Technical Documentation

and

Operating Manual

for

Triplex – Inline Piston Pump Type MPC 6070

1. General

This Technical Documentation and Operating Manual was compiled in accordance with the applicable German and European rules, regulations and standards, including the VDMA Data Sheet 24292 “Operating Manuals for Pumps and Pump Units”, DIN EN 809 “Safety Requirements on Pumps and Pump Units” and DIN ISO 16330 “Reciprocating positive displacement pumps and pump units - Technical requirements”, applicable from time to time.

If reciprocating positive displacement pumps are used in the mineral oil, petrochemical or natural gas industries, it may be additionally agreed that DIN EN ISO 13710 be observed; this would then also include the latest API –Standard 674 in its third edition.

2. Safety

This Manual provides basic instructions to be observed during the installation, operation and maintenance of the equipment. Therefore it is absolutely necessary for this Manual to be read by the mechanic and the responsible technical personnel/operator before assembling and starting up the equipment and to be available at the site of the machine/plant at all times.

In addition to the general safety instructions listed in this section, special safety instructions included in other sections of this Manual should be observed as well, e.g. for private use.

2.1 Designation of instructions in this Manual

Those safety instructions in this Manual which in the case of non-observance may cause hazards to persons are specially designated by hazard warning signs.

Hazard warning sign according to DIN 4844-W9
Electric voltage warning

Hazard warning sign according to DIN 4844-W8

Those safety instructions in this Manual which in the case of non-observance may put the machine and its functions at risk are specially designated with the word

Achtung! (Attention!)

- Arrow indicating sense of rotation
- Designation of fluid connections

must be maintained in a perfectly readable condition.

2.2 Personnel qualification and training

The operating, maintenance, inspection and assembly personnel must be qualified to perform the assigned work. Responsibilities, competence and supervision of the personnel must be laid down in detail by the operator. If the personnel lack the required knowledge, they must be trained and instructed accordingly. This can be provided by the machine manufacturer/supplier on behalf of the operator. Additionally the operator is obliged to see to it that the contents of this Manual are fully understood by the personnel.

2.3 Risks resulting from the non-observance of safety instructions

Non-observance of the safety instructions may result in risks for persons, the environment and machines. Any non-compliance with the safety instructions may result in the loss of all and any claims for damages.

Specifically, non-compliance may result in the following risks:

- Failure of key functions of the machine/plant
- Failure of required maintenance and service methods
- Electrical, mechanical and chemical hazards to persons
- Environmental hazards due to leaking hazardous substances

2.4 Safety awareness

The safety instructions in this Manual, any applicable national accident prevention regulations as well as any internal working, operating and safety regulations implemented by the operator must be observed.

2.5 Safety instructions for the plant/machine operator

- If hot or cold machine parts cause hazards, the operator must provide suitable means for these parts to be protected against accidental contact.

- Any protection against contact with moving parts (e.g. couplings) must not be removed while the machine is in operation.
- Any leaking hazardous pumping medium (e.g. explosive, toxic, hot medium leaking, e.g. from the shaft seal) must be discharged in such manner that any danger to persons or the environment is avoided. All and any legal requirements must be observed.
- Any electrical hazards must be avoided (for details see e.g. regulations issued by VDE and local utility companies).

2.6 Safety instructions for maintenance, inspection and assembly activities

The operator provides for all maintenance, inspection and assembly activities to be performed by authorized and qualified personnel, after having become thoroughly familiarized with this Manual. Generally, any work on the machine may only be performed with the machine switched off. The machine must be switched off according to the procedure described in this Manual.

Any pumps or pump units conveying health-hazardous media must be decontaminated.

Immediately upon completion of the work any safety and protective equipment must be reinstalled and/or made functional again.

Prior to restarting the equipment, follow the instructions given in the section on the initial start-up procedures.

2.7 Unauthorized conversion and spare parts manufacture

Any conversion or modification to the machine is prohibited unless coordinated and agreed with the manufacturer. Using only genuine parts and accessory equipment authorized by the manufacturer increases safety. Any use of different parts may lead to the exemption from liability for the resulting consequences.

2.8 Unauthorized modes of operation

Operating safety of the supplied machine is only guaranteed if the machine is used as defined in section 5.1 – General – of this Manual. The threshold limits specified in the data sheet may not be exceeded by any circumstances.

The pump is supplied complete with the Manufacturer's Declaration pursuant to the Machine Safety Act and enclosed herein under item 9. According to this declaration the pump may not be put into operation unless configured into a complete operational pump assembly or an operational plant and provided that the stipulations of any applicable regulations and this Operating Manual/Technical Documentation have been observed. Therefore the type label of the pump comes without a CE sign.

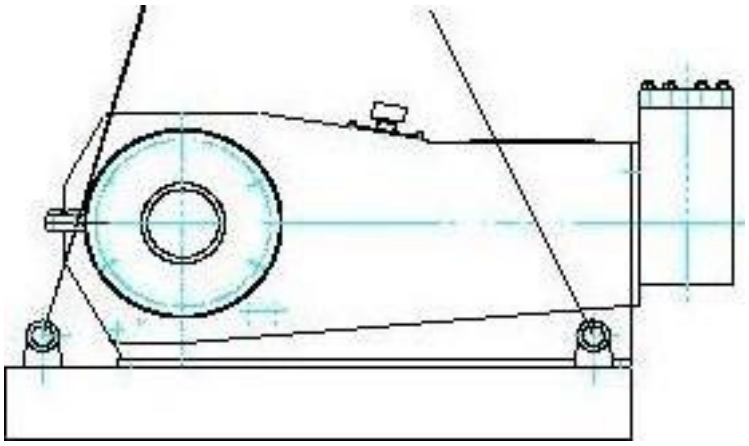
3. Transport and intermediate storage

Transport

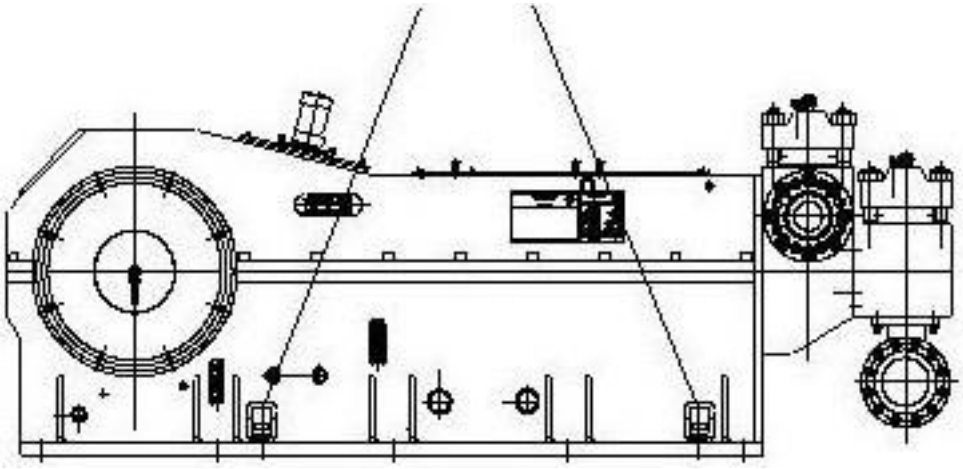
For environmental reasons the piston pump MPC 6070 is delivered without oil filling.

It is transported as shown in the below drawings. For the applicable weight see the set-up plan.

- Transport of the pump with base plate



- Transport of the pump without base plate



Storage / Preservation

Store the pump in a dry, frost-free, well ventilated and dust-free room. Any major temperature jumps must be avoided as the resulting condensed moisture may damage the drive unit. See also the information provided by the company Hydac about the installed ventilation dryer.

The piston pump delivered by OWH is preserved using the oil Tectyl 502-C, unless the customer has ordered different specifications. The preservation starts following completion of the assembly or functional / acceptance testing of the machine. The maximum duration for this type of preservation is 24 months for indoor storage and 3 months for outdoor storage.

Under these conditions it is not necessary to clean the parts of the pump prior to start-up.

Also whenever the pump is taken out of service over a longer period, it must be protected against corrosion.

In this case the following instructions must be followed:

- Drain gear oil
- Spray out the complete drive unit and wet all interior parts with preservation oil (recommended product: Tectyl 502-C) with the filter cap (drive unit item: 01-10) removed (Max. indoor storage 24 months and max. outdoor storage 3 months).
- It is recommended that the preservation activities be repeated regularly and before expiration of the storage period throughout the time the pump is out of service.
- Additionally wet the interior of the pump lantern (piston rods and inner liners) with preservation oil.
- Deposit silica gel bags in the housing of the drive unit and in the pump lantern in sufficient number, as specified by the respective manufacturer.
- In any event observe and follow the instructions and specifications provided by the preservation agent manufacturer.
- Prior to returning the pump to service, drain preservation oil, remove gel bags and fill gear oil back in. After draining the preservation oil, no cleaning is required; however, pump parts that have been treated with TECTYL 506 Valvoline must be carefully cleaned first.

4. Description of pump and accessories

The pump is a horizontal triplex – inline piston pump, the crankshaft of which can be optionally driven by a belt transmission, chain, torsionally flexible shaft coupling with geared drive, shaft-mounted gear unit, hydraulic transmission or hydrostatic drive. Combustion or electric engines can be used as primary energy converters.

The medium flows in via the common inlet at admission pressure. After passing the conical spring valve, the medium is guided into the pump body by the solid piston retracting in the liner. Then – with a forward stroke of the piston and with the spring valve in the inlet closed – the medium is pumped into the common pressure channel and the downstream pressure pipe via the self-actuating conical spring valve in the pressure section. The hydraulic resistivity in the downstream pressure pipe and in the drilling channel builds up the working or operating pressure of the piston pump, which does not generate any pressure itself.

The three pistons, arranged at 120 degrees, driven by the crankshaft (each fitted with four roller bearings) and moved by rods in an oscillating movement through the liners by means of spherical crosshead bearings. The axis of rotation of the crankshaft is positioned centrally in the parted welded casing of the drive unit and in one plane with the main axis of the crosshead bearings, the liners and the pistons.

Lubrication of the pistons in the liners is, on the one hand, by the pumping medium proper and, on the other hand, via the drive unit. Here water is fed into spray rings via externally fitted pipelines. The volumetric flow rate can be adjusted by means of a fix-mounted manually operated valve, also for cooling the liners.

The connecting rod bearings and the crosshead bearings are being force lubricated with hydraulic oil via bores in the crankshaft or via pipelines with separate connections on the side, while the roller bearings of the crankshaft are sinking into the oil bath. Two viewing glasses arranged on the side at two different levels enable the operator to check the oil level and whether there is any (condensed) water.

No special accessories are needed to operate the pump.

However, to facilitate operation in a time saving manner, OWH recommends its special extraction tool for assembling/disassembling the valve and piston liner units, which is available separately.

Technical specifications (according to DIN EN ISO 16330)

General

1.	Dimensions of the pump	L = 2,280 mm W = 1,250 mm H = 900 mm
2.	Weight (without oil filling)	G = approx. 4.250 kg

Pumping data:

15.	Nominal pumping rate (geometric displacement volume)	2,709 l/min
16.	Pumping medium	Water, drilling fluid
17.	Pumping medium – admission temperature	min. + 1°C max. + 60 °C
18.	Max. allowable continuous working pressure	150 bar
19.	Pumping medium – admission pressure	min. 3 bar max. 8 bar

Mechanical pump data:

20.	Nominal speed crankshaft	275 1/min
21.	Stroke	180 mm
22.	Max. piston force	200 kN
23.	Piston diameter	6“
24.	Mech. power demand	575 kW

25.	Average piston speed	1.65 m/sec
26.	Allowable operating temperature of drive unit (oil temperature)	50 °C – 80 °C

Additional pump data:

32.	Recommended lube oil viscosity (preheating required if starting below + 10°C)	Mineral oil VG 320
33.	Recommended oil filtration	25 mµ

Recommended controls

35.	Pumping medium – admission temperature	
36.	Pumping medium – admission pressure (pump to be switched off if pressure too high or too low)	
37.	Water inlet for piston rinsing (pump to be switched off if interrupted)	
38.	Inlet hydraulic oil lubrication of crosshead bearings Oil pressure and flow rate with on/off triggering	together, preferably: individually. By manometer and electrical
39.	Inlet hydraulic oil lubrication of crankshaft Oil pressure and flow rate with on/off triggering	By manometer and electrical
40.	Water content in the oil with temperature measurement (with on/off triggering), e.g. Hydac Aquasensor	
41.	Continuous monitoring of oil quality by bypass filter, e.g. Hydac system	
42.	Operating pressure	by manometer (optical)
43.	Gas pressure of pulsation dampers (with on/off triggering)	By manometer and electrical
44.	On-line / off-line monitoring (under development)	

5. Set-up / installation / controls / interlocking

If operated as a stationary unit, e.g. as a process pump, the pump is set up on a strip foundation made of sufficiently dimensioned beams or on poured concrete or brick foundations. The pump is fixed to the foundations using four vertical bores each provided in the base frame of the pump. Suitable bolts are to be fixed to the foundations beforehand (by welding or pouring). It goes without saying that the floor must be level and that no torsional forces may be induced into the drive unit housing.

For the intended use as a mud pump for drilling with changing operating locations the pump should be installed in a container. The base plate and the framework of the container must be designed with sufficient rigidity to accommodate the weight, the fastening elements of the pump and its drive unit without the risk of torsional damage during (crane) transports and movements on the construction sites. The gear unit, additional couplings and the drive unit proper must be assembled following the specifications of the respective manufacturer.

For hydraulic connection, the pump is equipped with flanged ports for connecting pipe and flexible tube lines on the admission as well as pressure side. Care must be taken that the flanges are tightened and released in a plane-parallel and tensionless manner. An angle error of more than 0.2 mm at the outer flange diameter should be avoided by all means. See Figure 1 and Table 1 as well as allowable forces and torques on page 12 EN ISO 16330.

Figure 1: Pipe line connection

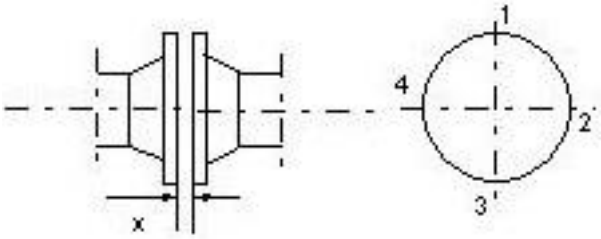


Table 1: Measurements at pipe line connection

Measuring point	Nominal value	Measured values at measuring points			
		1	2	3	4
	mm	mm	mm	mm	mm
Suction socket	0.2				
Discharge socket	0.2				

Even though the pump head and the drive unit of the OWH mud pump is of an extremely robust design, it is nevertheless recommended to install suitable absorption or resonator dampers and possibly also compensators on the admission and pressure side in order to vibration-decouple the hydraulics and mechanics of the fluid section of the pump from the inlet and discharging lines and stabilize the inflow and pumping of the drilling fluid. OWH may provide further assistance on request.

Due to the displacement principle of the piston pump, any abrupt clogging of the pumping line in principle generates an unlimited pressure in the pump. Therefore suitable technical measures, which cannot be overridden by the operating personnel, must be in place to ensure that upon any clogging of the mud line the pressure flow of the pump can be deviated and discharged without risk. Moreover, any valves in the admission and pumping line that must be open when the pump is started must be interlocked to ensure that the pump does not start with any of these valves closed. Also in this respect OWH may provide further assistance and recommendations.

As to necessary controls and interlocking, at this point reference is made to items 35 and 44 under “Technical specifications” in chapter 4. However, the pump manufacturer is only in a position to make recommendations as he has no detailed knowledge about the layout and operating concept of the overall pumping plant. This makes it impossible for the pump manufacturer to make specific decisions, as to whether e.g. optical supervision

is sufficient or whether it might be necessary to install an interlocking system based on electrical sensing equipment, e.g. when the pump is operated in a closed container.
The latter option can be illustrated by way of the example of lube oil pressure in the two lubrication circuits: it is an indispensible prerequisite that the lube oil supply is completely in place before the pump is started. This can be reliably achieved by checking the oil pressures after having sufficiently vented the lines and filled in the oil. In principle the oil pressures must be checked permanently throughout the operation of the pump. The decision as to whether these checks are to be made purely visually by – permanently present - operating personnel or whether the checks are to be handled fully automatically by electrical sensing equipment is to be made by the plant engineer, possibly together with the plant operator.

This especially applies to all safety-relevant aspects of a high-pressure pumping plant. Here EN 809 provides valuable assistance in the form of a highly detailed check list. For this reason the type label of the pump must not bear the CE designation, as the primary safety and system responsibility rests with those who design and assemble the pumping plant.

6. (Initial) putting into service / Taking out of service

Prior to putting the piston pump into service, it must be verified within the framework of a final installation check that all plant design requirements, especially safety aspects, have been complied with.

As this pump order is a special case in that the plant configuration planned and implemented by the customer is completely new, there will additionally be a trial run on a suitable test site witnessed by both the supplier and customer. As the trial run may show that technical modifications need to be made, this documentation and operating manual can only be of a provisional character.

First the drive unit housing must be filled with oil in the quantity and quality (preferably VG 320) as specified in the technical specifications, either by pouring through a funnel into one of the bleeder holes in the upper cover or by pressure filling into the pressure port of the crosshead bearings.

The filling is completed when the oil level has reached the minimum level mark in the upper viewing glass (The top level mark is valid for a switched-off hot-run pump). Then start the lube oil circuits and let them run for about 15 minute to ensure that all air has escaped from the bores and lines in the drive unit.

At the same time check whether the required oil pressures of approx. 4 – 6 bar have been reached. If an interlocking for the oil pressures has been installed, lower the respective pressure below the threshold value to test and ensure the system's proper functioning.

Now switch in the water cooling/lubrication for the pistons. Initially adjust a somewhat lower flow rate by means of the manually operated valve at the drive unit.

Then test the functioning of the lube oil recooling system in an adequate manner, depending on whether it works automatically or is controlled by hand.

Now you can start filling the drilling fluid into the pump head by opening, if available, the gate/shut-off valve optionally installed in the admission pipes and switching in the admission pressure pump. The pressure at the inlet socket of the pump must reach at least 6 bar. This pressure may fall to 4 bar once the piston pump assumes operation. At the same time check whether the drilling fluid is being discharged at atmospheric pressure into the pumping line or a downstream bypass line. If pulsation-dampening components working on the absorption principle have been installed in the admission and pumping lines, also check, as far as possible, whether these have been properly primed.

Then start the piston pump, first at atmospheric pressure and at low speed. Constantly check the sense of rotation of the crankshaft and the build-up of the lube oil pressures.

Then, during the next 15 min (does not apply to the trial run, as for this a separate testing programme is applicable) speed the crankshaft up to nominal speed in several steps, readjust the water lubrication of the pistons and check for leakage. Following this, switch from the bypass to the pumping line and start normal operation, building up resistivity dependent pressure at variable speeds within the allowable performance limits. However, if the pump is started after an extended standstill period, we recommend that a functional test of the excess pressure protection system be performed.

If the pump is to be taken out of service, a differentiation is made between two conditions:

If operation is interrupted only for a short period (a few days or weeks), it is sufficient to rinse both the piston and the admission pressure pump at low speed and at atmospheric pressure with clear water to remove all residues of drilling fluid. To ensure that the residues are completely removed, also rinse the inside liner surfaces and the complete interior of the lantern.

If the pump has operated in the open air and there is the risk of frost, it is recommended that the pump be carefully drained to avoid damage by frost.

If the pump is to be taken out of service for a longer period, e.g. for several months, it is recommended that the lube oil be drained and that the interior of the drive unit and the pump head be protected by long-term preservation, including greasing of the liner and the bare piston and pressure rods, also under the bellows, as protection against corrosion. Additionally, deposit moisture absorbing agents, e.g. silica gel bags, inside the drive unit and close the vent holes.

7. Maintenance / Service

For the time being this operating manual is limited to the description of those maintenance and service activities on the newly developed piston pump that can and should be performed independently by the operating personnel. Any additional activities, e.g. the complete or partial disassembly of the drive unit, should initially only be performed together

with the manufacturer and will be added to this manual once further experience is available.

7.4 Lube oil change - Intervals

Provided that the Aquasensor and the degree of contamination do not require a shorter interval (can be checked by Hydac CS 2000), the first oil change can be performed after 2000 operating hours, but not later than 12 months.

Subsequent oil and oil filter changes every 2000 operating hours, but not later than every 12 months, provided that the Aquasensor and the degree of contamination do not require shorter intervals. Log the results of the oil test and certify the changes in the pump logbook.

With a view to the results achieved in tribological research and the relatively large quantity of oil required by the here described pump, it might be recommendable to use modern oil monitoring systems, which no longer schedule rigid intervals for oil and oil filter changes but schedule the oil and oil filter changes more flexibly depending on the actual degree of contamination and wear. This is a more cost effective solution for the pump operator. It is recommended to obtain specialist advice in this matter.

For oil purging, as required for certain parts, e.g. the liners, temperature resistance is specified at max. 100 °C.

8. Failures, possible causes and remedies

	Failure	Possible causes	Remedy
1.	Safety valve triggers	Pumping pressure too high	Reduce speed Open bypass
		Safety valve defective	Replace safety valve

		Valve in pump head defective	Check valves
2.	Required pumping pressure does not build up or drops	Speed too low	Increase speed
		Bypass too wide open	Reduce opening of bypass
		Valve in pump head defective	Check valves
		Drilling fluid too thin	Check viscosity
		Piston seal defective	Replace piston seal
		Grooves in liner	Replace liner and piston seal
		Seals at pump head or in pressure line leaking	Replace seals
		In connection with knocking noise: Cavitation	Check admission side, increase admission pressure, check
		Cavitation erosion between valve seat and pump body	Replace defective parts
3.	Leaking oil at seal ring of crankshaft	Seal ring leaky	Replace seal rings
		Air filter blocked	Clean air filter
4.	Leaking oil at thrust pad sealing	Seal rings and/or gaskets leaky	Replace seals
		Air filter blocked	Clean air filter
		Bellows defective	Check pressure rod for grooves and replace bellow

5.	Water and drilling fluid in intermediate lantern	Piston rod seals leaky	Replace seal
		Piston rod damaged	Replace piston rod and seal
		Bellow damaged	Replace bellow
6.	Temperature rise at sensor XD / YW 003	Piston cooling failed, piston seal burned	Repair piston cooling, replace damaged parts
7.	Aquasensor triggers	Water in oil, air filter blocked	Replace oil, clean or replace air filter
		Pressure rod seals defective	Replace oil, replace seal
8.	Oil temperature sensor XD/ YS 004/3 triggers. Oil temperature too high	Oil cooling failed	Repair cooling
		Oil level dropped	Find and replace defective seals, refill oil
		Lacking oil, pressure marks or pitting at crosshead sleeve and cylinder	Major repair together with OWH
		Friction bearing of connecting rod run out or pitted due to contaminated oil	Major repair together with OWH
		Antifriction bearing of crankshaft defective	Major repair together with OWH
9.	Knocking noise in piston pump	Cavitation, possibly caused by:	Improve admission conditions, adjust admission pressure
		Knocking valves	Replace, if already damaged
		Too much play in spherical crosshead bearing	Adjust play; if necessary, replace damaged parts

		Damaged bearings at crankshaft and connecting rod	Replace damaged parts
10.	Pumps stops or does not start	Interlocking has triggered	Identify activated interlocking and Repair failure

Applicable guideline for tightening of torques is the chart “Bolt torques for strength classes according to DIN 267”

10.4 Conversion table

Pressure

From	to	Conversion
psi	Kilopond/cm² (kp/cm²)	psi x 0.07031 = kp/cm²
Kilopond/cm² (kp/cm²)	psi	kp/cm² x 14.22 = psi
psi	Bar	psi x 0.07 = Bar
Bar	psi	Bar x 14.29 = psi

Measure of length

From	to	Conversion
Inch (in)	Millimeter(mm)	in x 25.4 = mm
Millimeter(mm)	Inch (in)	mm x 0.03937 = in
Zoll	Millimeter(mm)	Zoll x 25.4 = mm
Millimeter(mm)	Zoll	mm x 0.03937 = Zoll
Fuß (foot)	Meter (m)	foot x 0.3048 = m
Meter (m)	Fuß (foot)	m x 3.281 = foot
Yard	Meter (m)	Yard x 0.9144 = m
Meter (m)	Yard	m x 1.0936= Yard
Mile (mls)	Kilometer (km)	mls x 1.609 = km
Kilometer (km)	Mile (mls)	km x 0.622= mls

Force

From	to	Conversion
Pounds (lbs)	Newton (N)	lbs x 4.45 = N
Newton (N)	Pounds (lbs)	N x 0.225 = lbs
PS	Kilowatt (kW)	PS x 0.735 = kW
Kilowatt (kW)	PS	kW x 1.36 = PS

Weight

From	to	Conversion
Pounds (lbs)	Kilopond/cm²(kp/cm²)	lbs x 0.45 = kp/cm²
Kilopond/cm²(kp/cm²)	Pounds (lbs)	kp/cm² x 2.2 = lbs
Ounces (oz)	Gramm (g)	oz x 28 = g
Gramm (g)	Ounces (oz)	g x 0.035 = oz
Pounds (lbs)	Kilogramm (kg)	lbs x 0.4536 = kg
Kilogramm (kg)	Pounds (lbs)	kg x 2.205 = lbs

Torque

From	to	Conversion
Foot-pounds (ft-lbs)	Newton-Meter (Nm)	ft/lbs x 1.35 = Nm
Newton-Meter (Nm)	Foot-pounds (ft-lbs)	Nm x 0.74 = ft/lbs
Newton-Meter (Nm)	Kilopond/cm² (kp/cm²)	NM x 0.102 = kp/cm²

10.5 Maintenance schedule

Daily, prior to starting

Visual outside inspection of the pump, checking of oil level at upper viewing glass and for any water at lower viewing glass. Opening of hinged cover and visual inspection of both lantern chambers. Look for unusual phenomena, such as heavy oil leakage at piston rod seals or heavy drilling fluid leakage from the liner. Log all observations in the (digital) pump log book.

Daily, after attainment of operating temperature

Visual inspection of pump head. Look for any leakages. Visual inspection of both lanterns. Look for leaking oil or drilling fluid. Acoustic inspection for unusual noise and vibrations. Log all observations in the pump log book.

Monthly

Functional test of all connected controls and interlockings.
Check torques of all fastening bolts and nuts at pump head.
Check fastening bolts of the drive unit for tightness.

After 2,000 h, but not later than after 12 months.

First oil change: Oil change after 2,000 operating hours, provided that the Aquasensor and the degree of contamination do not require a shorter interval (possible check with Hydac CS 2000).

Every 2,000 h, but at least once a year	Subsequent oil and oil filter changes every 2000 operating hours, but not later than every 12 months, provided that the Aquasensor and the degree of contamination do not require shorter intervals. Log the results of the oil test and certify oil and filter changes in the pump logbook.
As required, as mainly dependent on drilling fluid	Replacement of pump head valves, valve springs and seats, solid pistons, liners and flapper plate, log in pump log book
After 24 months	1st small overhaul by OWH or qualified personnel from Customer (replacement of piston rod seals, check of crosshead play, inspection of pump head).
After 48 months	2nd small overhaul
After six years	Big overhaul by OWH. Dismounting of pump head, dismounting of upper part of drive unit, checking of antifriction and friction bearings, of the liner and the crosshead cylinder, including replacement of parts showing wear as a precautionary measure. Additionally, small overhaul.
In the seventh year	Revision of the maintenance schedule by OWH together with Customer based on log book entries and overhaul reports.