OALCF Tasks for the Apprenticeship Goal Path: Prepared for the Project, *Developing Best Practices for Increasing, Supporting and Retaining Apprentices in Northern Ontario (2014)*

OALCF Task Cover Sheet

Task Title: Understanding and Identifying Hydraulic Power Systems

Learner Name:	
Date Started:	**Date Completed:**
Successful Completion: Yes___ No___	
Goal Path: Employment___ Apprenticeship ✓ Secondary School___ Post-Secondary___ Independence___	
Task Description: Understand and identify parts and uses of the Hydraulic Power System.	
Competency: A: Find and Use Information B: Communicate Ideas and Information D: Use Digital Technology	**Task Group(s):** A1: Read continuous text B2: Write continuous text D2: Use digital technology
Level Indicators: A1.2: Read texts to locate and connect ideas and information A1.3: Read longer texts to connect, evaluate and integrate ideas and information B2.2: Write texts to explain and describe information and ideas D.2: Perform well-defined, multi-step digital tasks	
Performance Descriptors: see chart on last page	
Materials Required: • Pen and paper • Computer • Attached document - Hydraulic Power Systems • Attached document - Parts of a Hydraulic Cylinder • Attached document - Hydraulic Cylinder Designs	

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Learner Information and Tasks

Millwrights must be able to identify parts and uses of Hydraulic Power Systems. Each part plays an important role in the successful operation of a particular hydraulic cylinder. Occasionally millwrights will need to find information on the internet if it is not available on site. Use the attached documents - **Hydraulic Power Systems, Parts of a Hydraulic Cylinder** and **Hydraulic Cylinder Designs** to complete the following tasks, unless told differently.

Task 1: List all parts of the Hydraulic Power System.

Task 2: What fluid is typically used in hydraulic cylinders?

Task 3: The static seal/o-ring is major component of the hydraulic system. What is the purpose of the static seal/o-ring. Use the internet to do a keyword search to locate the information.

Task 4: Piston rods are made with cold-rolled steel. Explain what is meant by cold-rolled steel. Use the internet to conduct a keyword search to locate the information.

Task 5: Use the internet to search for the full meaning of the acronym PFTE and explain what this material is used for in an industrial application of the hydraulic system.

Task 6: Compare the Welded Body Cylinder design with the Tie Rod Cylinder design. List the advantages of both designs.

Task 7: Why are pressure gauges a valuable component in the operation of the hydraulic power system?

Task 8: Name 3 mounting options for cylinders.

Task 9: The cylinder barrel typically has a surface finish of 4 to 16 microinch. What is the definition of a microinch? Use the internet to locate the definition.

Task 10: The piston in a hydraulic cylinder has a very critical function. Explain what that function is and how it works.

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Hydraulic Power System

Overview

Hydraulic Power Systems are used in manufacturing operations of all kinds, from simple holding and clamping operations to bending, punching and assembling.

The primary component in hydraulic power systems is the hydraulic pump.

A hand-operated, single speed hydraulic pump is a single piston type designed to develop up to 10,000 lbs per sq in. (PSI) pressure.

The hydraulic cylinder is constructed with a reservoir body, at one end of which is the power head. The head contains the power cylinder and piston, usually about 3/8 to 1/2 inch in diameter.

A two speed hand pump is the same as single speed but has a second piston with a larger diameter.

High pressure hoses are vital to the operation of a hydraulic tool. They are constructed with a nylon core tube and polyester fiber reinforcement.

Pressure gauges are not always a necessity but a valuable component. Gauges give a visual cue of pressure generated by the pump and can help in preventing overloading of the hydraulic system.

Hydraulic Cylinders operate on either a single or double acting principle which determines the type of return or piston retraction.

Single acting cylinders have one port and in simplest form retract due to weight or force of the load. They are also made with an inner spring assembly which enables positive retraction regardless of the load.

Doubling acting cylinders have two ports and the fluid flow is shifted from one to the other to achieve both hydraulic cylinder lifting and retraction.

Double and single acting are manufactured with solid pistons or with centre hole pistons.

Centre hole pistons allow insertion of pull rods for pulling applications.

Single acting is a push type and load return style.

Operation

Hydraulic cylinders get their power from pressurized hydraulic fluid, which is typically oil. The hydraulic cylinder consists of a cylinder barrel, in which a piston connected to a piston rod moves back and forth. The barrel is closed on one end by the cylinder bottom (also called the cap) and the other end by the cylinder head (also called the gland) where the piston rod comes out of the cylinder. The piston has sliding rings and seals. The piston divides the inside of the cylinder into two chambers, the bottom chamber (cap end) and the piston rod side chamber (rod end / head end).

Flanges, trunnions, clevises, Lugs are common cylinder mounting options. The piston rod also has mounting attachments to connect the cylinder to the object or machine component that it is pushing / pulling.

A hydraulic cylinder is the actuator or "motor" side of this system. The "generator" side of the hydraulic system is the hydraulic pump which brings in a fixed or regulated flow of oil to the hydraulic cylinder, to move the piston. The piston pushes the oil in the other chamber back to the reservoir. During the retraction stroke, if oil is pumped into the head (or gland) at the rod end and the oil from the cap end flows back to the reservoir without pressure, the fluid pressure in the rod end is (Pull Force) / (piston area - piston rod area):

Parts of a Hydraulic Cylinder

A hydraulic cylinder consists of the following parts:

Cylinder barrel

The main function of cylinder body is to hold cylinder pressure. The cylinder barrel is mostly made from a seamless tube. The cylinder barrel is ground and/or honed internally with a typical surface finish of 4 to 16 microinch. Normally hoop stress is calculated to optimize the barrel size.

Cylinder base or cap

The main function of the cap is to enclose the pressure chamber at one end. The cap is connected to the body either by welding, threading, bolts, or tie rod. Caps also perform as cylinder mounting components [cap flange, cap trunnion, cap clevis]. Cap size is determined based on the bending stress. A static seal / o-ring is used in between cap and barrel (except welded construction).

Cylinder head

The main function of the head is to enclose the pressure chamber from the other end. The head contains an integrated rod sealing arrangement or the option to accept a seal gland. The head is connected to the body in one of the following methods: threading, bolts, or tie rod. A static seal / o-ring is used in between head and barrel.

Piston

The main function of the piston is to separate the pressure zones inside the barrel. The piston is machined with grooves to fit elastomeric or metal seals and bearing elements. These seals can be single acting or double acting. The difference in pressure between the two sides of the piston causes the cylinder to extend and retract. The piston is attached with the piston rod by means of threads, bolts, or nuts to transfer the linear motion.

Piston rod

The piston rod is typically a hard chrome-plated piece of cold-rolled steel which attaches to the piston and extends from the cylinder through the rod-end head. In double rod-end cylinders, the actuator has a rod extending from both sides of the piston and out both ends of the barrel. The piston rod connects the hydraulic actuator to the machine component doing the work. This connection can be in the form of a machine thread or a mounting attachment.

Seal gland

The cylinder head is fitted with seals to prevent the pressurized oil from leaking past the interface between the rod and the head. This area is called the seal gland. The advantage of a seal gland is easy removal and seal replacement. The seal gland contains a primary seal, a secondary seal / buffer seal, bearing elements, wiper / scraper and static seal. In some cases, especially in small hydraulic cylinders, the rod gland and the bearing elements are made from a single integral machined part.

Seals

The seals are considered / designed as per the cylinder working pressure, cylinder speed, operating temperature, working medium and application. Piston seals are dynamic seals, and they can be single acting or double acting. Generally speaking, Elastomer seals made from nitrile rubber, Polyurethane or other materials, are best in lower temperature environments, while seals made of Fluorocarbon Viton are better for higher temperatures. Metallic seals are also available and commonly use cast iron for the seal material. Rod seals are dynamic seals and generally are single acting. The compounds of rod seals are nitrile rubber, Polyurethane, or Fluorocarbon Viton. Wipers / scrapers are used to eliminate contaminants such as moisture, dirt, and dust, which can cause extensive damage to cylinder walls, rods, seals and other components. The common compound for wipers is polyurethane. Metallic scrapers are used for sub zero temperature applications, and applications where foreign materials can deposit on the rod. The bearing elements / wear bands are used

to eliminate metal to metal contact. The wear bands are designed as per the side load requirements. The primary compounds for wear bands are filled PTFE, woven fabric reinforced polyester resin and bronze.

Single acting vs. double acting

- Single acting cylinders are economical and the simplest design. Hydraulic fluid enters through a port at one end of the cylinder, which extends the rod by means of area difference. An external force or gravity returns the piston rod.

- Double acting cylinders have a port at each end, supplied with hydraulic fluid for both the retraction and extension.

Hydraulic Cylinder Designs

There are primarily two styles of hydraulic cylinder construction used in industry: Tie rod style cylinders and welded body style cylinders.

Tie rod cylinder

Tie rod style hydraulic cylinders use high strength threaded steel rods to hold the two end caps to the cylinder barrel. This method of construction is most often seen in industrial factory applications. Small bore cylinders usually have 4 tie rods, while large bore cylinders may require as many as 16 or 20 tie rods in order to retain the end caps under the tremendous forces produced. Tie rod style cylinders can be completely disassembled for service and repair.

The National Fluid Power Association (NFPA) has standardized the dimensions of hydraulic tie rod cylinders. This enables cylinders from different manufacturers to interchange within the same mountings.

Welded body cylinder

Welded body cylinders have no tie rods. The barrel is welded directly to the end caps. The ports are welded to the barrel. The front rod gland is usually threaded into or bolted to the cylinder barrel. This allows the piston rod assembly and the rod seals to be removed for service.

Welded body cylinders have a number of advantages over tie rod style cylinders. Welded cylinders have a narrower body and often a shorter overall length enabling them to fit better into the tight confines of machinery. Welded cylinders do not suffer from failure due to tie rod stretch at high pressures and long strokes. The welded design also lends itself to customization. Special features are easily added to the cylinder body. These may include special ports, custom mounts, valve manifolds, and so on.

The smooth outer body of welded cylinders also enables the design of multi-stage telescopic cylinders.

Welded body hydraulic cylinders dominate the mobile hydraulic equipment market such as construction equipment (excavators, bulldozers, and road graders) and material handling equipment (forklift trucks, telehandlers, and lift-gates). They are also used in heavy industry such as cranes, oil rigs, and large off-road vehicles in above-ground mining.

Adapted from Wikipedia

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Answer Sheet

Task 1: List all parts of the Hydraulic Power System.

Cylinder barrel, Cylinder base or cap, Cylinder head, Piston, Piston rod, Seal gland, Seals

Task 2: What fluid is typically used in hydraulic cylinders? **Oil**

Task 3: The static seal/o-ring is major component of the hydraulic system. Use the internet to locate the purpose of the static seal/o-ring.

A seal that is made between two stable and immovable components.

To block or separate fluid in reciprocating motion applications.

Task 4: Piston rods are made with cold-rolled steel. Explain what is meant by cold-rolled steel. Use the internet to locate the information. **Definitions may vary depending on the website selected.**

Cold rolled steel is rolled to its final dimensions well below scaling temperatures.

Cold Finished Steels are just that - the final rolling is done when the steel is cold (room temperature), the whole operation bathed in oil, so the finished product is unoxidized, the grey of the actual steel, and as smooth as the rollers that do the processing.

Task 5: Use the internet to search for the name used in the following acronym. *PFTE* What is this material used for in a hydraulic system?

Polytetrafluoroethylene

In industrial applications, owing to its low friction, PTFE is used for applications where sliding action of parts is needed: plain bearings, gears, slide plates, etc.

Task 6: Compare the Welded Body Cylinder design with the Tie Rod Cylinder design. List the advantages of both designs.

Welded Body Cylinder	**Tie Rod Cylinder**
Narrower and shorter length	can be completely disassembled for service and repair
Do not fail from tie rod stretch	
Customizable	
Special features can be added easily	

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Task 7: Why are pressure gauges a valuable component in the operation of the hydraulic power system?

Gauges give a visual cue of pressure generated by the pump and can help in preventing overloading of the hydraulic system.

Task 8: The cylinder cap is used to enclosed the pressure chamber. What other role does it perform?

Caps also perform as cylinder mounting components [cap flange, cap trunnion, cap clevis].

Task 9: The cylinder barrel typically has a surface finish of 4 to 16 microinch. What is the definition of a microinch?

The microinch is a common imperial unit of distance equal to one millionth of an inch, or 25.4 nanometers (nm). The microinch is used for precise machining tolerances and also to describe the roughness of surfaces.

Task 10: The piston in a hydraulic cylinder has a very critical function. Explain what that function is and how it works.

It separates the pressure zones inside the cylinder barrel. The difference in pressure between the two sides of the piston causes the cylinder to extend and retract.

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Task Title: Understanding and Identifying Hydraulic Power Systems

	Performance Descriptors	Needs Work	Completes task with support from practitioner	Completes task independently
A1.2	• scans text to locate information			
	• locates multiple pieces of information in simple texts			
A1.3	• integrates several pieces of information from texts			
	• manages unfamiliar elements (e.g. vocabulary, context, topic) to complete tasks			
	• identifies the purpose and relevance of texts			
	• compares or contrasts information between two or more texts			
	• uses organizational features, such as headings, to locate information			
	• follows the main events of descriptive, narrative, informational and persuasive texts			
	• obtains information from detailed reading			
B2.2	• writes texts to explain and describe			
	• conveys intended meaning on familiar topics for a limited range of purposes and audiences			
	• begins to sequence writing with some attention to organizing principles (e.g. time, importance)			
	• uses limited range of vocabulary and punctuation appropriate to the task			
	• begins to organize writing to communicate effectively			
D.2	• selects and follows appropriate steps to complete tasks			
	• locates and recognizes functions and commands			

	• makes low-level inferences to interpret icons and text			
	• performs simple searches using keywords (e.g. internet, software help menu)			

This task: was successfully completed___ needs to be tried again___

Learner Comments

_____ _____

Instructor (print) **Learner Signature**