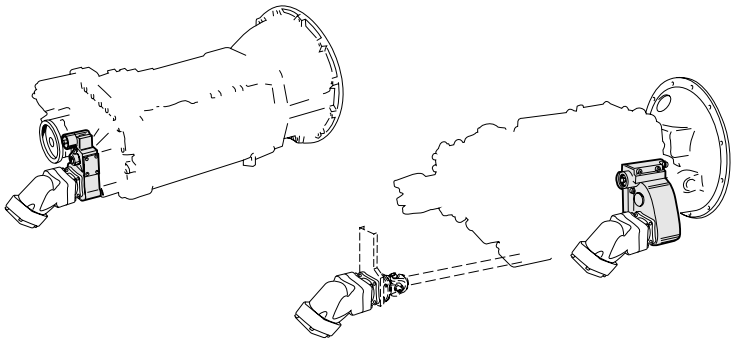
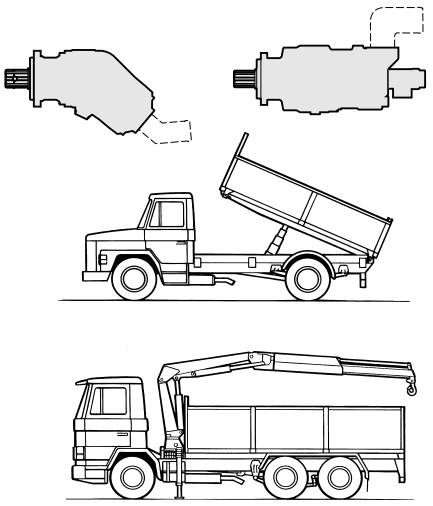
Choice of power take-off and pump type

Gearbox driven power take-off
(under clutch control)

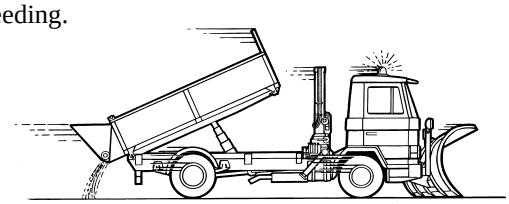
Hydraulic power is used when the vehicle is stationary. A power take-off with a high ratio (over 1:1) gives a large flow with a small pump. Choose a low ratio (under 1:1) to avoid overspeeding when control is exercised from the driver's position.



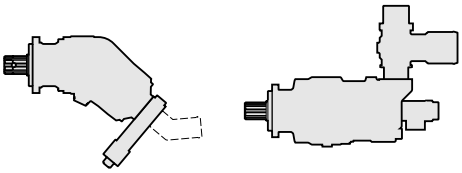
Pump choice: SC or SL



Combined vehicle: Road-maintenance vehicles, etc.
Hydraulic power is used when the vehicle is in motion as well. Choose a power take-off with a low ratio to avoid overspeeding.

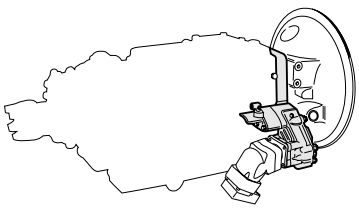


Pump choice: SC with By-pass or SL with Savtec©

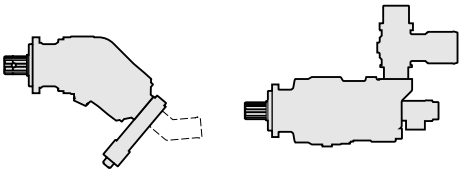


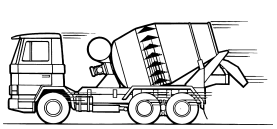
Engine-driven power take-off
(not under clutch control)

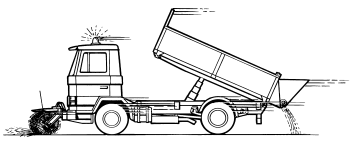
Hydraulic power can be used when the vehicle is in motion as well.

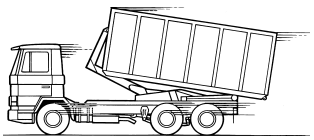


Pump choice: SC with By-pass or SL with Savtec©









Dimensioning of the hydraulic system

Choice of pump size

Displacement D

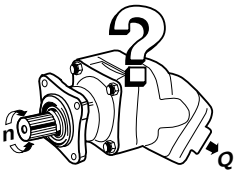
$$D = \frac{Q_1 \times 1000}{n_M \times z} \quad (cm^3 / varv)$$

Torque M

$$M = \frac{D \times p}{6.3} \quad (Nm)$$

Power P

$$P = \frac{Q_2 \times p}{60} \quad (kW)$$



Q_1 = Flow demand (l/min.)
n_M = Engine speed (rpm)
z = PTO ratio

D = Pump displacement (cm^3/rev)
p = Working pressure (MPa)
Q_2 = Flow (l/min.) $= \frac{D \times n_M \times z}{1000}$

Calculation of "pump size", i e displacement

Example 1: A crane has a flow demand of 60 litres/min. The engine speed selected is 900 rpm and the ration of the power take-off is 1:1.4. What pump is appropriate?

$$D = \frac{60 \times 1000}{900 \times 1.4} = 47{,}6 \text{ cm}^3\text{/rev.}$$

Select pump SC 47

NB Check that the speed of the pump ($n_{pump} = z \times n_M$) does not exceed the max recommended speed.

Calculation of torque and power output

Example 2: What will the torsional load and the power output be with the power take-off in Example 1 when the working pressure is 28 MPa (280 bars).

$$M = \frac{47.1 \times 28}{6.3} = 209 \text{ Nm} \qquad P = \frac{59.3 \times 28}{60} = 27.7 \text{ kW}$$

NB! In order to avoid overloading, compare the torsional load 209 Nm and the power output 27.7 kW with the maximum permissible values for the power takeoff.

System construction

Oil tank

Oil volume (l)

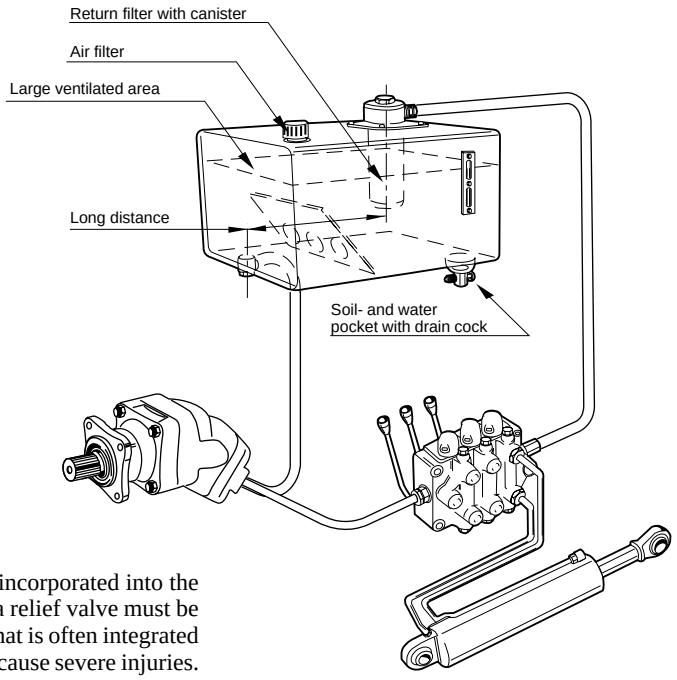
* At least equal to the oil flow (litres/min.) with short working cycles e g tipper operations.
* At least 1.5 times the oil flow with long working cycles e g a forestry crane
* At least twice the oil flow in continuous operation

The following will be required to prevent foaming:

* Return filter with canister
* Air filter
* Large ventilated area
* Long distance between suction and return connections

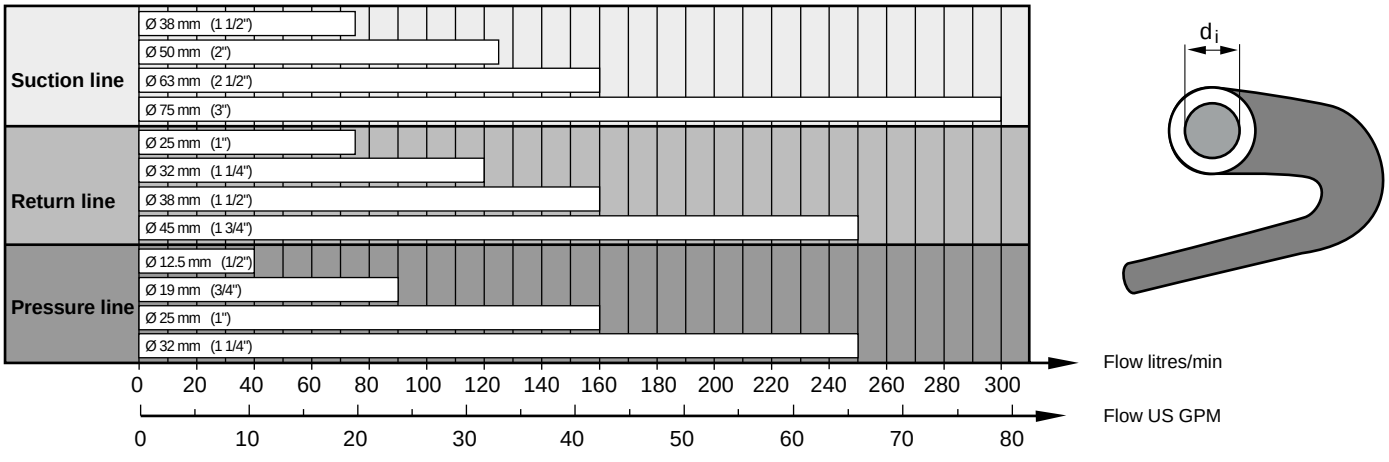
The upper side of the tank must be sealed so that water cannot run in The tank must be sited so that the oil level is higher than the pump

* Choose a large-bore suction line of the shortest possible length so as to avoid cavitation
* use of a suction strainer is advisable to catch coarse particles from the oil tank (SL only)
* Choose large-bore pressure and return lines so as to avoid pressure losses (heat generation).



NB: A relief valve with sufficient capacity for the intended flow must be incorporated into the system. In systems having a quick-fit coupling in the pressure line an extra relief valve must be fitted between the pump and the quick-fit coupling, in addition to the one that is often integrated into the valve assembly. This prevents breakdowns which could otherwise cause severe injuries.

Recommended line size (d_i)



Filtration

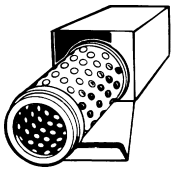
It pays to invest in cleanliness:

*** Increases operational reliability and service life.**
*** Reduces maintenance costs.**

In order to satisfy most market demands relating to operational reliability and service life, the oil's rate of contamination should correspond to class 16/13 in accordance with ISO 4406.

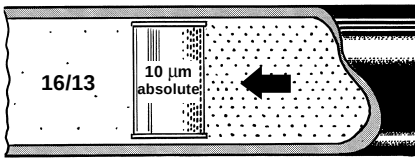
The hydraulic system is therefore equipped with a return filter and an air filter with an absolute filtration rating of 10 µm. For low pressures and shorter service life demands, an absolute filtration rating of 25 µm is accepted.

Where necessary, the hydraulic system must be fitted with a pressure filter, mounted in the pressure hose immediately after the pump.



Changing the filter cartridge: First change after 50 running hours. From then on, change every 200 - 500 running hours depending on the operating conditions, subject to a minimum of two changes a year.

Contamination class 16/13



Maximum 64 000 particles >5 µm/100 ml
Maximum 8 000 particles >15 µm/100 ml

Hydraulic oil

Grade:

- Mineral oil

Use a high grade oil whose technical properties fulfil at least the following demands:
ISO type HM VG 32-68 depending on the ambient temperature.
Alt. DIN 51524-2 HLP

- Environmental oil

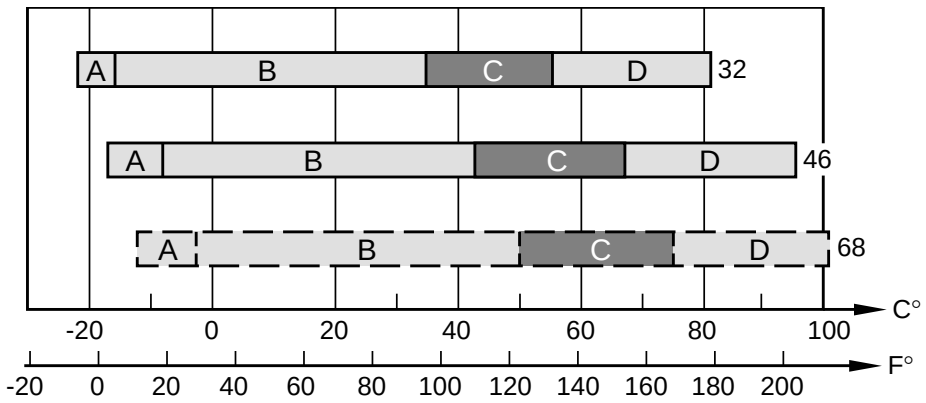
Use a synthetic ester which satisfies the same technical demands as the above-mentioned standards, e.g. BP Biohyd SE-S or similar.

Consult SUNFAB about difficult to ignite hydraulic fluid.

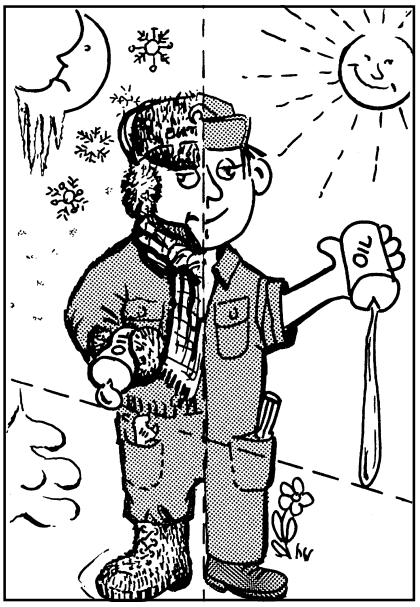
Viscosity:

The hydraulic oil's viscosity reduces (the oil becomes thinner) as the temperature rises. It is preferable to choose an oil which has a high viscosity index (VI). A higher VI gives less variation of viscosity during a temperature change.

*** At a viscosity higher than 1500 cSt (the limit for cold-starting) the pump cannot draw oil.**
*** When the viscosity goes below 10 cSt the lubrication performance becomes inadequate, besides which the efficiency of the system is impaired.**



Example: Hydraulic oil 32. The designation "32" means that the viscosity is 32 cSt at 40°C (104°F). The lowest starting temperature is -23°C (-9°F), the highest working temperature is 82°C (180°F). The ideal working temperature is 30 - 55°C (95 - 130°F).



A = The hydraulic system can be started but cannot be put under load. Only circulation pumping at idling speed. (1500-700 cSt).

B = The system can be put under load. (700-40 cSt).

C = Ideal working zone. (40-20 cSt).

D = Highest recommended operating temperature. (20-10 cSt).

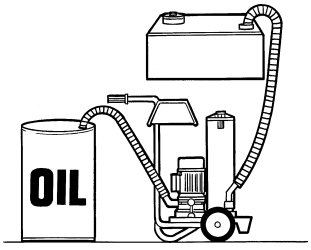
N.B: The diagram is valid for hydraulic oils with a viscosity index of about 180 cSt.

Water in the hydraulic oil

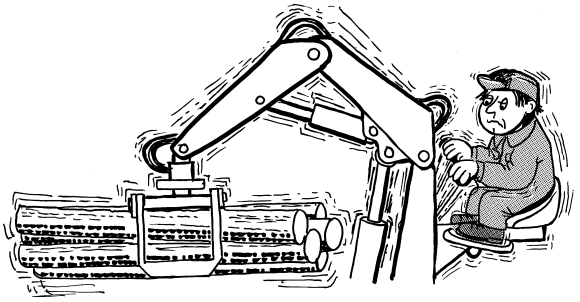
* Damage
* Corrosion on component surfaces
* Breakdown of the hydraulic oil. The lubrication performance deteriorates and wear increases.
* Ice formed at freezing temperatures may clog up the system

Oil filling - Oil changing

* New hydraulic oil in the drum has too high a degree of contamination
* The oil should therefore be filled by way of a filter unit (see illustration).
* Do not mix different grades of oil
* In the event of a pump breakdown: Change the oil or pass it through the filter unit and replace the filter cartridge before putting the pump back into service.
* The oil should be changed about every 1000 running hours, though at least once a year. Change the filter cartridge as well.



Trouble shooting



Action in the event of defective performance of the hydraulic system

Fault	Fault localisation	Cause	Remedial action
Equipment works unevenly	Investigate whether the flow in supply hose from the pump is pulsing Oil marks on the pump and suction line may indicate leakage of air. Check the oil level in the tank. Examine whether the oil is foaming	1. Pump not bled after fitting 2. Leakage of air into the suction line or pump 3. Low oil level 4. No canister round return filter 5. Ventilated area of oil tank is too small 6. Dirt in the pressure or suction valve (SL) 7. Defective pressure or suction valve (SL)	1. Bleed the pump 2. Repair the air leak 3. Fill to proper level 4. Change to a return filter with canister 5. Change to an oil tank with a larger ventilated area 6. Remove the dirt (see dism. of pump) 7. Replace the pump
Equipment works unevenly when starting and at thigh pump speeds	Investigate whether the pump cavitates. This will be indicated by the flow pulsations and pump noise disappearing whenever the speed is reduced	1. The bore of the suction line is too small 2. Restriction in the suction line 3. Blocked suction strainer (SL) 4. Oil too viscous 5. Oil tank pressure below ambient	1. Replace the suction line by a larger diameter one 2. Remove the restriction 3. Replace the suction strainer 4. Change to an oil with a lower viscosity 5. Ensure that the oil tank vent is not blocked
Oil is abnormally hot	Run the pump without load at working speed and measure the back-pressure in the supply line, close to the pump. The pressure must not exceed 2 MPa. Check that the pressure reaches the correct value whenever a function is operated to its limit	1. Too small bore, or restriction in the supply or return line 2. Dirty pressure or return filter 3. Excessive oil flow 4. The pressure relief valve opens at too low pressure 5. Oil not viscous enough 6. Oil tank too small 7. Low oil level 8. High continuous output	1. Change to larger diameter lines. Remove restriction. 2. Replace filter inserts 3. Reduce speed or change to a smaller pump 4. Adjust or replace the valve 5. Change to a higher viscosity oil 6. Change to a larger oil tank 7. Fill to proper level 8. Fit an oil cooler
Equipment has insufficient force	Check that the pressure reaches the correct value whenever a function is operated to its limit	1. The pressure relief valve opens at too low pressure 2. Defective control valve	1. Adjust or replace the valve 2. Replace the control valve
Equipment works abnormally slowly under load	Connect a flow meter close to the pump. Check the flow 1. the flow is correct under load 2. The flow is abnormally small under load	1. The pressure relief valve opens at too low pressure 2. The pump is worn	1. Adjust or replace the valve 2. Replace the pump
Noise from the pump	1-5. Investigate whether the pump cavitates. This will be indicated by the flow pulsations and noise disappearing whenever the speed is reduced. Check whether the noise is propagated through the hydraulic system 6. Check whether the noise occurs at all speeds	1. The bore of the suction line is too small 2. Restriction in the suction line 3. Blocked suction strainer (SL) 4. Oil too viscous 5. Oil tank pressure below ambient 6. Worn pump	1. Replace the suction line by a larger diameter one 2. Remove the restriciotn 3. Replace the suction strainer 4. Change to an oil with a lower viscosity 5. Ensure that the oil tank is ventilated 6. Replace the pump
Oil leakage from the pump	Locate the oil leak	1. Leakage at the suction connection 2. Leakage at the shaft seal 3. Leakage at the vent bolts	1. Replace the O-ring and tighten the hose clips. 2. Replace the shaft seals 3. Tighten the vent bolts. If necessary, replace the seal washer.
The pump vibrates (drive shaft mounting)	Investigate whether the pump vibrates despite the lack of flow pulses, i e the equipment does not run unevenly	1. Play in the drive shaft 2. Incorrect joint angles on the drive shaft 3. Imbalance in the drive shaft 4. The joint forks are not correctly aligned	1. Replace the drive shaft 2. Ensure that the axles of the power take-off and pump are parallel. 3. Remedy the drive shaft 4. Disconnect and turn the splined joint so that the forks are in line with one another

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