What is a Hydraulic Actuator?

Hydraulic actuator definition is, a device that is used to change the fluid's pressure energy into mechanical is known as a hydraulic actuator. The hydraulic actuator includes a cylinder or a fluid motor that works through hydraulic power for mechanical operation. The mechanical motion provides an output in the form of rotary, linear otherwise oscillatory motion. When liquids are almost unfeasible to compress, then a hydraulic actuator uses a large force.

Hydraulic Actuator

The Hydraulic actuator working principle is, it uses liquid pressure to work instead of instrument air pressure to provide a force on the diaphragm to move the valve actuator, then to the stem of the position valve. Almost all types of hydraulic actuators use a piston instead of a diaphragm for changing liquid pressure into mechanical power.

Types of Hydraulic Actuator

Hydraulic actuators are classified into three types based on actuation like linear actuator, rotary actuator, and semi-rotary actuator.

- A linear actuator is used for linear actuation. They provide the force or motion within a straight line, such hydraulic actuators are called a hydraulic cylinders.
- A rotary actuator is used for rotary actuation. They provide the torque or rotational motion; such hydraulic actuators are called hydraulic motors. By using these actuators, constant angular movement can be achieved.
- The semi-rotary actuator is used for the partial angle of actuation. These are capable of partial angular movements that can be numerous complete revolutions although 360 degrees or below is more usual.

Specifications

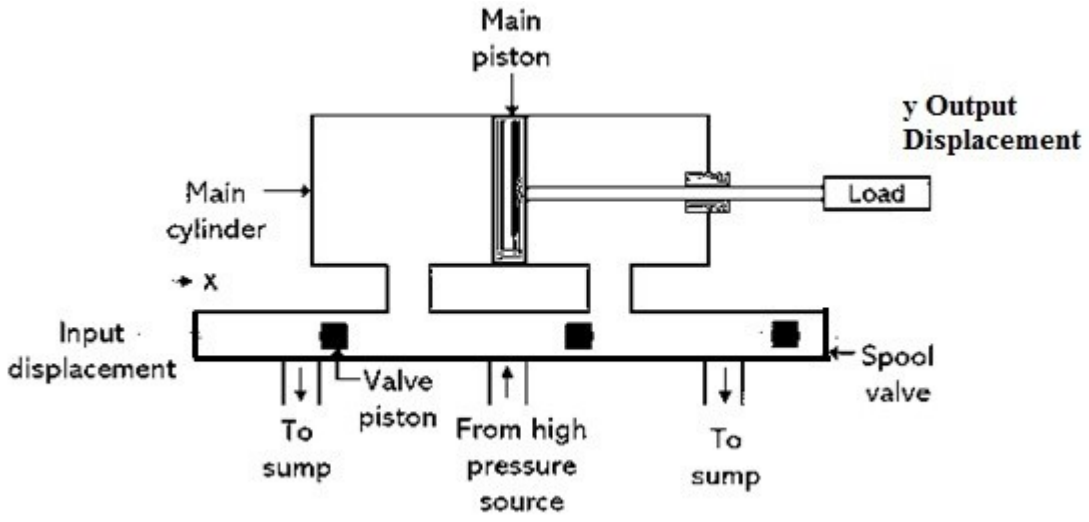
The specifications of hydraulic actuator include the following.

- Its supply voltage is full bridge supply like 24 V ± 10 %
- Battery voltage supply ranges from 20V to 36 V
- Input power is 40 VA max
- Controlled current outputs range from 0 to 1.6 A
- Pulse width modulated signal is 160 Hz

- Primary current is + 0.2 to 1.1 A
- The maximum current is 1.6 A
- Differential inlet is 0 to ± 10 V (or) 0 to ± 20 mA
- Ramp time changes approximately from 1 to 10 seconds @ 100 % of nominal value
- Acceptable ambient temperature ranges from – 10 °C – 70 °C
- Connections are Plug connector, 64-pole & DIN 41612

Hydraulic Actuator System & Its Working

The schematic diagram of the hydraulic actuator system is shown below.



Hydraulic Actuator Working

This system mainly uses Pascal's Law, which states that when the pressure is applied at a particular point to a limited fluid within a container then it transmits evenly in all the ways within the liquid & the container's walls without any loss.

If pressure (P) is applied to an area (A), then the output force because of an applied force will be:

F = P * A

If a specific force like 'F' is applied within a smaller region to include pressure 'P' in a limited fluid, then the generated force on a larger area can be somewhat larger as compared to the force formed through the pressure.

In this method, the pressure which is applied at a particular point is used for generating extremely large forces. So this principle is used by several hydraulic systems. The major components of the hydraulic actuator mainly include a spool valve or pilot valve & main cylinder or power cylinder.

The operating of this hydraulic actuator can be done like this. When the difference within pressure is created at the two areas of the main cylinder then the translational movement of the piston occurs.
The main cylinder includes two regions and two chambers which are acquired by separating the main cylinder through the main piston.

In the cylinder, the rate of fluid supply within the cylinder can be controlled through the spool valve. This valve includes four ports where each port can be connected to a dissimilar part of the system. The first two separate ports are connected to the drain region & fluid supply respectively whereas the other two ports are connected separately toward the two chambers within the main cylinder.

At first, the spool valve is present at the neutral point, thus there is no flow of fluid within the main cylinder. In the hydraulic actuator, the fluid flows then the load will move accordingly. So, when input displacement is '0' then the output displacement will be 0.

Once input displacement is given, the spool valve moves in the direction of the right which causes the fluid to move from the high-pressure source to the left side chamber in the main cylinder. So, the force on the left chamber in the cylinder increases than the right side chamber, then accelerating force can be generated which causes to move of the load.

Here, the load moves in the direction of the fluid which flows. This works like power amplification because the force supplied to move the valve is fairly very small as compared to the generated force that moves the load. Thus, hydraulic actuators will operate in this way.

Hydraulic Actuator Advantages & Disadvantages

The advantages of a hydraulic actuator include the following.

- Design is simple
- Inexpensive
- Strong construction
- High force capabilities
- Protection of the engine from overloads
- The rotating parts provide a quick change of operating modes.
- Transformation is simple from rotating movement to reciprocating one
- These actuators generate 25 times greater forces as compared to pneumatic cylinders of equivalent size.
- They also operate up to 4,000 psi.
- They can hold pressure & torque stable
- The pumps & motors within the actuator can be arranged at a considerable distance through a small amount of power loss.

The disadvantages of a hydraulic actuator include the following.

- Inflexibility
- High maintenance
- Sensitive to temperature
- Partial motion control capabilities
- Insufficient data collection capabilities
- Operating efficiency is low
- Its efficiency is low as compared to others
- Its operation conditions will influence its main characteristics
- They need several complementary parts like a liquid reservoir, pump, motor, heat exchangers, and release valves through noise decrease equipment.
- Loss of liquid can lead to less efficiency and hygiene problems resulting in potential damage to surrounding components and areas.

Applications

The applications of hydraulic actuators include the following.

- These are used in high force-based applications.
- These are used for various applications like crane drives, winches, self-driven cranes, excavators, wheel motors in military vehicles, feeder drives, agitator drives
- & mixer, roll mills, trammels & kilns, drum drives for digesters, shredders for cars, tires, drilling rigs, high-powered lawn trimmers & trench cutters.
- Hydraulic jack
- Highly precise positioning for heavy loads
- Hydraulic brake
- Controlling oh close-loop velocity
- Hydraulic ram
- It can be used as a sensor