

Hydraulics 101: How Do Hydraulics Work



Learn about the basics of hydraulics for tractors, farm equipment, log splitters or other equipment and machinery, how hydraulic systems work and how to maintain a hydraulic pump.

What is Hydraulics?

A hydraulic system uses compressed fluid to transfer force applied at one point to another point. The basic components that make up a hydraulic system are:

- Reservoir
- Pump
- Valves
- Fluid
- Motor
- Hose
- Filter
- Cylinder

The hydraulic reservoir stores non-pressurized hydraulic fluid, typically hydraulic oil. This fluid is the lifeblood of the hydraulic system. The hydraulic oil also travels through a filter that collects impurities.

Hydraulic pumps transfer the fluid from the reservoir to the hydraulic system. This transfer raises the energy level of the fluid by increasing its pressure. The motor provides the power source for the pump.

The high-pressure fluid acts upon the rod and piston within a hydraulic cylinder. Each stroke of the cylinder converts the fluid power (pressure) into work (mechanical force). The reservoir oil level falls while the rod and piston are extending.

When the rod and piston retract, the fluid returns to the reservoir. The metal walls of the reservoir cool the fluid by allowing heat to escape. The reduced pressure in the reservoir also allows trapped or dissolved air to escape from the fluid. If cylinders must compress air bubbles, the efficiency of the system is reduced.

There are two types of valves, directional control valves and pressure relief valves. Directional control valves manage the flow path of the fluid in the system. Pressure relief valves protect the system plumbing and components against pressure overloads. They also limit the output force exerted by rotary motors and cylinders. These valves open whenever the pressure goes beyond the set value, allowing oil to flow back into the reservoir.

The fluid travels from one component to the next within a hydraulic system through a hydraulic hose.

Types of Hydraulic Valves

The following types of **hydraulic valves** are available at Tractor Supply Co. Check with your local store for more information:

- Converta Valve
- Detent Kit
- SCO Open Center / Detent Valve
- Open Center Valve
- Two Circuit Hydraulic Multi-Plier Valve
- SBS Series Valves
- Single Spool, 3-Position, 4 Way
- Double Spool, Both 3-Position, 4 Way
- Double Spool, Both 3-Position,
- 4 Way w/Float

Q and A: Answers to the most frequently asked questions about hydraulics

What is the difference between a one-stage pump and a two-stage pump?

A one-stage, or single-stage, pump has only one maximum pressure and one flow rate. Single-stage pumps are typically attached to the crankshaft or PTO shaft on a farm tractor or large industrial engine. Applications for a single stage pump include backhoes and manure loaders. Two-stage pumps are typically mounted to small gas or diesel engines. A two-stage pump will first produce high volumes of fluid, moving the cylinder in and out quickly. When the pump receives resistance, a second set of gears will produce high pressures for lifting or splitting. However, the volume of fluid will drop considerably during this stage. This mechanism has many practical applications. For example, in log splitters equipped with a two-stage pump, in stage one, the rod travels faster up the cradle until the rod starts to split the wood. At that point, the speed slows but the force increases.

What is the difference between a single-acting cylinder and a double-acting cylinder?

In a single-acting cylinder, pressure is applied to one side of the piston. Therefore, work occurs in one direction only. The cylinder returns to its original position under the weight of the load (or by means of a manual lever). In a double-acting cylinder, pressure can be applied to either side of the piston. This allows work to occur in either direction.

What is the difference between a tie-rod cylinder and a welded cylinder?

Tie-rod cylinders are held together by four rods. They cost less than welded cylinders and are easy to repair. On a welded cylinder, the fixed end is welded in place, adding strength and durability for high-pressure applications such as log splitters.

What is the difference between an open and closed system?

The terms "open system" and "closed system" refer to two methods of reducing the pressure on the pump, which minimizes wear and tear. Open systems are common on log splitters and most tractors prior to 1960. When an open system is in neutral, an open center valve connects all lines directly back to the reservoir, bypassing the pump. The pump is always pumping, allowing a constant flow of oil without building pressure. Closed systems are common on construction machinery and modern farm equipment, including most John Deere models. When a closed system is in neutral, the closed center valve blocks the flow of oil from the pump. The oil travels instead to an accumulator, which stores the oil under pressure.

How do I convert an open system to a closed system?

To convert an open center valve to a closed center valve, remove the short conversion plug and replace it with a closed center plug. You must also replace the relief valve on the handle end with a "no relief" plug. Once you convert to a closed system, you will need to plumb an outlet to the tank to dump the oil from the return passage. Refer to the valve packaging for further instructions and part numbers.

What is the difference between NPTF and JIC fittings?

NPTF and JIC fittings both prevent leakage on the ports of hydraulic components. However, NPTF or "dry seal" taper pipe threads do this by using the resistance of the male to female thread taper. JIC or "straight" threads use an O-ring. Note: Do not use JIC and NPTF fittings interchangeably. Significant damage to the seal and the parts could result. However, you can purchase special adapters to convert from one type of fitting to another. Consult Tractor Supply's product catalog for a complete listing of fittings and adaptors.

What is the difference between the various I.S.O. tips and OEM old-style tips and couplers?

There are three types of I.S.O. tips. All three are interchangeable with each other and universal, except as noted below. The I.S.O. tip with ball was the first standard, universal tip in the marketplace. It seals

with a metal-to-metal seat. This seal tends to “weep” when disconnected, but it is still the most widely used tip in the industry. The I.S.O. tip with poppet has the same basic design. However, this tip seals with an O-ring that presses together with the poppet to form a tight, 360-degree seal. This “soft seal” reduces fluid loss. In the future, this will be the choice of OEM manufacturers. The I.S.O. tip with pressure relief poppet has a secondary poppet in the tip. When pressure builds up in the hose, this secondary poppet allows pressure to be displaced to the coupler. The tip can then connect without pressure. Certain OEM designs that predate the introduction of I.S.O. tips require the use of OEM old-style tips. These tips and couplers are unique to each manufacturer, and cannot be interchanged. Specific conversion adapters are required for these machines to accept I.S.O. tips. See the in-store conversion adapter chart for more information.

Can I use galvanized or brass fittings?

No. Galvanized and brass fittings do not meet the psi ratings of hydraulic systems. The metal tends to flake. This flaking can contaminate the oil and damage the hydraulic pump.

Can Teflon tape be used on hydraulic fittings?

No. Teflon tape may flake. This flaking can contaminate the oil and damage the pump. Warranties are typically voided by using Teflon tape. Use a hydraulic-rated liquid Teflon sealant instead.

Can I use a standard valve for a single-acting cylinder?

No. A standard valve does not permit oil to escape as the cylinder retracts. This trapped oil eventually causes a pressure overload. If you are converting to a single-acting cylinder, Tractor Supply stocks a Converta valve specifically designed for that purpose. >Note: The Converta valve does not have a loadcheck. Do not use this valve in a load-lifting system.

What valve do I need for a loader?

Tractor Supply carries two valves ideal for loader applications. The SBAF2 is a double-spool valve with a floating detent on the first spool that allows the bucket to ride the contours of the ground. The SBA22 is a double-spool valve that is spring-centered to neutral on both spools, so that there is no “float.”

What valve do I need for a log splitter?

Tractor Supply offers an open-center, single-spool valve specifically designed for log splitters. This valve has a preset 2000 psi relief, but is adjustable. The valve is also rated for a 30 GPM flow rate.

What is the difference between hydraulic oil and hydraulic fluid?

Hydraulic oil is petroleum oil refined for use in hydraulic systems. This oil typically has additives to prevent rust and minimize foaming. Hydraulic fluid is any liquid in a hydraulic system that is not petroleum-based (such as water-based and synthetic mixtures.) These fluids are used in applications where there is a risk of fire (such as wet brakes, clutches, and transmissions). Note: The term “hydraulic fluid” is often used interchangeably to mean oil or any other fluid within a hydraulic system. Refer to your owner’s manual for the requirements of your system. Using the incorrect fluid can harm seals and cause your system to break down.

Do I need to change the oil and filter?

Yes. Oil contaminants can increase operating temperatures and damage components. Change the oil and filter regularly to prolong the life of your system. Refer to your owner’s manual for part numbers and recommended frequency.

How big should the reservoir be?

Generally, the size of the reservoir should be 3 times system capacity, or 1.5 times the pump GPM rating. The reservoir must also have adequate surface area to allow heat to disperse.

What size hose do I need?

The size of the pipe, tubing, or hose in a hydraulic system is very important. If the hose is too small, the oil flows at a high rate of speed. This generates heat, which means that the fluid is losing power. If the hose is too large, the time and cost of installation may be too high. A 2-wire hose is recommended for applications above 1800 psi. However, specifications vary by manufacturer, so read product packaging for specific application suggestions and psi ratings.

Hydraulic Farm and Ranch Equipment Troubleshooting Guide

Hydraulic system failure can arise from many points within the system. The following guide may help you locate and resolve problems quickly. Always refer to the technical manuals for your system before performing repairs.

Assessing Poor Cylinder Performance in a Hydraulic System

Check for	Recommended action(s)
Oil leaks	Check all components for internal or external leaks. Tighten fittings. Repair or replace damaged seals or components. Check relief valve for proper settings.
Low oil, no oil	Check reservoir. Add oil as necessary.
Viscous or cold oil	Allow ample warm-up period.
Dirty or clogged oil filter	Drain oil. Replace filter or filter element.
Restricted oil line	Clean or replace dirty or damaged oil lines.
Worn or dirty pump	Clean, repair, or replace. Check alignment. Check for contaminated oil. Drain and flush system.
Dirty, damaged, or worn components or seals	Clean, repair, or replace components. Check for cause of excessive wear.
Bent ram	Check for side pressure on rod or improper mounting of cylinder.
Blown seals	Check relief valve settings. Make sure you are using correct hydraulic fluid for system.
Slipping or broken pump drive	Repair or replace belts, couplings, etc. Check for proper alignment and tension.
Leaking cylinder	Repair/replace seals. Isolate cylinder and check holding capability of control valve.
Excessive load	Check unit specifications for load limits.
Air in system	Check suction side of system for leaks. Repair. Purge air from system.
Air leaks in pump section line	Repair or replace line as necessary.
Low pump drive speed	Increase engine speed. Check manual for recommendations.
Improper adjustments	Adjust fittings, valves, etc. according to specifications in technical manuals.
Loader slipping or dropping	Check for leaking cylinder or air in system.

Improper cylinder for application Check PSI and cylinder travel time. May need cylinder with a larger or smaller bore.

Incorrectly sized or adjusted restrictor Replace or adjust restrictor as necessary.

Hydraulic system definition of terms

- Accumulator: In a closed system, the accumulator stores the pressurized oil.
- Bore: The interior diameter of a cylinder.
- Cylinder: The chamber within which a rod and piston move back and forth under the influence of fluid pressure, gravity, or mechanical force.
- Detent: A catch or lever that locks the movement of the valve handle and spool in place.
- Fitting: A device for creating a seal within a hydraulic system.
- GPM: Acronym that stands for "Gallons Per Minute".
- Piston: A fitting within a cylinder that moves back and forth with the rod.
- Positive Displacement Pump: A pump that displaces an exact amount of fluid per revolution, such as a gear, vane, or piston pump.
- PSI: Acronym that stands for "Pounds Per Square Inch".
- Ram: A term commonly used to refer to the rod and piston within a cylinder.
- Rod: A bar which drives the piston back and forth through the chamber of the cylinder.
- Seal: A tight closure that prevents the passage of hydraulic fluid.
- Spool: The internal passageways within a hydraulic valve. The standard spool has two ports that are blocked when the system is in neutral.
- Stroke: The movement, in either direction, of the piston and rod within a cylinder.
- Thread: Ribbing within a pipe or fitting that allows it to create a seal with another pipe or fitting.

Other Supplies You May Need for a Hydraulic System

- Heavy Duty Double Acting Cylinders
- Hydraulic Hoses
- Converta Valve
- SCO Open Center/Detent Valve
- Two Circuit Hydraulic Multi-Plier Valve
- SBA Series Valves
- Quick Couplers
- Coupler Adapters
- Male Tips
- 5,000 PSI Hydraulic Gauge
- Swivel Adaptors
- 90° Adaptors
- Male & Female Adaptors
- Premium Universal Hydraulic Fluid
- Ford Hydraulic Fluid
- All Season Hydraulic Fluid
- Liquid Teflon Sealant Pipe