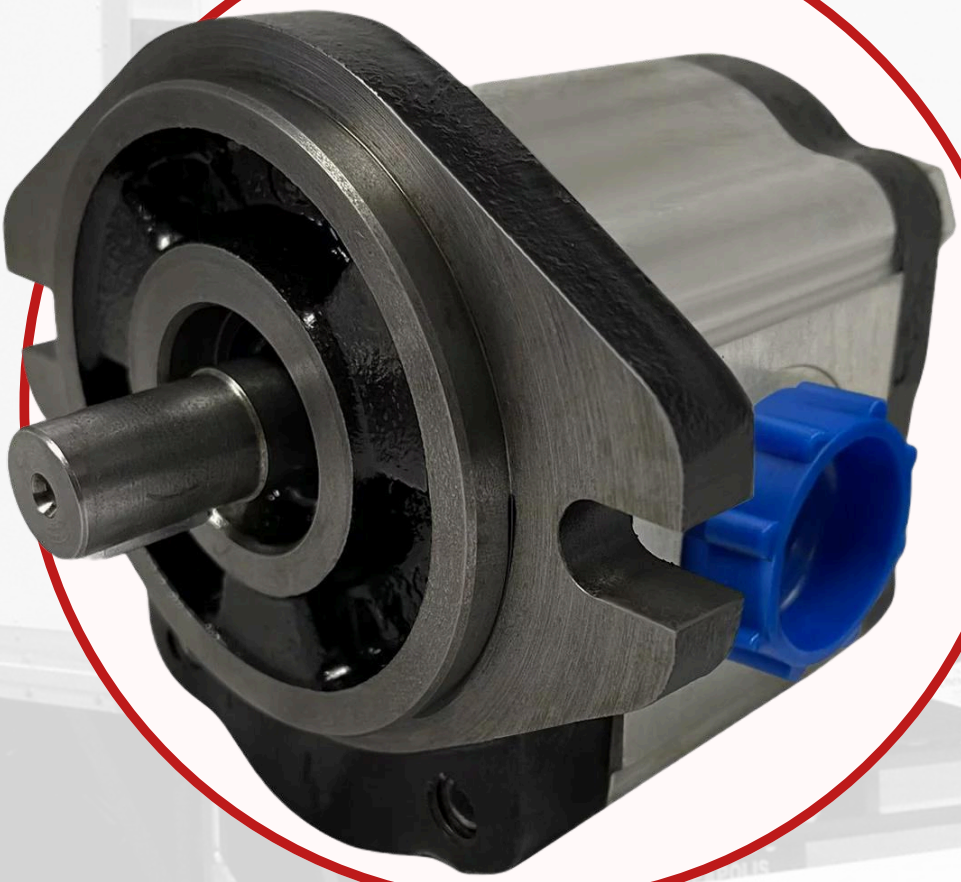
HYDRAULIC GEAR PUMPS

MANUAL



In this supporting document, Magister Hydraulics external gear pumps assembly and operation instructions were provided. Various pump manufacturer guidelines were also used during preparation of this manual.

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A1 TECHNICAL INTRODUCTION

Hydraulic pumps convert mechanical energy to hydraulic energy. They have two functions: They suck the fluid from reservoir to inlet by vacuum created with mechanical movement. They also send the fluid by mechanical movement to the outlet. Hydraulic pumps do not create pressure. Pressure is an indicator of resistance to fluid.

A2 PREPARATION CHECKPOINTS

Before installing new hydraulic pump, paying attention to the following points will prevent possible future problems:

1. Determine and eliminate cause of failure in old pump.
2. Retract all cylinder rods and drain tank.
3. Flush tank. Using diesel fuel under pressure, flush the tank thoroughly and wipe with clean cloth.
4. Install new filter elements. (min 10 micron) If there is no filtration in the system, please install a return filter 10 micron.
5. Assembly new pump.
6. Fill new oil to the reservoir. Please pay attention using correct fluid. In normal conditions, it is recommended to use 46 cSt mineral based hydraulic oil. But it may vary based on different climates. In cold countries it is recommended to use 32 cSt oil, in hot countries it is 68 cSt oil. Please always check the oil level during the following steps.
7. Disassemble all connections going to actuators in the system. If there is an accumulator, it needs to be bleeding before connecting the lines.
8. Activate each circuit by moving the control valve handle so lines are flushed with new oil. This flushes the lines and valves from the pump to all cylinders and motors. Be sure to check oil level, and add new oil if necessary.
9. Connect lines to blind end of cylinders and all fluid motors. Leave the rod end disconnected and with the engine at one-fourth throttle, activate circuits slowly until the cylinder bottoms out. New oil will be put in the blind end of the cylinder and old dirty oil flushed out the rod end. Do this for all cylinders in the machine.
10. Connect lines to the rod end of cylinders. Again, check oil level and add new oil if required.
11. Operate all cylinders and motors alternately for 30 min. At full throttle.
12. Change the filter element if necessary and check oil level.
13. Check oil temperature and make sure it is not more than 185° F. After the first start, please check the new pump by hand and make sure there is no overheating. If there is overheating, check the oil cooler in the system.

The above procedure, if followed, will allow you to install a new pump with confidence, knowing that you will get satisfactory pump life. Cutting short these steps can cause premature pump failure, the pump will not run long on a contaminated system.

B1 DRIVE OF THE PUMP

During pump assembly, there must not be axial and radial loads on the pump shaft. These loads can damage bushings. It is recommended to use elastic couplings.

Picture 1. Elastic coupling

Pump keys must be hand fitted during pump assembly. Hammering during assembly is not allowed since this can damage internal parts. There are other types of drives such as gear, chain, toothed belt or V-belt. In these connections, there will be additional loads on the drive shaft. For this reason, it is recommended to use pumps with front bearings.In order to reduce side loads, the diameters of the gear sprocket or pulley should be large and they should be close to the pump front cover.

B2 ROTATION OF THE PUMP

Magister hydraulics gear pumps can be operated clockwise or anti-clockwise rotation. They can only run in **one direction**: left or right. In order to determine pump rotation, a view from the shaft side is considered. In the part number “A” refers to anti-clockwise and “C” refers to “clockwise” rotation from shaft view. For example, 20C16X007 hydraulic pump rotation is clockwise from shaft view.

Arrow boss which shows pump rotation from shaft view.

Picture 2. Arrow showing rotation on pump front flange

B3 ASSEMBLY OF THE PUMP

Pumps are assembled with two or four bolts with centering spigots from their front flanges. The counter bore to receive mounting flange spigot should have a 1 mm x 45o chamfer on the pump side to ensure proper seating. It is recommended to use flexible hoses in order to minimize vibration.

Centering spigot

Picture 3. Group 20 external gear pump and hydraulic symbol

B4 PUMP SUCTION LINE

In order to prevent high suction vacuum, pump inlet connections should be arranged to provide max. 2 m/s flow velocity. It is recommended to use short and big section hose/pipes as much as possible at pump inlets to prevent big pressure drops. It is good to avoid sharp corners too. Please refer to **"DD.042 R(0) Pipe sizing chart"** document to choose proper pipe diameter size.

B5 PUMP PRESSURE LINE

Pump pressure lines should be protected with a pressure relief valve that maintains the pressure of the system. Setting of this valve should be determined by considering maximum operating pressure of the pump. For outlet velocity, lower than 5 m/s is acceptable.

Magister hydraulics pumps maximum working pressures are related to pump group, material and displacement of the pump. P1 maximum continuous pressure values were shown in table 1. P1 decreases as pump displacement increases. P1 pressure can be read on pump housing.

Pump group	P1 pressure
Grup 00	2320 – 2900 psi
Grup 10	1740 – 3626 psi
Grup 20	2320 - 3626 psi
Grup 30	2610 – 3626 psi

Table 1. Max. continuous pressure values for Magister hydraulics pumps

(P1: continuous working pressure, P2: intermittent working pressure, P3: peak pressure)

Operating pumps at more than P1 pressure continuously will decrease pump life time.

B6 CAVITATION

Hydraulic oil contains about 10 % dissolved air by volume. In some conditions, air is released from oil causing air bubbles. Then they collapse in certain pressure values and create erosion on the metal. Greater air content in oil erosion will be more. Main causes are leaks on the inlet line of the pump, flow line restrictions such as inadequate pipe size, elbow fittings, and sudden changes in flow line cross sectional area. Cavitation damages pump housing and bushings. Hydraulic pump under cavitation runs noisy and the system is observed in jerky condition.

B7 OIL TANK

In order to use correct oil tank capacity, 2-3 times of flow rate at maximum speed is considered. Too small a reservoir will fail to accommodate volume changes due to system components leading to vortex that causes air in the system. It also leaves insufficient time for the release of air in the oil and for the dissipation of heat. Return line should be below the minimum oil level. Oil suction ports also should be well immersed to eliminate vortex and as far as possible they should be located away from oil return pipe to avoid recirculation of air bubbles. Adequate air space needs to be provided over oil level. For this reason an air breather cap must be fitted to prevent dust particles coming through inside of the tank. This cap can also be used for filling hydraulic oil. Please check oil level regularly and always use the correct type of clean fluid.

B8 FILTRATION

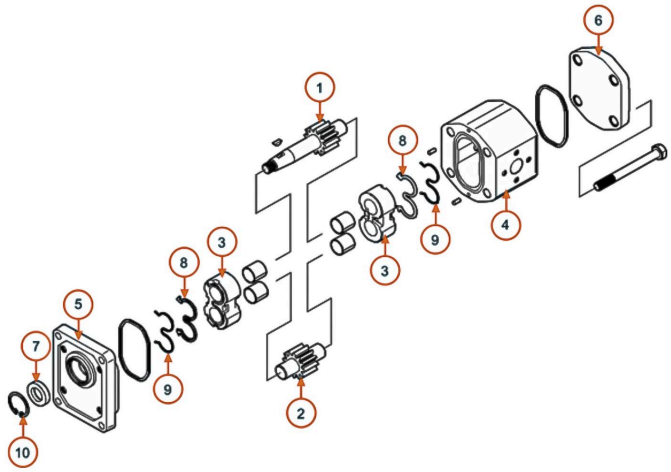
Dirt is the enemy of any hydraulic system or component. If there is not enough filtration, system lifetime will decrease. There must be a suction strainer in the suction line and filter in the return line. Most of the hydraulic pump problem's root cause is dirty hydraulic oil or inadequate filtration. 0.15 mm suction strainer and minimum 10 micron return filter are recommended to use.

B9 HYDRAULIC FLUID

It is recommended to use mineral based hydraulic oil with correct viscosity grade. In addition, the fluid should contain additives that prevent corrosion, oxidation and foaming. Fluids which have viscosity grade lower than 5.5 cSt shouldn't be used. It is recommended to use 46 cSt mineral based hydraulic oil. But it may vary based on different climates. In cold countries it is recommended to use 32 cSt oil, in hot countries it is 68 cSt oil. Viscosity range was shown in table 2.

Allowed range	**6 – 500 cSt**
Recommended range	10 – 100 cSt
Startup	...2000 cSt

Table 2. Viscosity range | For -4° F ... +230° F range FPM seals can be used.



Basic pump parts

1. Drive gear
2. Driven gear
3. Bushings
4. Body
5. Flange
6. Cover
7. Rotary shaft seal
8. Compensation seals
9. Anti-extrusion seals
10. Circlip

Picture 5. Components of a group 20 external gear pump.

B10 CALCULATIONS

Displacement [Cm3/rev/ (cc/rev]	V
Flow rate [L/min] [gpm]	Q
Pressure [bar] [psi]	p
Torque [Nm][ft lb]	M
Speed [rev/min]	n
Power [kW]	P
Volumetric efficiency	n_v
Hydraulic-mechanical efficiency	n_{hm}
Total efficiency	n_t

For external gear pumps, volumetric efficiency is around 93 %, Mechanical efficiency is around 85 % and total efficiency is around 80 %.

B11 GEAR PUMP ROTATION AND PORT LOCATION

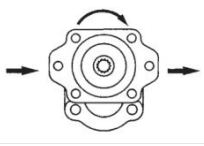
Gear pumps have an input shaft that drives an inner gear or “drive” gear. When the shaft turns the drive gear, the drive gear turns the “driven” gear. As these two gears rotate, oil is pulled into the suction port, split and carried around the perimeter of the gears, and finally, combined and pushed out the discharge port.

When determining the rotation of a gear pump, one must decide on the viewing orientation. As an industry standard, a pump’s rotation is determined when viewed looking at the input shaft. If your viewing orientation is at the rear of the pump, the technical rotation of the pump is opposite the visual rotation.

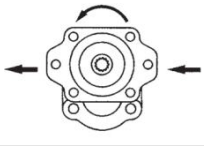
The suction and discharge ports are determined by the rotation of the input shaft. As with rotation, the position of each port is dependent upon the viewing orientation. Here too, the industry standard, when looking at the input shaft, is for the drive gear to be oriented above the driven gear, also known as “belly down.” In this orientation, a clockwise pump will have suction on the left and discharge on the right and vice versa. If the pump is oriented with the “belly up,” the suction and discharge ports will appear opposite.

In the chart below, direction of oil flow is represented by straight arrows and the rotation of the pump is indicated with an arced arrow.

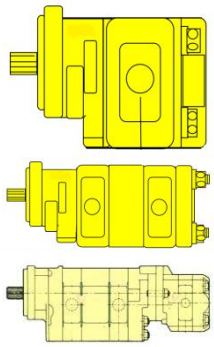
VIEWING PUMP WITH INPUT SHAFT ABOVE DRIVEN GEAR “BELLY DOWN”



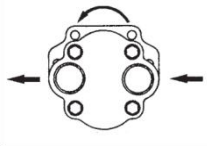
Clockwise
when viewed looking at input shaft.
(CW, RH, Right Hand)



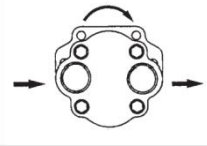
Counterclockwise
when viewed looking at input shaft.
(CCW, LH, Left Hand, Anti-Clockwise)



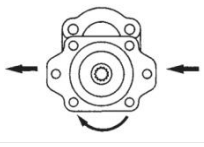
Clockwise
when viewed looking at rear of pump.
(CW, RH, Right Hand)



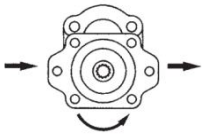
Counterclockwise
when viewed looking at rear of pump.
(CCW, LH, Left Hand, Anti-Clockwise)



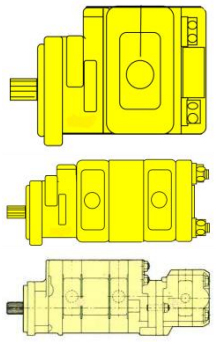
VIEWING PUMP WITH INPUT SHAFT BELOW DRIVEN GEAR “BELLY UP”



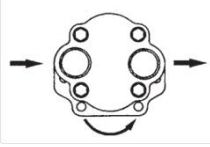
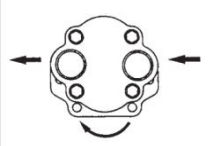
Clockwise
when viewed looking at input shaft.
(CW, RH, Right Hand)



Counterclockwise
when viewed looking at input shaft.
(CCW, LH, Left Hand, Anti-Clockwise)



Clockwise
when viewed looking at rear of pump.
(CW, RH, Right Hand)



Counterclockwise
when viewed looking at rear of pump.
(CCW, LH, Left Hand, Anti-Clockwise)