Hydraulic Actuators

A hydraulic actuator receives pressure energy and converts it to mechanical force and motion. An actuator can be linear or rotary. A linear actuator gives force and motion outputs in a straight line. It is more commonly called a cylinder but is also referred to as a ram, reciprocating motor, or linear motor. A rotary actuator produces torque and rotating motion. It is more commonly called a hydraulic motor or motor.

Cylinders. A cylinder is a hydraulic actuator that is constructed of a piston or plunger that operates in a cylindrical housing by the action of liquid under pressure. A cylinder housing is a tube in which a plunger (piston) operates. In a ram-type cylinder, a ram actuates a load directly. In a piston cylinder, a piston rod is connected to a piston to actuate a load. An end of a cylinder from which a rod or plunger protrudes is a rod end. The opposite end is a head end. The hydraulic connections are a head-end port and a rod-end port (fluid supply).

a. Single-Acting Cylinder. This cylinder only has a head-end port and is operated hydraulically in one direction. When oil is pumped into a port, it pushes on a plunger, thus extending it. To return or retract a cylinder, oil must be released to a reservoir. A plunger returns either because of the weight of a load or from some mechanical force such as a spring. In mobile equipment, flow to and from a single-acting cylinder is controlled by a reversing directional valve of a single-acting type.

b. Double-Acting Cylinder. This cylinder must have ports at the head and rod ends. Pumping oil into the head end moves a piston to extend a rod while any oil in the rod end is pushed out and returned to a reservoir. To retract a rod, flow is reversed. Oil from a pump goes into a rod end, and a head-end port is connected to allow return flow. The flow direction to and from a double-acting cylinder can be controlled by a double-acting directional valve or by actuating a control of a reversible pump.

c. Differential Cylinder. In a differential cylinder, the areas where pressure is applied on a piston are not equal. On a head end, a full piston area is available for applying pressure. At a rod end, only an annular area is available for applying pressure. A rod's area is not a factor, and what space it does take up reduces the volume of oil it will hold. Two general rules about a differential cylinder are that:

• With an equal GPM delivery to either end, a cylinder will move faster when retracting because of a reduced volume capacity.

• With equal pressure at either end, a cylinder can exert more force when extending because of the greater piston area. In fact, if equal pressure is applied to both ports at the same time, a cylinder will extend because of a higher resulting force on a head end.

d. Nondifferential Cylinder. This cylinder has a piston rod extending from each end. It has equal thrust and speed either way, provided that pressure and flow are unchanged. A nondifferential cylinder is rarely used on mobile equipment.

e. Ram-Type Cylinder. A ram-type cylinder is a cylinder in which a cross-sectional area of a piston rod is more than one-half a cross-sectional area of a piston head. In many cylinders of this type, the rod and piston heads have equal areas. A ram-type actuating cylinder is used mainly for push functions rather than pull. A single- acting ram applies force in one direction. This cylinder is often used in a hydraulic jack. In a double-acting, ram type cylinder, both strokes of a ram are produced by pressurized fluid.

actuating cylinder, which can be a single- or double acting type. In this cylinder, a series of rams are nested in a telescoping assembly. Except for the smallest ram, each ram is hollow and serves as a cylinder housing for the next smaller ram. A ram assembly is contained in a main cylinder housing, which also provides the fluid ports. Although an assembly requires a small space with all of the rams retracted, a telescoping action of an assembly provides a relatively long stroke when the rams are extended.

f. Piston-Type Cylinder. In this cylinder, a cross-sectional area of a piston head is referred to as a piston-type cylinder. A piston- type cylinder is used mainly when the push and pull functions are needed. A single-acting, piston-type cylinder uses fluid pressure to apply force in one direction. In some designs, the force of gravity moves a piston in the opposite direction. However, most cylinders of this type apply force in both directions. Fluid pressure provides force in one direction and spring tension provides force in the opposite direction. piston type cylinder. In this cylinder, a spring is located on the road side of a piston. In some spring loaded cylinders, a spring is located on a blank side, and a fluid port is on a rod end of a cylinder. Most piston-type cylinders are double-acting, which means that fluid under pressure can be applied to either side of a piston to provide movement and apply force in a corresponding direction.

This cylinder contains one piston and piston-rod assembly and operates from fluid flow in either direction. The two fluid ports, one near each end of a cylinder, alternate as an inlet and an outlet, depending on the directional-control valve flow direction. This is an unbalanced cylinder, which means

that there is a difference in the effective working area on the two sides of a piston. A cylinder is normally installed so that the head end of a piston carries the greater load; that is, a cylinder carries the greater load during a piston-rod extension stroke. The effective working area on both sides of a piston is the same, and it exerts the same force in both directions.

g. *Cushioned Cylinder.* To slow an action and prevent shock at the end of a piston stroke, some actuating cylinders are constructed with a cushioning device at either or both ends of a cylinder. This cushion is usually a metering device built into a cylinder to restrict the flow at an outlet port, thereby slowing down the motion of a piston.

h. Lockout Cylinders. A lockout cylinder is used to lock a suspension mechanism of a tracked vehicle when a vehicle functions as a stable platform. A cylinder also serves as a shock absorber when a vehicle is moving. Each lockout cylinder is connected to a road arm by a control lever. When each road wheel moves up, a control lever forces the respective cylinder to compress. Hydraulic fluid is forced around a piston head through restrictor ports causing a cylinder to act as a shock absorber. When hydraulic pressure is applied to an inlet port on each cylinder's connecting eye, an inner control-valve piston is forced against a spring in each cylinder. This action closes the restrictor ports, blocks the main piston's motion in each cylinder, and locks the suspension system.