International Journal of Research in Engineering, Science and Management
Volume-3, Issue-6, June-2020
www.ijresm.com | ISSN (Online): 2581-5792

Design of Mechanism to Replace Hydraulic Cylinder Piston Seals

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***Abstract*: The present paper describes the research and analysis difficulty for replacing piston seals. At present it is done by using screw wrench and hammering mechanism. Hence the fixture /machine should decrease the work of the labours and increase the process efficiency. Hence we designed a special fixture for easier mantling and dismantling of hydraulic cylinder endcaps. This fixture is operated by mechanical and hydraulic operations.**

***Keywords*: Hydraulic cylinder, Endcaps removal, Piston seals.**

1. Introduction

The main objective of our project is to design and fabricate a special fixture for easier mantling and dismantling of hydraulic cylinder endcaps. This fixture is operated by mechanical and hydraulic operations.

2. Problem Identification

In the industry, we noticed that the labours are facing with a difficulty for replacing piston seals. At present it is done by using screw wrench and hammering mechanism. It involves 2-5 labours to perform this operation. Hence the fixure /machine should decrease the work of the labours and increase the process efficiency.

3. Methodology

We use hydraulic cylinders as a source of power required to operate the machine. Hydraulic cylinders gets power from pressurized hydraulic fluids. The hydraulic cylinder has cylinder, in which piston rod moves back and forth. The cylinder is closed on one end by the cylinder end and the other end by the cylinder top where the piston rod comes out of the cylinder. The piston has gliding rings and also seals. A hydraulic cylinder is the motor operation of this system. The "generator" of the hydraulic system is the hydraulic pump which delivers a fixed flow of oil to the hydraulic cylinder, to give movement the piston. The piston pushes the oil in the chamber back to reservoir.

4. Types of Hydraulic Cylinders

- Single acting piston
- Single acting piston
- Double acting piston
- Single acting multiple stage cylinders
- Double acting multiple stage cylinders

5. Types of Mountings for Hydraulic Cylinders

Mountings play an important role in performance. Generally, fixed mounts are best for straight line force and avoiding wear. Common types of mounting include,

- Flange mounts
- Side-mounted cylinders
- Centerline lug mounts
- Pivot mounts

6. NFPA Approved Cylinder Mounting Styles

MP1 – Fixed Clevis
MP2 – Detachable Clevis
MF1 – Front Flange Mount
MF5 – Front Flange Extra Size Mount
ME5 – Front Head Flange Mount (not pictured)
MF2 – Rear Flange Mount
MF6 – Rear Flange Extra Size Mount
ME6 – Rear Head Flange Mount (not pictured)
MS2, MS3, MS7 – Side, Center and End Lug Mounts, respectively
MT1, MT2, MT4 – Front, Rear and Trunnion Mounts, respectively.

7. Repair

Hydraulic cylinders form the main of many hydraulic systems. It is a common to dissemble and rebuild an entire hydraulic cylinder repair. Inspection of the leakage issue is helpful in recognizing the problem and choosing the repair options.

A. *Disassembly*

First of all, you should place the cylinder in location, which has space to work. If you are working in a closed space, it will be difficult to keep track of opened up parts. After bringing the cylinder to correct spot, open the cylinder port and drain out all the fluid.

B. Diagnosis

Once the piston rod is completely removed, you will be able to see many seals on various parts that are connected to the piston rod. First of all, you need to examine the rod to see if there is any damage. If the shaft is bent or if the cylinder has scratches, then get them repaired at a repair shop. If the damage is permanent, then you can order or manufacture a new piston cylinder.

C. Replacing damaged parts

The parts of the hydraulic cylinder that are damaged need to be either repaired or replaced with new parts. The seals can be repacked with the help of cylinder seal kit. These kits will have seals and o-rings. Remember the type of old seal while removing them and fix the new ones. Make sure that you handle the new seals with most care so that they do not get damaged.

D. Rebuilding

Before reassembling all the parts, you should clean and dry the cylinder completely. Also clean the piston rod, shaft, of the cylinder. Get the damaged seals repacked. Then assemble the parts back on the cylinder piston. The assembly needs to be done reversed. Once you have assembled all the parts back, put the rod into the vise and screw back the bolts onto the rod.

E. Important tip

If the parts are severely damaged, then it is advisable to replace them with new parts with the help of a professional repair expert. Trying to replace/ repair too many parts on one's own can lead to faulty assembly. By following the above steps, you can finish the task of hydraulic cylinder repair. Make sure you prevent ingress of moisture or dirt after assembly of the parts.

8. Solution

The mechanism will going to be consist of mechanical and hydraulic operations to remove the endcaps of the hydraulic cylinders.

A. Working of hydraulic mechanism

Hydraulic systems are everywhere in mechanical systems and made of a variety of components. With properly located and perfect design components, the hydraulic system should generate minimum heat and operate with minimum maintenance.

9. Selection of Hydraulic Power Systems

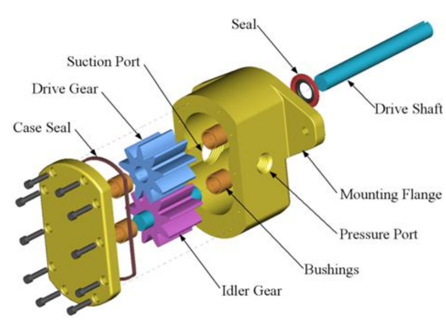
The power source, or prime mover, associated with most hydraulic power units is the motor, which is generally selected based on its speed, torque level, and power capacity. A motor capabilities complement those of the hydraulic power unit can reduce wasted energy and raise cost-efficiency.

The criteria for motor selection vary according to the type of power being employed. For example, an electric motor has an initial torque much greater, but diesel and gasoline-powered motors have a more torque-to-speed curve, delivering a relatively steady torque at both high and low speeds. Consequently, an internal combustion engine may be able to initiate a load, but not provide enough power to bring it to speed if it is not properly matched with the hydraulic power unit.As a rule of thumb, the power rating for a gasoline motor used with a hydraulic power unit needs to be at least twice that of an electric motor. However, the cost of the electricity consumed by a motor over its operational lifespan usually exceeds the cost of the motor itself. If the pressure and liquid flow are set at a constant, motor size can be measured according to the following parameters:

- Horsepower
- Gallons per minute (GPM)
- Pressure in pounds per square inch (psi)
- Mechanical efficiency

A. Selection of pumps

The main advantage of a positive displacement pump is its ability to produce a consistent flow. The flow rate will remain constant when there are changes in pressure. These pumps are a kind of rotating positive dislocation pump, which means they force a stable amount of liquid for every rotation. These pumps move liquid with machinery coming inside and outside of mesh for making a non-exciting act. These pumps are capable of pumping on high forces and surpass at pumping high thickness liquids.



A gear pump doesn't contain valves to cause frictional losses also high impeller velocities. So this pump is compatible for handling thick liquids as well as grease oils. These are not suitable for driving solids as well as harsh liquids.

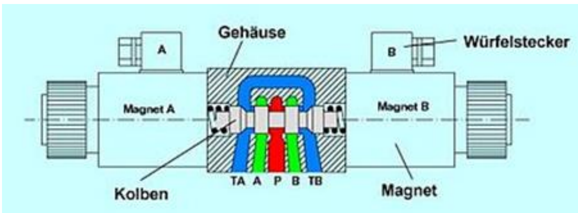
B. Selection of control valves

Directional control valves (DCVs) are one of the most fundamental parts of hydraulic systems. DCVs allow fluid flow into different paths from many sources. DCVs will usually consist of a spool inside a cylinder which is mechanically or electrically operated. The position of the spool restricts or permits flow, thus it controls the flow.

Directional Control Valves can be classified by,

- Number of ports
- Number of positions

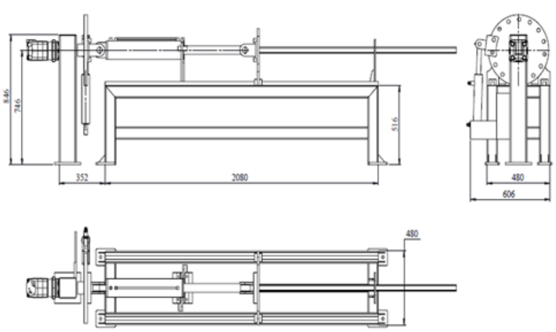
- Actuating methods
- Type of spool



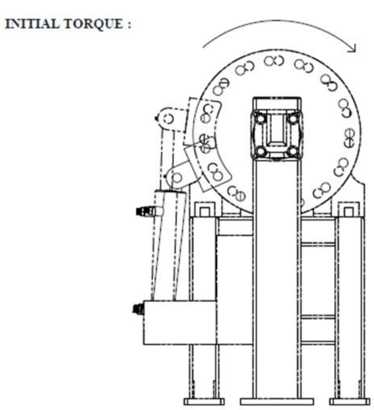
Directional valve, 5/3 gliding spool type, solenoid operated, showed on neutral. P is pressure inlet, A and B are utilization port, TA and TB are return port. When solenoid (magnet) A is energized, the spool is pulled to the left, connecting the port P to A and the port B to TB. When solenoid B is energized, the spool is pulled to the right, connecting P to B and A to TA.

They are widely used in the hydraulics. These valves make use of electromechanical solenoids for gliding of the spool. Because simple application of electrical power provides good control, these are used. However, electrical solenoids cannot generate large forces unless supplied with large electrical power. Heat generation poses a threat to extended use of valves when energized over time. Many have a limited duty cycle. This makes their direct acting use commonly limited to low actuating forces.

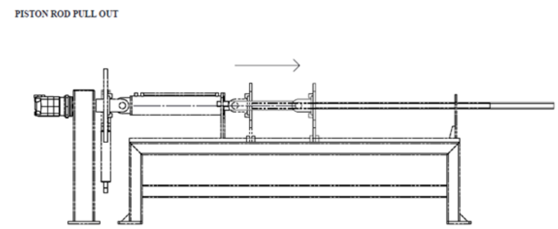
10. CAD Model



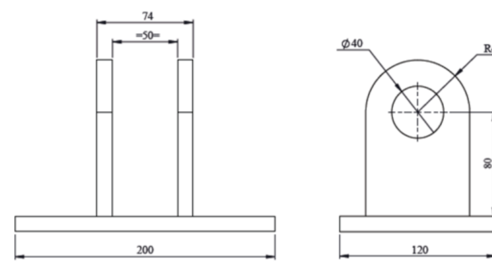
A. Application of initial torque



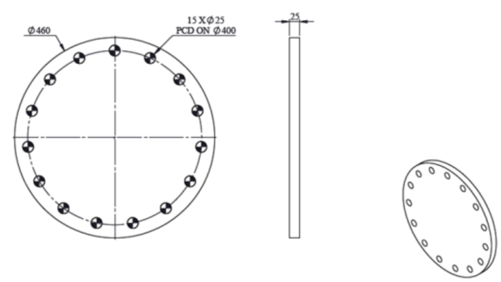
B. Piston rod pull mechanism



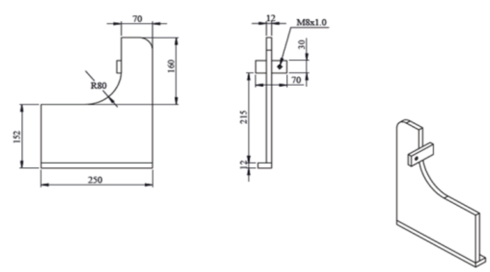
C. Bracket



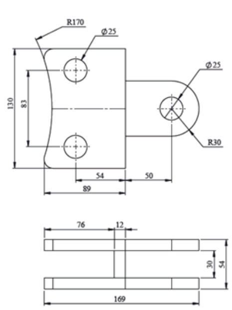
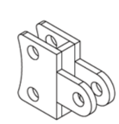
D. Circular Plate



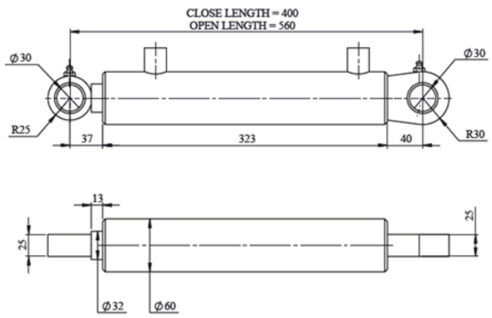
E. Cylinder cap lock



F. Clevis end hold

11. Hydraulic Cylinder Dimensions



12. Calculation

Hydraulic cylinder:

Max torque T_{max} e, = 1200 Nm

- Force required to actuate the member, P = 2πNT/60

Where N = revolutions of endcap = 0.125

$$P = \frac{2\times\pi\times 0.125\times 1200}{60}$$

= 942.47N

- Distance to be actuated by cylinder = effective stroke length
  = 160mm

- Oil pressure inside the cylinder, P = Force/ cylinder blind area

= 942.47/ ((π/4) × 55^2)
= 0.3967 N/mm^2
= 3.967 bar

- GPM of flow = (cylinder area × stroke length × time for 1 stroke)/ (231× 60)

= (0.785× 55^2× 320 × 1.81)/ (231 × 60)
= 95.69 GPM

- Cylinder speed(IPM) = (231×GPM)/ (60 × Net cylinder area)

= 24.31 IPM

13. Conclusion

This paper presented an overview on the design of mechanism to replace hydraulic cylinder piston seals.

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