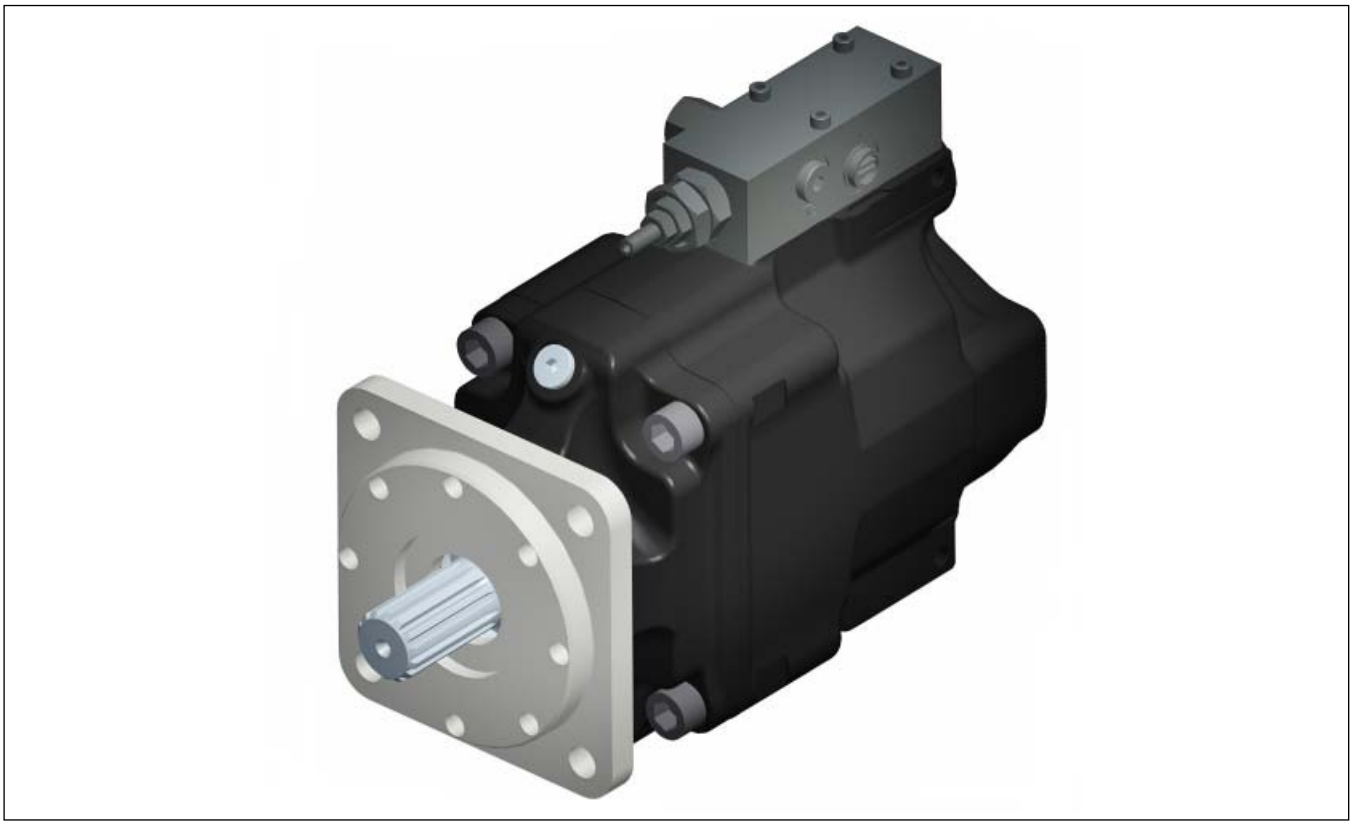
VP1 Pump



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Pump & Motor Division Europe
Trollhättan, Sweden

VP1 Pump SAE

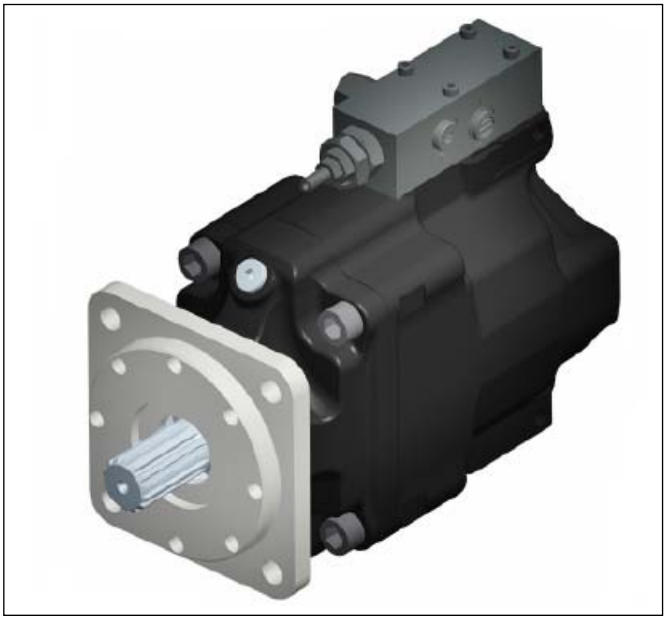
The VP1 is a variable displacement pump for truck applications. It can be close-coupled to a gearbox PTO (power take-off) or to a coupling independent PTO (e.g. an engine PTO).

An application that makes full use of all the features of the VP1 is truck cranes with a load sensing system. The complex systems of refuse collection vehicles and sewage trucks as well as various combinations of tippers, cranes, snow ploughs, and salt/sand spreaders can also be greatly simplified and optimised with the VP1 pump.

The VP1 provides the hydraulic system with the correct amount of fluid at precisely the right moment, effectively reducing energy consumption and heat generation. This means a smoother and quieter hydraulic system with much reduced impact on the environment.

The VP1 is highly efficient and extremely light. It is reliable, economical and easy to install.

The 3 sizes, VP1-095, -110 and -130 have small installation dimensions.



The VP1 is suitable for all load sensing systems, regardless of make.

Design

Large angle - compact design

The pump design permits a large angle, 20°, between piston and slipper shoe/swashplate, providing compactness and small outer dimensions.

Long life

The VP1 is designed for trucks with hydraulic load sensing systems. It is sturdy, yet simple, with few moving parts. The result is a reliable pump with long service life.

Features

- Variable displacement
- Low noise level
- High power-to-weight ratio
- Compact and light
- Highly efficient
- Sturdy design
- Withstands low temperatures

Retainer plate

The retainer plate (refer to the cut-away illustration in next page) is of a heavy duty design which makes the pump withstand high shaft speeds and fast speed changes.(e. g. engine PTO).

Specifications

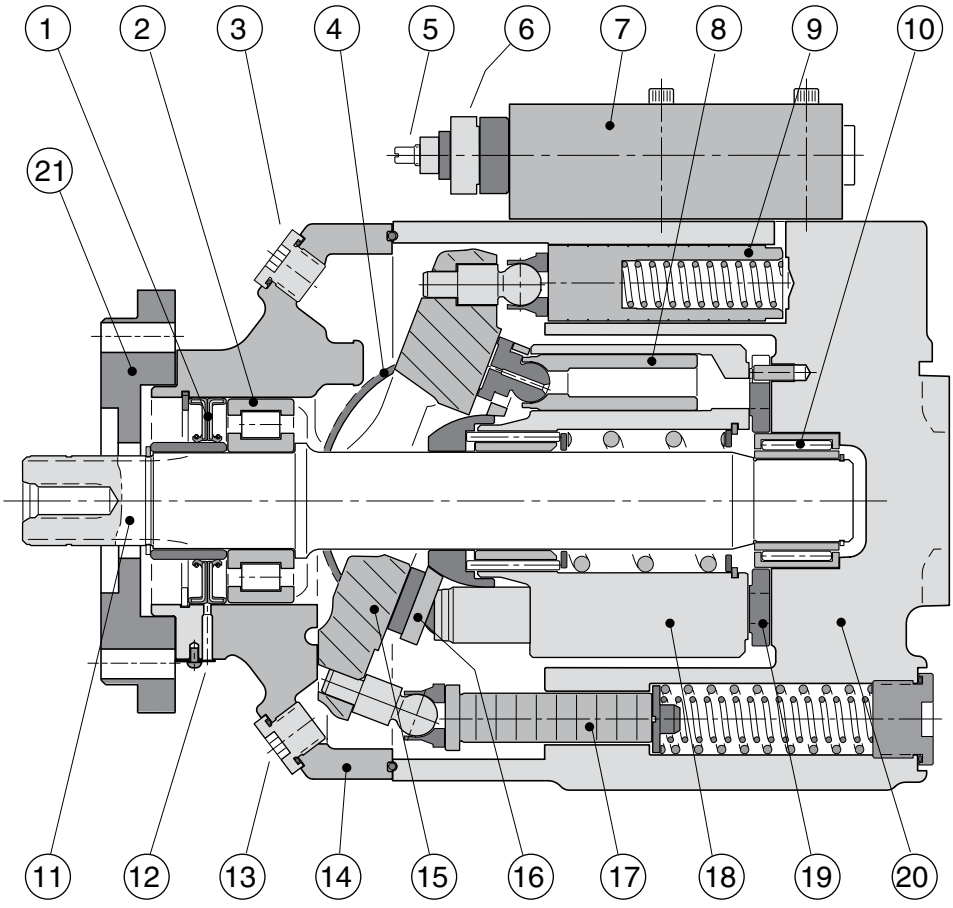
Size VP1--	095	110	130
Displacement [cm^3/rev]	95	110	128
[cu in/rev	*5.80*	*6.71*	*7.81*
Max operating pressure			
continuous [bar]/[*psi*]	400 / *5800*	400 / *5800*	350 / *5075*
intermittent [1] [bar]/[*psi*]	420 / *6090*	420 / *6090*	370 / *5365*
Mass moment of inertia J [kgm^2]	0.00681	0.00690	0.00690
Selfpriming speed [2] [rpm]			
2" suction line, max	1250	1100	900
$2^1/_2$" suction line, max	1750	1500	1300
3" suction line, max	2200	2100	1900
Min Speed [rpm]	500	500	500
Max Speed unloaded [rpm]			
(in bypass mode, no flow)	3000	3000	3000
Control type	LS		
Shaft end spline	Spline SAE C 14T 12/24 DP		
Mounting flange	SAE C 4 bolt flange		
Weight (with control) [kg]	*27*		
[lbs]	*59.5*		

1) Max 6 seconds in any one minute.

2) At an inlet pressure of 1.0 bar (abs.) with mineral oil at a viscosity of 30 mm^2/s (cSt).

VP1-095/-110/-130 cross section

1. Shaft seal
2. Roller bearing
3. 'Upper' purge plug
4. Bearing shell
5. Setting screw (pressure relief valve)
6. Setting bushing (standby pressure)
7. Control
8. Piston with piston shoe
9. 'Upper' setting piston (control pressure)
10. Needle bearing
11. Shaft
12. Drain hole, shaft seals
13. 'Lower' purge plug
14. Bearing housing
15. Swash plate
16. Retainer plate
17. 'Lower' setting piston (pump pressure)
18. Cylinder barrel
19. Valve plate
20. Barrel housing
21. SAE C 4 bolt flange



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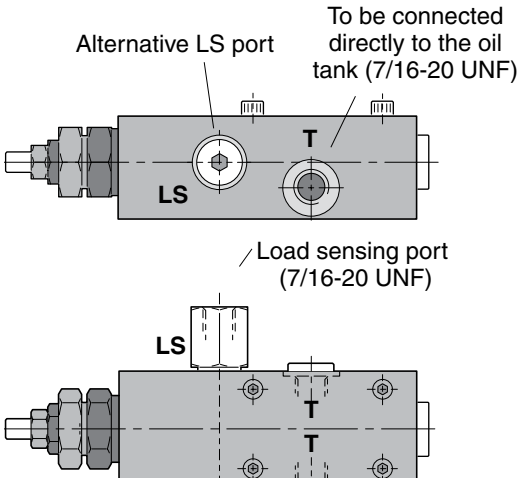
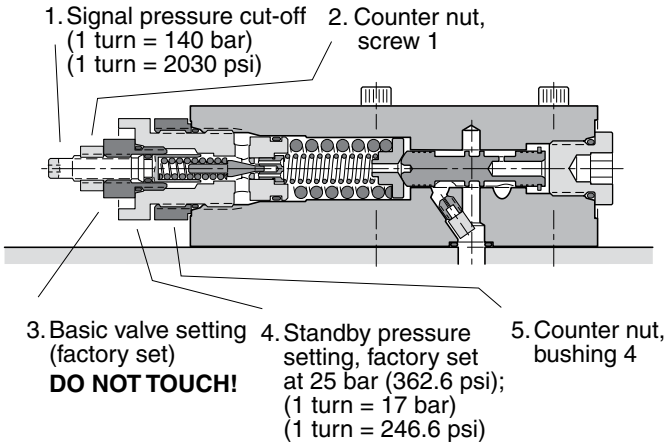
LS control (for VP1-095/-110/-130)



LS control ports.

NOTE: Always run a function, after adjusting the standby pressure or the max pressure setting, before you read the value.



LS control cross section.

Item	Wrench / dimension
1	Hex Head Wrench / 4 mm
2	Wrench / 13 mm
3	**DO NOT TOUCH**
4	Wrench / 27 mm
5	Wrench / 27 mm

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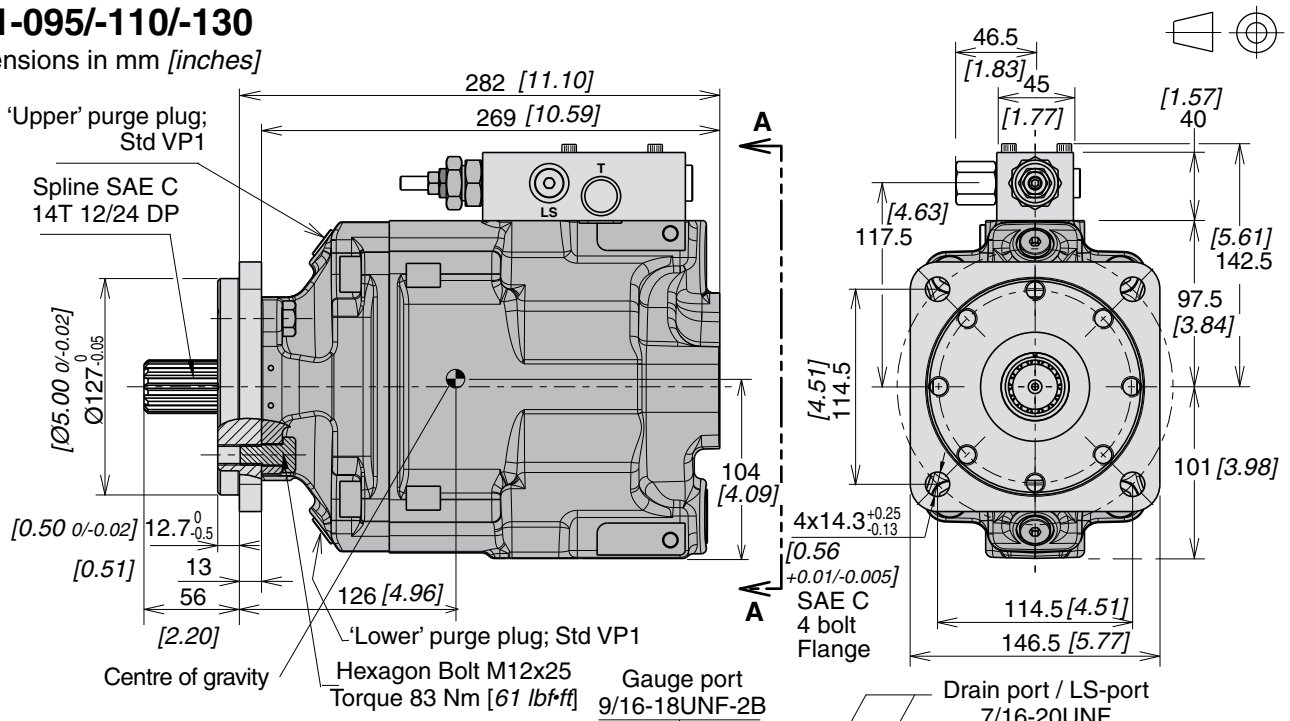
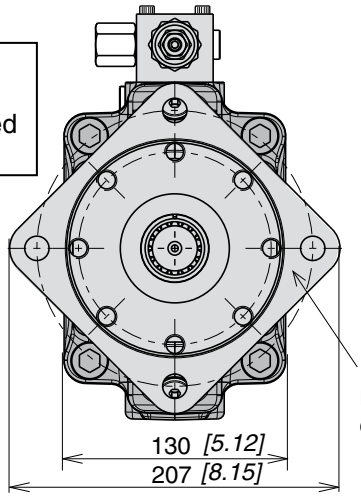
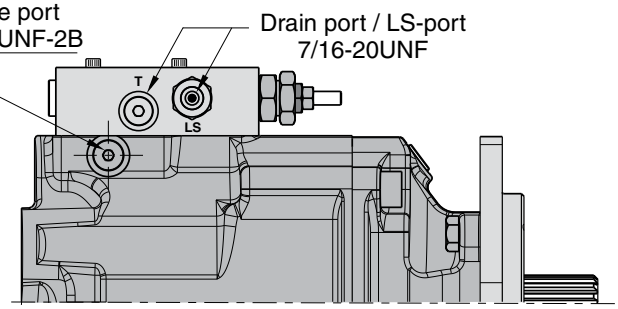
VP1-095/-110/-130

Dimensions in mm *[inches]*

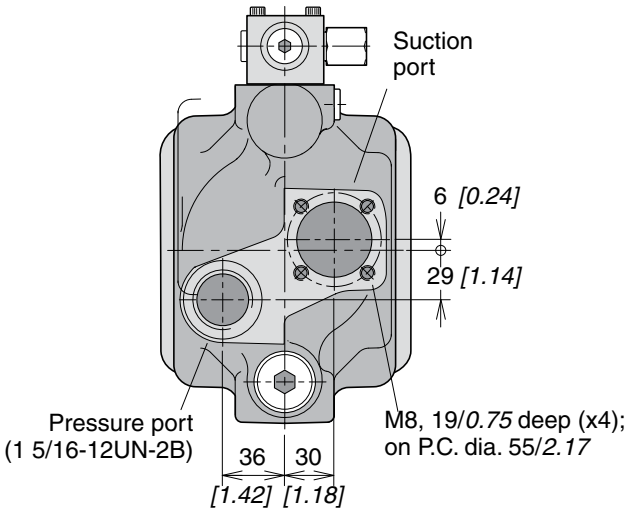




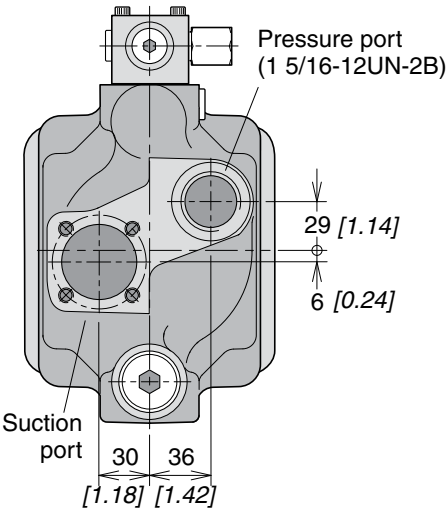


NOTE:
The pump **does not** include a suction fitting; it must be ordered separately. See page 18.

IMPORTANT!
The control is **not** drained through the pump case; an external drain line must be installed from control port T and, directly, to the oil tank.



View A–A
Left hand rotating pump



View A–A
Right hand rotating pump

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Ordering information

Example: **VP1 - 095 - RU - SV - S - 102**

Size
095, 110 or 130
Direction of rotation
L Left hand
R Right hand

All SAE Pumps are painted Black
Shaft end
S SAE C spline
Shaft seal
V FPM
Mounting flange
S SAE C 4 bolt
Main port
U SAE O-ring, UN threads

Standard model numbers

Designation	Ordering no.
VP1-095-RU	378 4095
VP1-095-LU	378 4096
VP1-110-RU	378 4093
VP1-110-LU	378 4094
VP1-130-RU	378 4091
VP1-130-LU	378 4092

NOTE:
The VP1 is uni-directional. Consequently, the desired direction of rotation must be stated *when ordering.*

VP1 in load sensing systems

When installed in a load sensing system, the VP1 supplies the correct amount of flow required by the various work functions currently engaged.

This means that energy consumption and heat generation are minimised and much reduced in comparison with a fixed displacement pump used in the same system.

Diagram 1 shows the required power (flow times pressure) in a constant flow system with a fixed displacement pump.

Diagram 2 shows the sharply reduced power requirement in a load sensing system with a variable displacement pump such as the VP1.

In both cases the pump pressure is slightly higher than what is required by the heaviest load ('Load 2') but the VP1, because of the much smaller flow being delivered, needs only the power indicated by the shaded area 'Load power'.

In a constant flow system, on the other hand, excess fluid is shunted to tank and the corresponding power, 'Wasted power' (shown in diagram 1), is a heat loss.

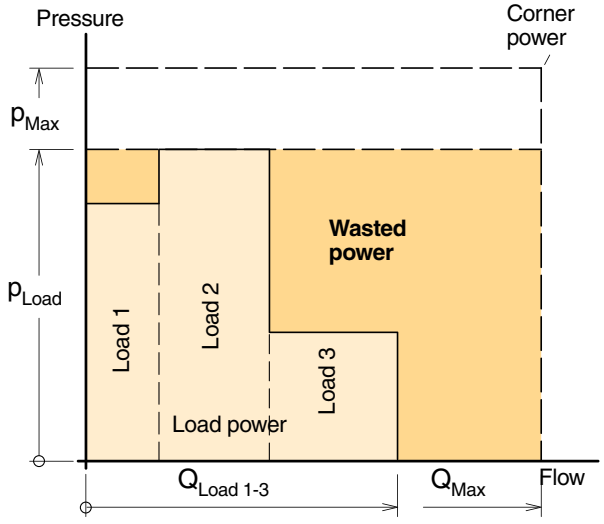


Diagram 1. Constant flow system with a fixed displacement pump.

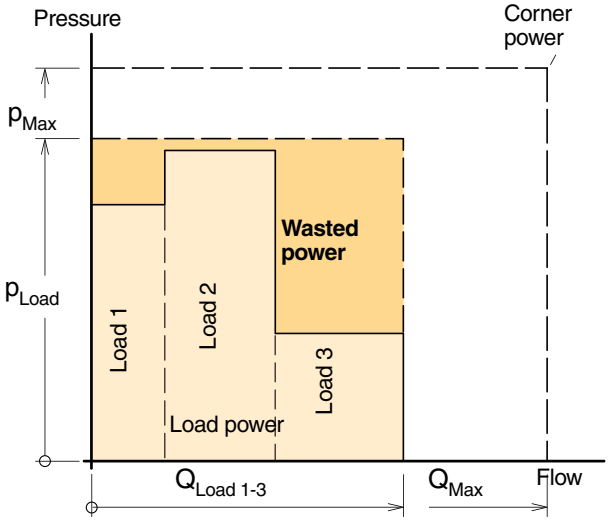


Diagram 2. Constant flow system with a variable displacement pump (e.g. VP1).

Systems comparison

System	Constant flow	Load-sensing
Pump	Fixed displ.	VP1 variable displ.
Pump adjustments	Pressure only	Pressure and flow
Load*	Some influence	Some influence
Energy		
consumption	High	Low
Heat generation	High	Low

* Simultaneous operation of loads with non-equal flows and pressures; refer to the above diagrams.

LS load sensing control function

Refer to corresponding hydraulic schematic below.

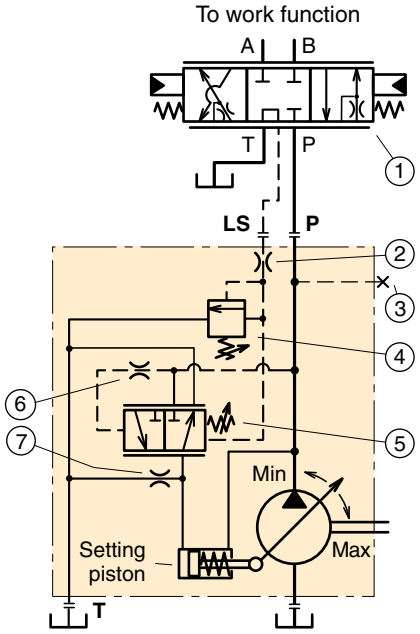
A selected 'opening' of the directional control valve spool corresponds to a certain flow to the work function. This flow, in turn, creates a pressure differential over the spool and, consequently, also a Δp between the pump outlet and the LS port.

When the differential pressure decreases (e.g. the directional valve is 'opened' further) the Δp also decreases and the LS valve spool moves to the left. The pressure to the setting pistons then decreases and the pump displacement increases.

The increase in pump displacement stops when the Δp finally reaches the setting (e.g. 25 bar) and the forces acting on the valve spool are equal.

If there is no LS signal pressure (e.g. when the directional valve is in the neutral, no-flow position) the pump only delivers sufficient flow to maintain the standby pressure as determined by the Δp setting.

Hydraulic schematic for VP1-095/-110/-130



1. Directional, load sensing control valve
2. Load signal orifice (0.8 mm)
3. Gauge port
4. Signal pressure limiter adjustment
5. Standby (Δp) pressure adjustment
6. System pressure dampening orifice (fixed)
7. Bleed-off nozzle (1.2 mm)

LS control adjustments

Pressure limiter

Pump size	Factory setting [bar/*psi*]	Max pressure intermittent [bar/*psi*]
VP1- 095/110/130	350 / *5075*	420 / *6090**

* **Note**: Max allowed pressure for size VP1-130 is 370 bar

LS load sensing valve

Pump size	Factory setting [bar/*psi*]	Min pressure [bar/*psi*]	Max pressure [bar/*psi*]
VP1- 095/110/130	25 / *363*	15 / *218*	40 / *580*

The factory setting, and the standard orifice sizes shown in the corresponding schematic below, will usually provide an acceptable directional valve characteristic as well as system stability.

For additional information, contact Parker Hannifin.

Pump selection

F1

The following table shows pump flow at selected PTO gear ratios and engine rpm's.

PTO gear ratio	Engine speed [rpm]	Pump flow [l/min / gpm]			
		F1-25	F1-41	F1-51	F1-61
1:0.8	800	16 / *4.23*	26 / *6.87*	33 / *8.72*	38 / *10.04*
	900	18 / *4.76*	29 / *7.66*	37 / *9.77*	43 / *11.36*
	1000	20 / *5.28*	33 / *8.72*	41 / *10.83*	48 / *12.68*
	1100	23 / *6.08*	36 / *9.51*	45 / *11.89*	52 / *13.74*
	1200	25 / *6.60*	39 / *10.30*	49 / *12.94*	57 / *15.06*
1:1.0	800	20 / *5.28*	33 / *8.72*	41 / *10.83*	48 / *12.68*
	900	23 / *6.08*	37 / *9.77*	46 / *12.15*	54 / *14.27*
	1000	26 / *6.87*	41 / *10.83*	51 / *13.47*	60 / *15.85*
	1100	28 / *7.40*	45 / *11.89*	56 / *14.79*	65 / *17.17*
	1200	31 / *8.19*	49 / *12.94*	61 / *16.11*	71 / *18.76*
1.1.25	800	26 / *6.87*	41 / *10.83*	51 / *13.47*	60 / *15.85*
	900	29 / *7.66*	46 / *12.15*	57 / *15.06*	67 / *17.70*
	1000	32 / *8.45*	51 / *13.47*	64 / *16.91*	74 / *19.55*
	1100	35 / *9.25*	56 / *14.79*	70 / *18.49*	82 / *21.66*
	1200	38 / *10.04*	61 / *16.11*	77 / *20.34*	89 / *23.51*
1:1.5	800	31 / *8.19*	49 / *12.94*	61 / *16.11*	71 / *18.76*
	900	35 / *9.25*	55 / *14.53*	69 / *18.23*	80 / *21.13*
	1000	38 / *10.04*	61 / *16.11*	77 / *20.34*	90 / *23.78*
	1100	42 / *11.10*	67 / *17.70*	84 / *22.19*	98 / *25.89*
	1200	46 / *12.15*	74 / *19.55*	92 / *24.30*	107 / *28.27*

NOTE:

- Make sure max torque and bending moment (due to the weight of the pump) of the utilised PTO are not exceeded. (The approx. center of gravity of the various pump sizes are shown in the installation drawings).
- Make sure max allowed output torque from the PTO is not exceeded.
- Contact Parker Hannifin if the inlet (suction) pressure is believed to be less than 1.0 bar (absolute); insufficient inlet pressure can cause noise and pump damage because of cavitation.

Flow and torque formulas (no regard to efficiency)

Flow: $Q = \frac{D \times n}{1000}$ [l/min]

where: D is pump displacement [cm^3/rev]
n is shaft speed [rpm]

Torque: $M = \frac{D \times p}{63}$ [Nm]

where: D is pump displacement [cm^3/rev]
p is utilised pressure [bar]

A suitable pump size for a truck application can be selected as follows:

Operating conditions

As an example, a cargo crane specifies:

- Flow: 60-80 l/min (15.84-21.12 gpm)
  Pressure: 230 bar (3336 psi)
  Diesel engine speed ≈ 800 rpm

Determine pump speed

As example a PTO with a Gear Ratio of 1:1.54.

The pump speed will be:

- 800 x 1.54 ≈ 1200 rpm

Select a suitable pump size

Use diagram 1 and select a pump that will provide 60 - 80 l/min at 1200 rpm.

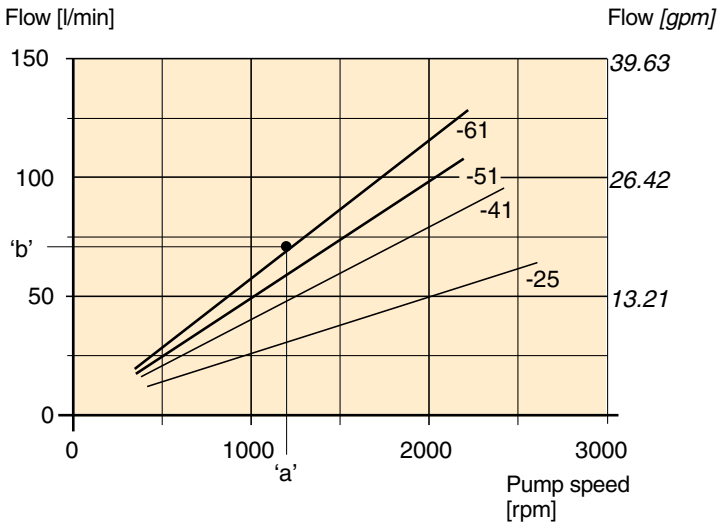


Diagram 1.

Follow line 'a' (1200 rpm) until it crosses line 'b' (70 l/min).

- F1-61 is a suitable choice

Required input torque

Make sure the PTO and the gear-box tolerates the pump torque. Use diagram 2 to obtain the required pump torque.

Follow a line from 'c' (230 bar) until it crosses the F1-61 line (the selected pump).

- Read 220 Nm (at 'd')

NOTE: A rule-of-thumb is to select the highest PTO ratio and the smallest pump size that meets the crane specification without exceeding the pump speed, pressure, and power limitations.

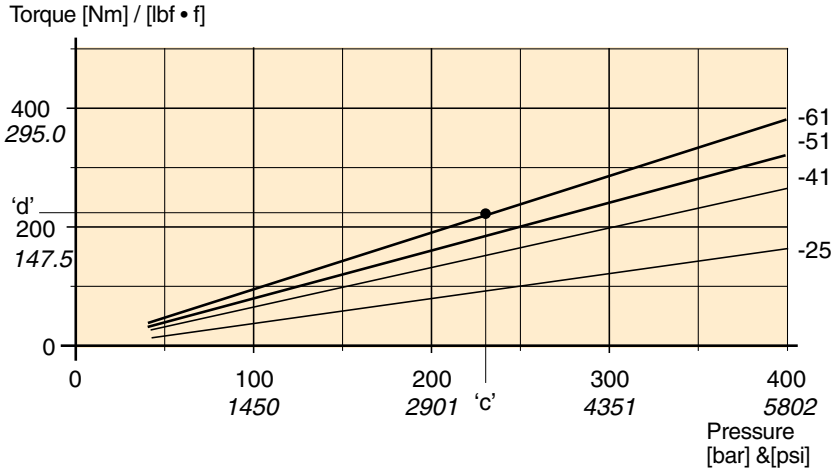


Diagram 2.

Line selection
all pumps

Line type	Flow velocity [m/s] *[feet/s]*
Inlet (suction)	max 1.0 / *3.28*
Outlet (pressure)	max 5.0 / *16.40*

Flow rate	Flow velocity [m/s] *[feet/s]* at selected line sizes [mm/inches]							
[l/min] *gpm*	19 / $^3/_4$"	25 / 1"	32 / $1^1/_4$"	38 / $1^1/_2$"	51 / 2"	64 / $2^1/_2$"	75 / 3"	
25/*6.60*	1.5 / *4.92*	0.8 / *2.62*	0.5 / *1.64*	0.4 / *1.31*	0.2 / *0.66*	0.1 / *0.33*	0.1 / *0.33*	Inlet (suction) line
50/*13.21*	2.9 / *9.51*	1.7 / *5.58*	1.0 / *3.28*	0.7 / *2.30*	0.4 / *1.31*	0.3 / *0.98*	0.2 / *0.66*	
75/*19.81*	4.4 /*14.44*	2.5 / *8.20*	1.6 / *5.25*	1.1 / *3.61*	0.6 / *1.97*	0.4 / *1.31*	0.3 / *0.98*	
100/*26.42*	5.9 /*19.36*	3.4 /*11.15*	2.1 / *6.89*	1.5 / *4.92*	0.8 / *2.62*	0.5 / *1.64*	0.4 / *1.31*	
150/*39.63*	8.8 /*28.87*	5.1 /*16.73*	3.1 /*10.17*	2.2 / *7.22*	1.3 / *4.27*	0.8 / *2.62*	0.5 / *1.64*	
200/*52.83*	-	-	4.1 /*13.45*	2.9 / *9.51*	1.6 / *5.25*	1.1 / *3.61*	0.7 / *2.30*	
250/*66.04*	-	-	5.3 /*17.39*	3.7 /*12.14*	2.1 / *6.89*	1.3 / *4.27*	0.9 / *2.95*	

Table 1. Outlet (pressure) line

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In order to obtain sufficient inlet (suction) pressure to the pump, low noise level and low heat generation, flow speeds shown in table 2, right, should not be exceeded.

From table 1 (page 13), select the smallest line dimension that meets the flow speed recommendation; example:

- At 100 l/min *26.42 gpm*, a 50 mm *2"* suction line and a 25 mm *1"* pressure line is needed.

NOTE: Long inlet (suction) lines, low inlet pressure (caused by e.g. a reservoir positioned below the pump) and/or low temperatures may require larger line dimensions.

Alternatively, the pump speed will have to be lowered to avoid pump cavitation (which may cause noise, deteriorating performance and pump damage).

Line type	Flow velocity [m/s] *[feet/s]*
Inlet (suction)	max 1.0 / *3.28*
Outlet (pressure)	max 5.0 / *16.40*

Table 2.

Nomogram

Flow - Line dimension - Flow velocity

Example 1
Pressure line
Q = 65 l/min
17.17 gpm
d = 3/4"
v = 3.8 m/s
12.47 feet/s

Example 2
Suction line
Q = 50 l/min
13.21 gpm
v = 0.8 m/s
2.62 foot/s
d = 1 1/2"

1gpm=3.785 l/min
1 l/min=0.264 gpm
1 foot/s=0.305 m/s
1 m/s=3.281 feet/s
1psi=0.0689 bar
1 bar=14.504 psi

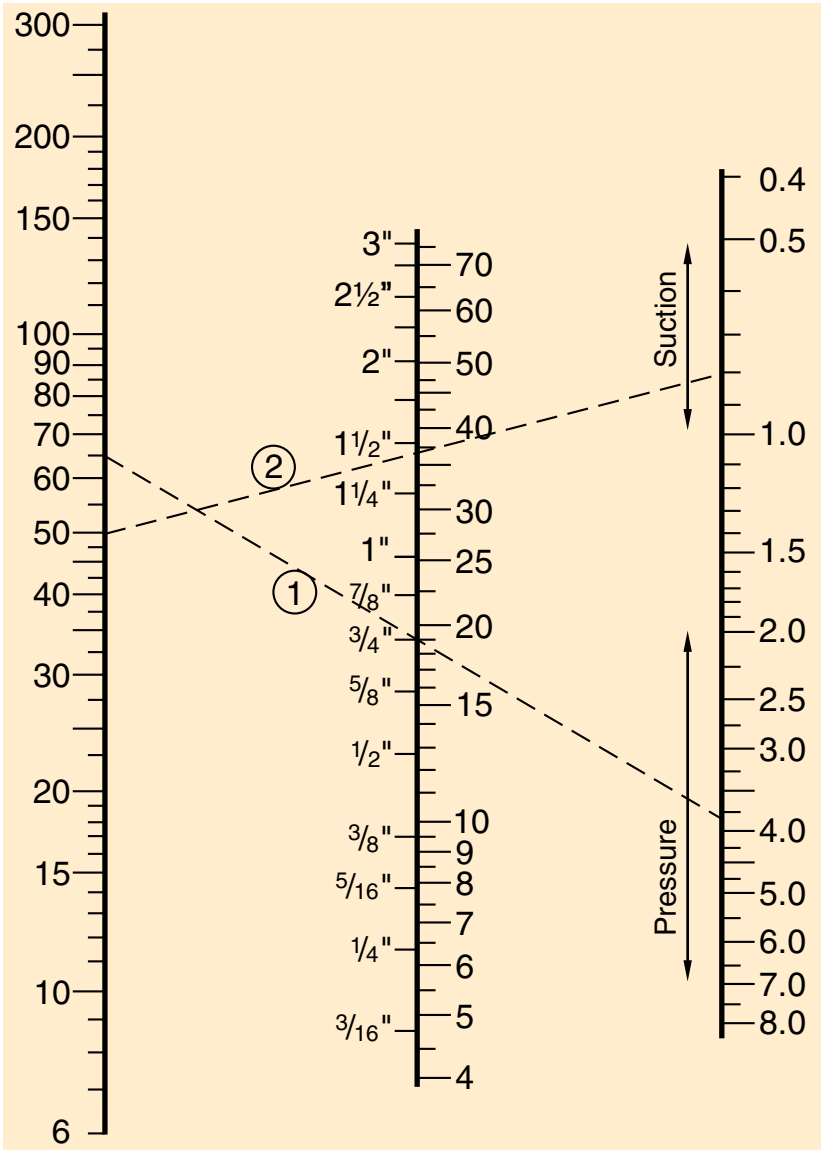

Table 3.

Q = Flow [l/min]

d = internal line diametre [Ø mm]

v = Flow velocity [m/s]

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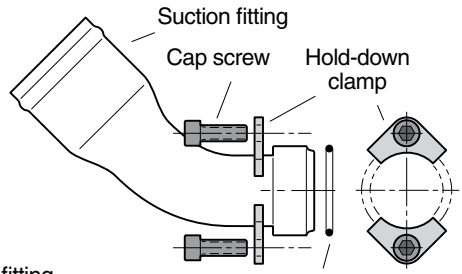
Suction fittings

for series F1, VP1-095, -110 and -130

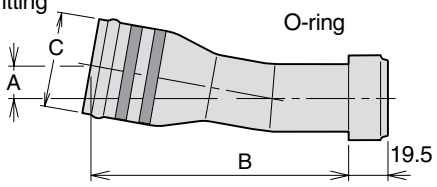
A 'suction fitting' consists of a straight, 45°, 90° or 135° suction fitting, clamps, cap screws and O-ring.



'Straight' suction fittings for F1, VP1-095/-110/-130

Ordering no.	A mm/*inch*	B mm/*inch*	C dia. mm *(in.)*
378 0635[1)]	0	85 / *3.35*	38 *(1 1/2")*
378 0636[2)]	17 / *0.67*	136 / *5.35*	50 *(2")*
378 0637[3)]	25 / *0.98*	145 / *5.71*	63 *(2 1/2")*
378 3523[3)]	32 / *1.26*	174 / *6.85*	75 *(3")*

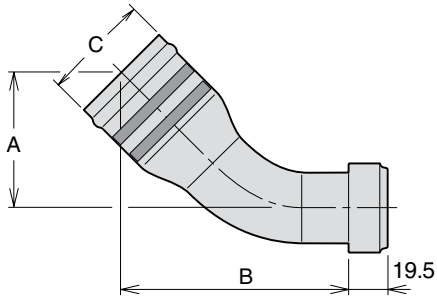
'Straight' fitting



45° suction fittings for F1, VP1-095/-110/-130

Ordering no.	A mm/*inch*	B mm/*inch*	C dia. mm *(in.)*
378 1234[1)]	60 / *2.36*	104 / *4.09*	32 *(1 1/4")*
378 0633[1)]	60 / *2.36*	104 / *4.09*	38 *(1 1/2")*
378 0364[2)]	67 / *2.64*	110 / *4.33*	50 *(2")*
378 0634[3)]	75 / *2.95*	117 / *4.61*	63 *(2 1/2")*
378 3367[3)]	95 / *3.74*	138 / *5.43*	75 *(3")*
378 1062	67 / *2.64*	110 / *4.33*	40 *(1.57)*
378 0975	67 / *2.64*	110 / *4.33*	45 *(1.77)*

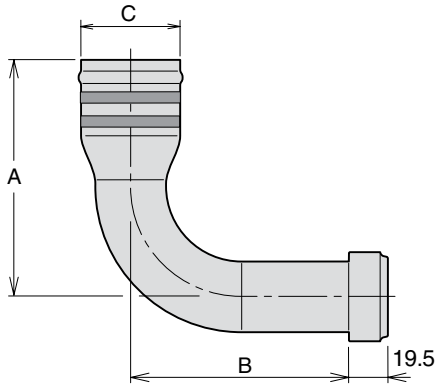
45° fitting



90° suction fittings for F1, VP1-095/-110/-130

Ordering no.	A mm/*inch*	B mm/*inch*	C dia. mm *(in.)*
378 0978[1)]	126 / *4.96*	83 / *3.27*	38 *(1 1/2")*
378 0979[2)]	135 / *5.31*	83 / *3.27*	50 *(2")*
378 1980[3)]	147 / *5.79*	83 / *3.27*	63 *(2 1/2")*
378 0976	135 / *5.31*	83 / *3.27*	45 *(1.77)*
378 8690[3)]	185 / *7.28*	83 / *3.27*	75 *(3")*

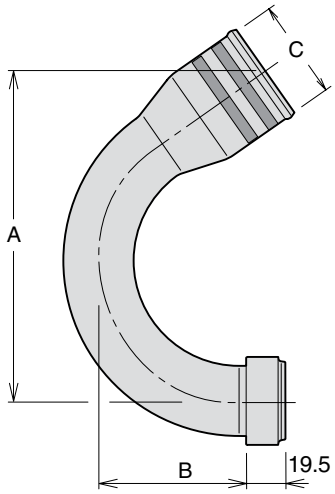
90° fitting



145° suction fitting for F1, VP1-095/-110/-130

Ordering no.	A mm/*inch*	B mm/*inch*	C dia. mm *(in.)*
378 1867	165 / *6.50*	73 / *2.87*	50 *(2")*

145° fitting



1) Recommended for size F1-25.
2) Recommended for size F1-41,-51,-61.
3) (3 clamps and 3 screws)

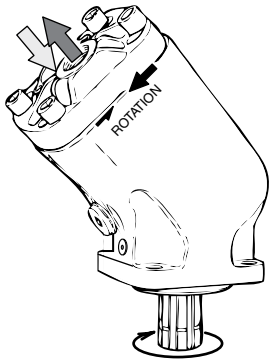
Spare parts

Additional Hold-down-clamp kit consists of:
hold-down-clamp cap screw and O-ring
Ordering no. 378 1321

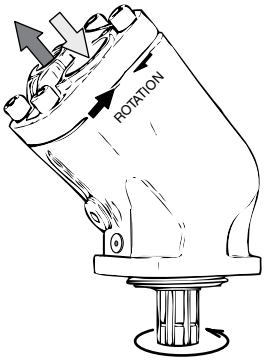
Additional Hold-down-clamp kit for mounting on BPV
Ordering no. 378 2439

NOTE: A suction fitting *must be ordered separately* (not included with the pump). To choice the correct dimension of suction connection, see chapter 3.

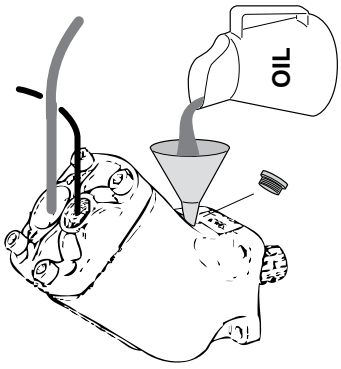
Installation and start-up for F1



Left hand (L.H.; counter clockwise) rotating pump.



Right hand (R.H.; clockwise) rotating pump.



Before start-up, the housing must be filled with hydraulic fluid.

Direction of rotation

The pictures above show direction of flow vs. shaft rotation.

The direction of rotation can be changed (i. e. from right hand to left hand) by turning the end cap.

Remove the four cap screws and turn the end cap about half a turn while making sure it stays in contact with the barrel housing.

Re-fit the cap screws and torque to 59-74 lbf ft (80-100 Nm).

Installation

Make sure max torque and bending moment (due to the weight of the pump) of the utilised PTO are not exceeded. (The approx. center of gravity of the various pump sizes are shown in the installation drawings).

NOTE: In order to obtain the longest bearing life, the pump should be installed according to the information shown on page 20 "Pump bearing life".

Fluid viscosity

Recommended viscosity:
20 to 30 mm^2/s (cSt).

Operating viscosity limits:
- Min 10 mm^2/s; max 400 mm^2/s.
- At start-up, max 4000 mm^2/s.

Fluids

The fixed displacement pumps data shown in the specifications for each pump in chapter 1 and 2 are valid when operating on high quality, mineral based hydraulic oil.

Type HLP (according to DIN 51524) hydraulic oil is suitable as well as biologically degradeable fluids like natural and synthetic esters and polyalfaolefins.

The utilised hydraulic fluid shall meet one of the following Swedish standards:

- SS 15 54 34
- SMR Hydraulic Oil Standard 1996-2.

Contact Parker Hannifin for further information.

NOTE: - ATF (automatic transmission fluid) and API type CD engine oils may also be useable.
- Seals are made of nitrile rubber; make sure the utilised fluid is compatible with this material.

Fluid temperature

Main circuit: Max 75 °C *167 °F*.

Drain line

Fixed displacement pumps don't need an external drain line as they are internally drained.
When the pump is mounted in a Engine-PTO we recommend a drain line from the bypass valve directly to oil tank.

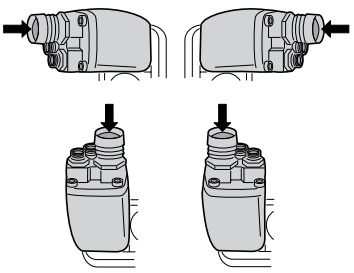
Filtration

Filtration should follow ISO standard 4406, code 20/18/13.
To obtain the longest life of fixed displacement pumps, we recommend an oil cleanliness of 10 µm (absolute).

Start-up

Make sure the entire hydraulic system is clean before filling it with a recommended hydraulic fluid.
In particular, make sure the pump is filled (to at least 50%) as the internal leakage does not provide sufficient lubrication at start-up.

NOTE: - The suction port should always be above the pressure port when the pump is installed above the reservoir oil level.
- During operation, the pump must be filled with oil to at least 50%.



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If any oil should drop out of the indication-hole on the pump;

- Stop the system immediately.
- Determine the cause of leakage.
- Replace damaged parts.
- Make sure you have corrected the source of the problem, not only the symptom.

Parker can not be held responsible for damage to PTO, engine and gearbox caused by improper maintenance of the hydraulic system.

Pump bearing life

Bearing life is dependent on how the pump is installed on the PTO as shown in the illustrations below.

A pump mounted according to fig. 1 gives the lowest bearing life; the highest is obtained when installed according to fig. 3.

Parker Hannifin will assist in determining bearing life in a particular application.

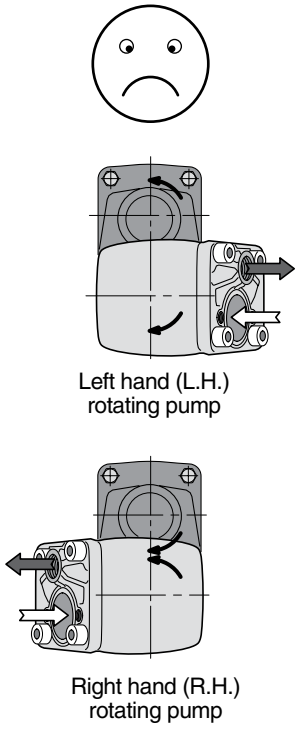

Fig. 1.

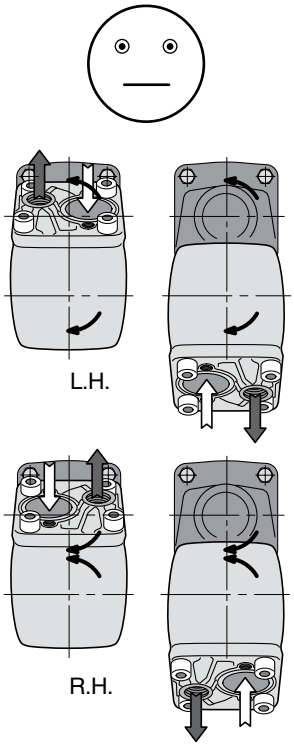

Fig. 2.

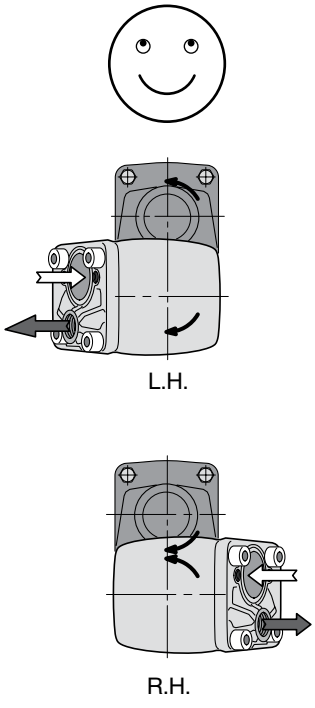

Fig. 3.

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Installation and start-up for VP1

Direction of rotation

The basic VP1 pump is uni-directional; there is a left hand and a right hand version (indicated by the arrow on the side of the VP1 pump (fig. 4 and 5).

Consequently, the required direction of rotation must be stated when ordering the pump.

Installation

The VP1 can be installed (close-coupled) directly on a PTO.

Before start-up, the pump must be filled with hydraulic fluid and purged. Utilise the uppermost purge plug (refer to the installation drawing on page 12, chapter 2).

Figure 6 (page 19) shows two ways of installing a gear on the VP1 shaft. On a non-geared or a geared PTO with support bearings, the pump shaft is usually installed directly in the internally splined PTO output shaft.

Make sure max torque and bending moment (due to the weight of the pump) of the utilised PTO are not exceeded. (The approx. center of gravity of the various pump sizes are shown in the installation drawings).

Hydraulic fluids

The VP1 data shown in the specifications on

page 10 are valid when operating on a high quality, mineral based fluid.

Hydraulic fluids type HLP (DIN 51524), ATF (auto- matic transmission fluids), and API type CD engine oils are suitable.

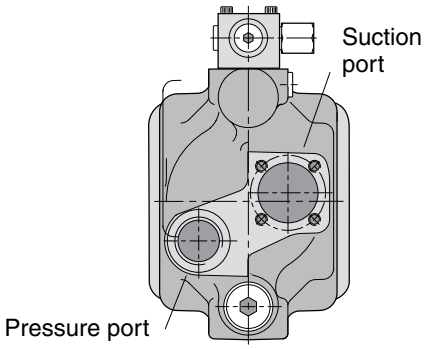

Fig. 4. Left hand rotating pump.

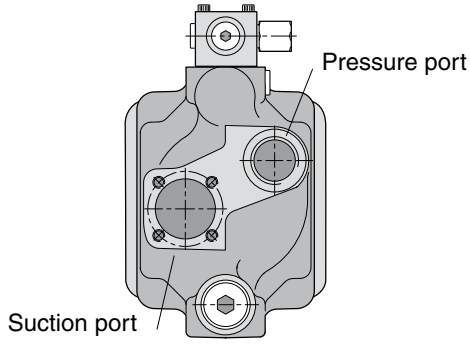

Fig. 5. Right hand rotating pump.

Fluid temperature

Main circuit: Max 75 °C *167 °F*.

Viscosity

Recommended viscosity: 20 to 30 mm^2/s (cSt).
Operating viscosity limits: 10 to 400 mm^2/s.
At start-up: Max 1000 mm^2/s.

Filtration

To obtain long VP1 life, we recommend a filtration level of:

- 25 µm (absolute) in clean environment or at low pressures.
- 10 µm (absolute) in contaminated environment or at high pressures.

Filtration should meet ISO standard 4406: code 20/18/13.

Drain line

The LS valve *requires a separate drain line;* it should be routed directly to the reservoir (refer to fig. 8).

Start-up

Make sure the entire hydraulic system is clean before filling it with a recommended fluid.
In addition, the VP1 pump must be purged to remove any entrapped air in the pump housing; utilise the uppermost purge port (fig. 8).

IMPORTANT

As shown in fig. 8, the pump inlet must always be below the lowest reservoir oil level.

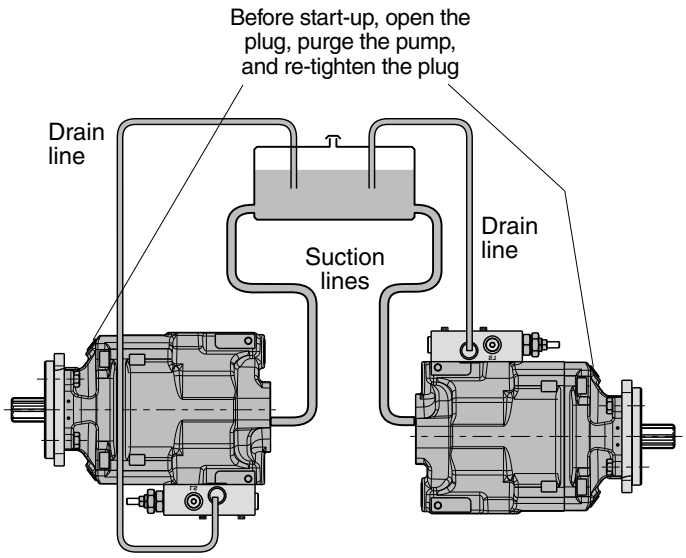

Fig. 8. VP1 should be installed below the reservoir fluid level.

Purging should be performed when the pump is connected to the reservoir and the system is filled with fluid.

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