reservoir to ensure optimal suction characteristics .Also the inlet piping arrangement is to be made keeping this in view . Before start up ,the pump housing and the inlet piping is to be completely filled with clean oil .The case drain piping is to be done to the drain port which is at a higher elevation so that pump casing retains maximum oil .

Independent piping is to be done from case drain port into the reservoir .The end of the drain pipe is to be placed below the minimum oil level and it is to be positioned far away from reservoir outlet .The size of the case drain pipe is to be such that it allows free flow of oil and does not build up back pressure by restriction .

APPLICATION GUIDE LINES



- Pipe internal diameter must be more than the pump suction flange bore.
- The pipe/tube end of the suction line shall be machined at 45° or provide a funnel like outlet.
- Pipe bending shall be done to maximum possible radius.
- Suction line closer to the pump shall be out of a flexible hose.

Pump Operation

Rotation of the pump drive shaft causes the barrel, guide plate and pistons to rotate. The piston shoes are held against the swash plate face by the guide plate. The angle of the swash plate creates a reciprocating motion to each piston within the barrel. Inlet and outlet ports connect to a kidney slotted plate called port plate. As the piston moves out of the barrel, a vacuum is created and fluid is forced into the void by atmospheric pressure. The fluid moves with the barrel past the intake kidney slot. The motion of the piston reverses and fluid is pushed out of the barrel into the outlet port.

Maintenance

The design of the pump does not require any special preventive maintenance for itself as long as it is used within the specified operational limits of pressures / speed / temperature / viscosity and fluid cleanliness.

CONTROLS

The J9V model piston pumps are offered with a variety of control options that are designed for optimum performance of the pump in different types of applications.

CONSTANT PRESSURE CONTROL (CP)

This control maintains the pressure in a hydraulic circuit at a constant set value within the control range during pump operation irrespective of changing flow demands of the load on the pump. The pump supplies only that much volume of oil as required by the load. If the pressure in the circuit tends to raise above the set value, then the pump swash plate angle is proportionally reduced which in turn reduces the flow of oil to the load and thus preventing the pressure raise. In the starting condition when supply pressure is zero the control spring positions the swash plate at its maximum angle allowing the pump to supply the maximum volume of oil to the load in the circuit. As the pressure in circuit raises, the swash plate angle is progressively reduced by the control piston resulting in lesser oil flow to the circuit. It is further possible to restrict the minimum and maximum angles of the swash plate by adjustable set screws for limiting the pump flow to 50% of it's maximum rating. As it is possible to set the pressure control at a pressure higher than the maximum rated pressure of the pump it is recommended that an additional pressure relief valve (set to about 20 bar more than the maximum allowed control pressure) be used in the circuit .

Also to ensure that the pressure control is not set for higher than the permissible value, help of a pressure gauge mounted on the pump outlet side be considered.

CONSTANT PRESSURE CONTROL - REMOTELY SET (CPR)

This is same as above Constant Pressure Control except that in this a remotely mounted Pressure relief Valve is used at port X as shown in the circuit. This along side for pressure setting of the pump.

PRESSURE & FLOW CONTROL (CPF) - LOAD SENSING

In addition to the constant pressure control this also maintains constant flow to the load. The pump flow is determined by an external orifice (not part of pump control block) fitted in the circuit between the pump and the load as long as the load pressure is less than the set pressure. The differential pressure at the external orifice is used to regulate the pump displacement to match the load requirement. The pressure drop across the orifice is maintained constant and there by achieving constant flow to the load. If the differential pressure across the orifice tends to increase then the swash plate is swivelled to minimum angle reducing the pump flow and if the pressure differential is reducing then the swash plate is swivelled to the maximum angle increasing the pump flow to load. These corrections go on continuously until a balance is restored at the flow control orifice. A bleed down orifice is provided at the control valve to vent the trapped pressure in the load sense line.

PRESSURE & FLOW CONTROL - X PORT CLOSED(CPFR)

This is same as above valve (CPF) except that it has no bleed orifice connecting the load sense line to tank.

PRESSURE, FLOW & POWER CONTROL (CPFH)

This control allows to limit the pump drive power at a constant speed (rpm) to set value in relation to the pump flow and pressure (p x v = constant). Efficient power consumption is achieved with this and a constant drive torque is maintained with varying pressure and flows.

Operating pressure exerts a force on a piston within the control piston on to the swash plate. An externally adjustable spring force acts on the opposite side of this and this determines the power setting. When the force exerted by the operating pressure is more, the pilot control valve is operated, positioning the swash plate towards zero flow. When the pressure exerted by operating pressure is lower, the swash plate is positioned to give maximum flow. Here also it is possible to set the minimum and maximum angles of the swash plate by an external adjusting screw to limit the pump flow to 50% of it's maximum capacity.

PUMP START-UP PROCEDURE

AERATION

Circuit design and reservoir must prevent aeration of the oil. Proper care must be taken to ensure that joint, seals and gaskets will not leak or deteriorate. This is most important in low pressure and suction lines. Connections should be tightened properly to prevent air from entering the system.

It is recommended to use sight glasses in the reservoir in order to determine whether significant amounts of air is present in the fluid or not. Fluid bubbles on the surface of the reservoir may indicate the presence of excessive aeration.

Note: Do not operate if the fluid is milky and not clear.

RESERVOIRS

OIL LEVEL

Oil level of the reservoir should be as high as possible above the suction line opening. All return lines should discharge near the tank bottom, always below the oil level, and far away from the pump inlet.

Reservoirs should incorporate means (dip stick, sight gauge etc.) for easy checking of the oil level. In the absence of these devices, the oil level cannot be checked and in case of a leak, the pump can be starved and damaged due to loss of lubrication property.

It is preferable for location of reservoirs above the pumps. This causes flooded suction for the pump and reduces the possibility of pump cavitation.

SUCTION AND RETURN LINES

Pump inlet and tank return lines should be attached to the reservoir by flanges or welded heavy duty coupling. If the inlet (suction) line is connected to the bottom of the reservoir, the coupling should extend above the bottom inside the tank.

This prevents residual dirt entering the suction line when the tank is cleaned. Proper seals should be used on all the suction line connections so that they will not leak nor deteriorate.

BAFFLE PLATE

A baffle plate in the reservoir is recommended to separate the suction and return lines. The plate helps return oil to circulate around the outer wall of the reservoir for cooling before it re-enters the pump. It also helps entrained air to separate from the oil. Cascade effects are minimised by providing baffle plate opening.

MAGNETS

Magnets in a reservoir should be able to pick up ferrous particles not retained by filters or strainers. Magnets should be assembled to the support bars located between suction and return lines, and should be accessible for cleaning.

FILLER-CUM-BREATHER

Reservoirs are vented to the atmosphere through an opening that lets air leave or enter the space above the oil as the fluid level rises or falls. A filler-cum-breather unit which can filter air, is used to handle the air flow required to maintain atmospheric pressure whether the tank is full or empty.

PREPARATION PRIOR TO START-UP

The reservoir and the pipe lines should be cleaned properly prior to filling with fluid.

FLUSHING

The reservoir should be filled with filtered hydraulic oil to a sufficient level to prevent vortexing at the suction connection to pump inlet. It is recommended to clean the system by flushing and filtering, using an external pump.

Before putting the oil into the system, the user must clean it accurately. It is recommended to fill the reservoir using mobile filtration units.

FILLING AND REMOVING AIR

If the pump is mounted above the oil level, it should be filled with the oil through the outlet port. If the pump is mounted below the fluid level, the pump outlet fitting can be loosened to allow fluid to displace the air. It is desirable to loosen the fill cap on the reservoir to allow the flow freely. When a solid stream of fluid without air begins to drain through the fitting, then it should be retightened.

An air bleed valve in the outlet line of the system is recommended to remove trapped air. The pump should be filled with oil before start-up, if this device is used.

Note : The pump should not be operated with the outlet pressure lower than the inlet pressure.

PUMP START-UP

The pump should be always started on no load condition. Start the engine and run the pump in idle condition for approximately five minutes. Once the pump is started, it should prime and pump within a few seconds. If it does not, check for no restrictions between the reservoir and the inlet of the pump and no leaks in the inlet line and connections. Also ensure that trapped air can escape from the outlet.

After smooth run of the pump, start operating the controls of the system. Extend all actuators to maximum safe limit to completely fill the system with fluid.

Ensure that the fluid level is not below the "LOW" limit. In case it is low, add fluid to the reservoir to bring the fluid to the normal fill level.

GENERAL CHARACTERISTICS

Specification	Units	J9V009	J9V018	J9V027	J9V045	J9V072	J9V099	J9V135
Displacement	cm3/rev	9	18	27	45	72	100	140
	in3/rev	0.55	1.10	1.65	2.74	4.40	6.10	8.54
Max. speed. (n_o)	rpm	3600	3300	3000	2600	2200	2000	1800
Limiting Speed (n max)	rpm	4300	3900	3600	3100	2600	2400	2100
Max. Flow (at n_o)	lpm	37	59	84	117	156	200	252
	gpm	9.8	15.6	22.2	30.9	41.2	52.8	66.5
Flow at 1500 rpm	lpm	13.5	27	40.5	67	106	148.5	202.5
	gpm	3.6	7.1	10.7	17.7	28.0	39.2	53.5
Continuous Operating Pressure	bar	280	280	280	280	280	280	280
	psi	4060	4060	4060	4060	4060	4060	4060
Peak Pressure	Bar	350	350	350	350	350	350	350
	psi	5075	5075	5075	5075	5075	5075	5075
Max. Power (at n_o & 280 bar)	KW	16	27.7	39	55	73	93	114/129
	HP	21.5	37.12	52.3	73.8	97.9	124.7	152.9/173
Power at 1500 rpm & 280 bar	KW	6	12.6	20	32	51	69	94.5
	HP	8.1	16.9	26.8	42.9	68.4	92.5	126.7
Max Torque	Nm	42	80	125	200	316	445	623
	lbf.ft	31.0	59.0	92.2	147.5	233.1	328.2	459.5
Weight (approx)	Kg	8	12	15	21	33	45	60
	lbs	17.6	26.5	33.1	46.3	72.8	99.2	132.3
Case Pressure	Kg/cm2	0.50	0.50	0.50	0.50	0.50	0.50	0.50
	psi	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Peak Case Pressure	Kg/cm2	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	psi	28.5	28.5	28.5	28.5	28.5	28.5	28.5
Filling Volume	Liter	0.2	0.4	0.7	1	1.6	2.2	3.0
	gallon	0.05	0.11	0.19	0.26	0.42	0.58	0.79
Max. Permissible Axial Load F Max	Newton	400	700	1000	1500	2400	4000	4800
	lbf	90	157.5	225	337.5	540	900	1080
Max. Permissible Radial Load Fr Max	Newton	250	350	1200	1500	1900	2300	2800
	lbf	56.25	78.75	270	337.5	427.5	517.5	630

HYDRAULIC FORMULAE

FORMULA FOR	WORD FORMULA	LETTER FORMULA
FLUID PRESSURE, P (lbs/in^2)	PRESSURE $= \frac{\text{Force (lbs)}}{\text{Area (in}^2\text{)}}$	$P = \frac{F}{A}$
CYLINDER AREA (in^2)	AREA $= \frac{p}{4}$ x diameter^2(in) or π x radius^2(in)	$A = \frac{\pi D^2}{4}$ or .785 D^2 or πr^2
FORCE (PUSH OR PULL) (lbs)	FORCE = Pressure (psi) x AREA (in^2)	F = P.A
PUMP INPUT POWER (HP)	HORSEPOWER $= \frac{\text{Flow (gpm) x Pressure (psi)}}{\text{1714 x Overall Efficiency}}$	$HP = \frac{Q.P}{1714\ \eta_o}$
VELOCITY or SPEED (ft./sec)	VELOCITY $= \frac{\text{231 x Flow Rate (gpm)}}{\text{12 x 60 x Area (sq. inches)}}$	$v = \frac{231\ Q}{720\ A}$
VOLUME, V (gallons)	VOLUME $= \frac{\pi \text{ x Radius}^2\text{(inches) x Stroke (inches)}}{231}$	$V = \frac{\pi r^2 L}{231}$
FLOW, Q (gpm)	FLOW $= \frac{\text{Displacement (in}^3\text{/rev) x speed (rpm)}}{231}$	$Q = \frac{d.\ n}{231}$
VOLUMETRIC EFFICIENCY η_v (PUMP)	Vol. Eff $= \frac{\text{Output (gpm)}}{\text{Theoritical (gpm)}}$ x 100	
OVERALL EFFICIENCY, η_o	Ove. Eff $= \frac{\text{Output HP}}{\text{Input HP}}$ x 100	
MOTOR TORQUE, T (lb inch)	TORQUE $= \frac{\text{Pressure (psi) x Motor Displacement (in}^3\text{/rev)}}{2\pi}$	$T = \frac{P\ d}{2\pi}$
MOTOR TORQUE (lb inch)	$= \frac{\text{63025 x Horse Power}}{\text{Speed (rpm)}}$	$T = \frac{63025\ HP}{n}$
	$= \frac{\text{36.77 x Flow Rate (gpm) x Pressure (psi)}}{\text{Speed (rpm)}}$	$T = \frac{36.77\ QP}{n}$
MOTOR TORQUE, T/100 psi	TORQUE/ 100 psi $= \frac{\text{Motor Displacement (in}^3\text{/rev.)}}{0.0628}$	T/100 psi $= \frac{d}{0.0628}$
MOTOR SPEED, n (rpm)	SPEED $= \frac{\text{231 x Flow Rate (gpm)}}{\text{Motor Displacement (in}^3\text{/rev.)}}$	$n = \frac{231\ Q}{d}$
MOTOR POWER, HP	HORSE POWER $= \frac{\text{Torque Output (inch pounds) x Speed (rpm)}}{63025}$	$HP = \frac{T.n}{63025}$
VOLUMETRIC EFFICIENCY, η_v (MOTOR)	Vol. Eff $= \frac{\text{Theoritical (gpm)}}{\text{Input (gpm)}}$ x 100	

Pipe volume varies as the square of the diameter; volume in gallons = 0.0034 D^2L
where D = inside diameter of pipe in inches
L = length in inches

Velocity in feet per second $= \frac{0.320 \text{ x flow (gpm)}}{D}$

Specific gravity of oil is approximately 0.85
Thermal expansion of oil is about 1 cu. in. per 1 gallon per 10^o F rise in temperature
Conversion Factors :
1 HP = 0.746 kw hr   1 bar = 14.5053 psi   1 kg = 2.2045 lbs
1 US gallon = 231 cubic inches.   1 kg = 9.8066 N
1 gallon/min = 3.8 lpm