Hydraulic Cylinders

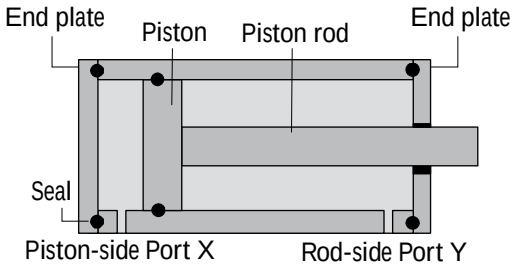
An actuator is a positive displacement device that drives the attached load to get some useful work. It converts hydraulic power into mechanical power. The output motion can be either linear or rotary. Accordingly, there are two basic types of actuators:

- Linear actuators
- Rotary actuators

Linear actuators convert hydraulic energy into a controllable straight-line mechanical energy. Rotary actuators convert hydraulic energy into a controllable rotary mechanical energy.

Basic Cylinder Working

It consists of a hollow body with a movable piston and piston-rod assembly, end-caps, and necessary seals and ports. The piston-rod passes through the opening at one end, and hence, it is considered as a single-ended cylinder. Seals are provided for the leak-free operation. The cylinder also consists of bearing surfaces for its piston and piston-rod.



It is designed with either spring-assisted fast retraction or controlled retraction. If the system fluid is pumped into the piston chamber through the port X and the fluid in the piston-rod chamber is discharged through the port Y, then the piston-and-rod assembly extends with a definite force (thrust). A reciprocating linear motion can be obtained quite easily.

Classification of Actuators

Table below gives a broad classification of hydraulic actuators showing their main types and sub-types:

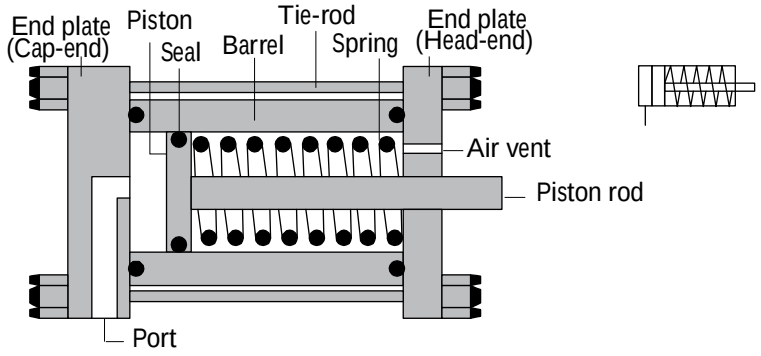
Main types	Sub-types	Examples
Linear actuators	Single-acting	Spring-returned
		Gravity returned
	Double-acting	Non-cushioned type
		Cushioned type
	Variants	Plunger/Ram cylinder
		Position sensing cylinder
		Double-rod-end cylinders
	Special assemblies	Tandem cylinder
		Telescopic cylinder

Types of Hydraulic Loads

A resistive load tends to oppose the motion of the actuator. Cutting or shearing operation acting against the motion of the cylinder is an example of a resistive load. An overrunning load moves and acts in the same direction as that of the actuator. A descending heavy weight on the cylinder is an example of an overrunning load. A heavy flywheel/fan attached to a shaft is an example of an inertial load.

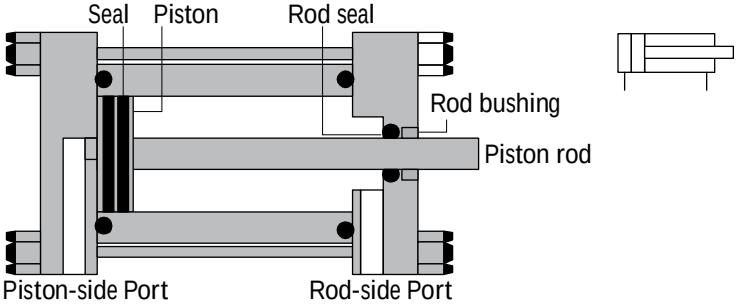
Single-acting Cylinders

It converts system flow and pressure into linear movement and mechanical force. It is designed to exert force hydraulically in one direction - either on its extension stroke or retraction stroke. It utilizes some other force, such as a spring force or gravity, to complete the movement in the other direction. It is capable of performing work only in one direction of its motion.



Double-acting Cylinders

It can perform work in both directions of its motion. Practically the maximum stroke length of the cylinder is limited to about 2000 mm [6.5 ft] due to the possible buckling of the extended cylinder with a very long piston-rod. They offer high pushing and pulling forces. They perform well in applications, especially where precise low-speed control is required.

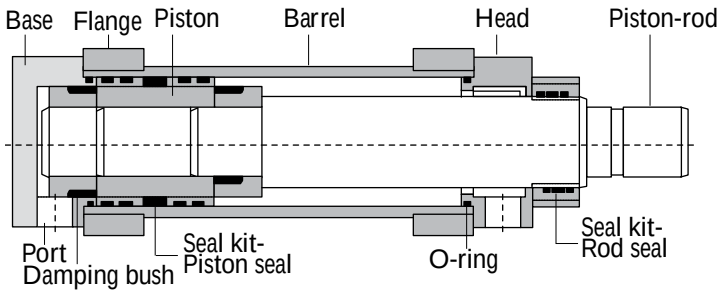


Constructional Features of Hydraulic Cylinders

A cylinder is a positive displacement device that drives the attached load to get some useful work. Let us glance through the cross-section of the cylinder and then proceed to the description that follows.

Introduction

A cylinder consists of a barrel, a piston and piston rod assembly, end-caps, bearings, seals, and ports. The barrel is in the form of strong, seamless steel tubing or cast. The piston is made of cast iron or steel and is fitted with seals. The steel piston rod is machined and highly polished. The piston rod bearings are made of brass or bronze to take care of the side loads and ensure the proper lubrication requirement. The end-caps provide the ports. The description of the parts follows.



Barrel
It is made of a seamless drawn tube that is precision-machined to an accurate finish. The internal surface must be very smooth so that wear and leakage can be controlled. The top-quality manufacturing process ensures its straightness and roundness.

Piston
The piston must be a perfect fit inside the barrel. It must be reasonably cylindrical and finely finished for its smooth output motion. It is usually made of fine-grained alloy steel and bronze coated. The grooves on the piston are provided to contain seals.

Piston rod
The smooth, hard, and corrosion-resistant surface is essential for the piston rod. The piston rod is, usually, made of induction-hardened steel/stainless steel. It is also surface-hardened/chrome-plated with an ultra-fine surface finish for its resistance to wear and corrosion.

End caps
End-caps are attached to the ends of the barrel to enclose the pressure medium. They are cast from iron or aluminium, or made from high-quality steel. They can be fixed by tie-rods or threaded or welded to the barrel.

Cushion
It is a device that is incorporated to minimize shock loads as the piston approaches its end-of-stroke position.

Seals
The leakage can be controlled by using appropriate elastomeric sealing devices.

Piston Wear Bands
Wear rings/bands serve to limit the wear on its piston and piston rod seals and provide protection against side loads. They are, usually, made from glass-reinforced nylon, which has good wear resistance and non-scoring properties.

Piston rod Seal/Wiper
A specially-designed rod seal prevents pressurized fluid from leaking out. The wiper/scrapper prevents external contamination, such as dust/dirt from entering through the rod gland.

Piston rod Bearing
A piston rod bearing guides the cylinder piston rod as it passes back and forth through the rod gland.

Cylinder Body Style
Hydraulic cylinders are constructed in a variety of body styles. According to their structural designs, there are four basic types of hydraulic cylinders. They are (1) Tie-rod cylinders, (2) Mill cylinders, (3) Threaded-end cylinders, and (4) Welded cylinders.

Tie-rod Cylinders
Four or more high-strength threaded steel tie-rods run through the length of the cylinder. The tie-rods actively hold together the two end-caps and the barrel. A large-bore high-pressure tie-rod cylinder may have as many as 24 tie-rods joining the end-caps.

Mill type Cylinders
They are heavy-duty cylinders designed for harsh environments and demanding service conditions, as in steel mills, mines, and furnaces. A mill type cylinder has a thick wall tubular housing, which provides exceptional strength and heat resistance.

Threaded-end Cylinders
In this type, the end-caps are threaded to fit the internal thread of its tubular housing.

Welded Cylinders
In a welded cylinder, a heavy-duty barrel is welded along its entire outside diameter to its end-caps. The welded cylinders are compact and designed for high strength. They are space efficient in their overall length, as compared to the tie-rod cylinders.

Authored by JOJI Parambath, Founder/Director, Fluidsys Training Centre, Bangalore
email: info@fluidsys.in | website: https://fluidsys.org

Reference: JOJI PARAMBATH, Industrial Hydraulic Systems – Theory and Practice, Universal Publishers, Boca Raton, USA, 2016. Please visit: http://www.universal-publishers.com/book.php?method=ISBN&book=1627340580

Note: A comprehensive account of the topic is given in the textbook on 'Industrial Hydraulic Systems-Theory and Practice' by Joji Parambath.
