



# HYDRAULICS SYSTEMS IN WASTE MANAGEMENT



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GreenVETAfrica mission is to offer an innovative capacity building programme on Green Waste Management in Nigeria and Ghana

# HYDRAULICS SYSTEM IN WASTE MANAGEMENT

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# HYDRAULICS SYSTEM IN WASTE MANAGEMENT

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# HYDRAULICS SYSTEMS IN WASTE MANAGEMENT

## EXAMPLES OF HYDRAULIC APPLICATIONS IN WASTE MANAGEMENT

THE GARBAGE TRUCK

THE BALER

THE COMPACTOR



# HYDRAULICS SYSTEMS IN WASTE MANAGEMENT : THE BALER



# HYDRAULICS SYSTEMS IN WASTE MANAGEMENT :THE GARBAGE TRUCK



# WHAT IS HYDRAULICS TECHNOLOGY?

HYDRAULICS IS USING PRESSURIZED FLUID TO PERFORM MECHANICAL WORK.

IT IS A MEANS OF POWER TRANSMISSION BY PUSHING ON A CONFINED FLUID (USUALLY PETROLEUM OIL) TO DO WORK.

IN HYDRAULICS THE INPUT COMPONENT IS THE PUMP –IT GENERATES PRESSURE.

WHILE THE OUTPUT COMPONENT IS THE ACTUATOR- THE DEVICES THAT DOES THE WORK.



# HYDRAULICS SYSTEMS IN WASTE MANAGEMENT

## SOME MERITS OF USING THE HYDRAULIC SYSTEM

IT IS A FORCE MULTIPLIER; USING SMALL COMPONENTS TO GENERATE LARGE FORCES.

IT IS SELF-LUBRICATING.

ITS MOTION IS SMOOTH AND EVEN AND CAN BE REVERSED.

IT HAS FAVOURABLE HEAT DISSIPATION.

IT CAN BE STARTED UNDER MAXIMUM LOAD.

# HYDRAULICS SYSTEMS IN WASTE MANAGEMENT

## DEMERITS OF USING THE HYDRAULIC SYSTEM

POLLUTION BY WASTE OIL

OIL ATTRACTS DIRT.

HAZARDS RESULTING FROM ACCIDENTS.

DANGERS OF RESULTING FROM EXCESSIVE PRESSURES.

# HYDRAULICS SYSTEMS IN WASTE MANAGEMENT

## QUIZ

1.LIST TWO HYDRAULICS MACHINES USED IN WASTE MANAGEMENT ?

2.HYDRAULICS TECHNOLOGY IS INVOLVES USING \_\_\_\_\_ TO

DO WORK

3.MENTION ONE MAIN ADVANTAGE OF USING HYDRAULICS

TECHNOLOGY .

# SOME BASIC PRINCIPLES OF HYDRAULICS

# PRESSURE

Pressure results whenever there is a resistance to fluid flow or to a force which attempts to make the fluid flow

The resistance may come from:

Load on an actuator

Restriction (or orifice) in the piping and valves

Weight of the fluid

# PRESSURE TRANSMISSION

Pascal's Law:

pressure applied on a confined fluid is transmitted undiminished in all directions, and acts with equal force on equal areas, and at right angles to them

$P(\text{pressure}) = F(\text{Force})/A(\text{Area})$  (N/m<sup>2</sup> or Pa)

i.e. 1 Pa(Pascal) = N /m<sup>2</sup>



## UNITS OF PRESSURE

The weight of the gases on the earth's surface is used as the standard that is why atm is used.

1 atm

=  $1.013 \times 10^5$  N/m<sup>2</sup> (Pa) i.e Pascal

= 1.013 bar

= 14.7 lb/in<sup>2</sup> (or psi) pounds per square inch

## VELOCITY AND FLOWRATE IN HYDRAULICS

Apart from pressure there are other quantities that are measured in hydraulics.

**VELOCITY**- this is to measure the average distance the fluid particles travel per unit time.

Velocity = distance/time (m/s)

**FLOWRATE** - a measure of the volume of fluid passing a point in a given time.

Flow Rate,  $Q$  = Volume/time ( $\text{m}^3/\text{s}$  or  $\text{l}/\text{min}$ )

# Principle of Continuity of Fluid Flow

States that:

the velocity of a fluid flowing through a pipe increases as the area of the pipe decreases, and decreases as the pipe's area increases.

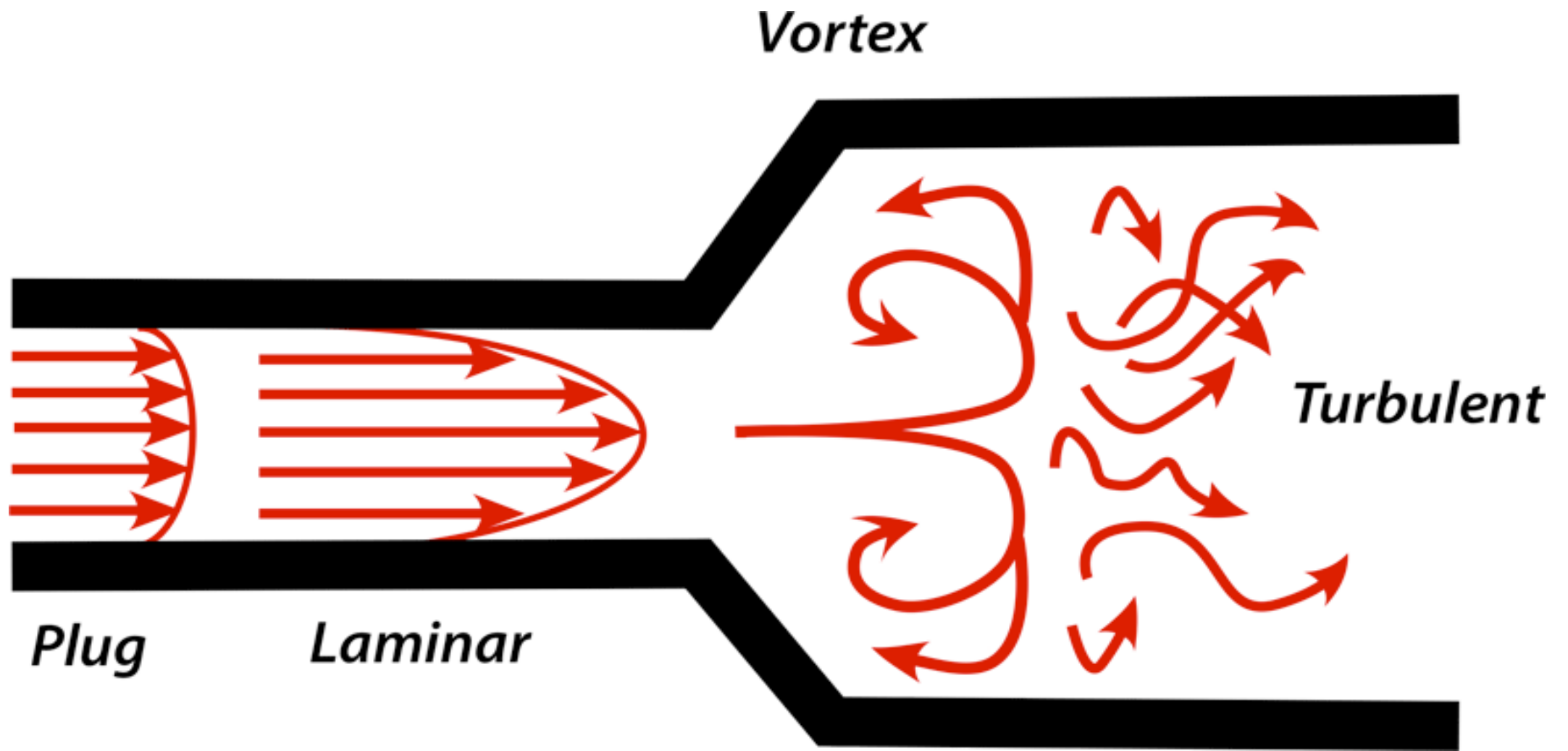
## **TYPES OF FLOW: Laminar flow & Turbulent Flow**

### **Laminar flow:**

when the particles of a fluid move through a pipe, they will move in straight, parallel flow paths or ordered cylindrical layer, this occurs at low velocity in straight pipelines.

### **Turbulent flow:**

when the particles do not move smoothly parallel to the flow direction. The particles at the centre of the pipe swing out to the side hindering other particles.



# CAUSES AND EFFECTS OF TURBULENT FLOW

Turbulent flow occurs :

- a. when there are sudden changes in the direction of flow.
- b. sudden changes in cross sectional area.
- c. by very high velocity (above 6 m/s).

## EFFECTS OF TURBULENT FLOW

- a. Increase in temperature.
- b. Pressure losses
- c. Frothing [bubble formation]
- d. Cavitation



# HYDRAULIC FLUIDS

## **PURPOSE OF FLUIDS**

The primary functions of hydraulic fluids are:

1. Power transmission
2. Lubrication
3. Sealing
4. Cooling

# OTHER QUALITY REQUIREMENTS OF THE FLUID

In addition to the primary functions, the fluid may have some other quality requirements such as :

1. Prevent rust.
2. Prevent formation of sludge and gum
3. Prevent foaming.
4. Prevent corrosion and pitting.

Petroleum oil is commonly used because:

1. It **transmits power** readily because it is only **slightly compressible**.
2. Its most desirable property is its ability to **lubricate**. Its major disadvantage is that it is **combustible**.

# VISCOSITY

It is the measure of a fluids resistance to flow or the inverse of fluidity.

If a fluid flows easily, its viscosity is low. It can also be said that the fluid is thin or has a low body.

Viscosity is a compromise:

It is required for lubricating & sealing but it causes friction.

## SOME EFFECTS OF VERY HIGH VISCOSITY

1. High resistance to flow.
2. Increased power consumption.
3. High temperature caused by friction.
4. Possibility of sluggish or slow operation.



# SOME EFFECTS OF VERY LOW VISCOSITY

- 1.Excessive internal leakage.
- 2.Excessive wear or even seizure under heavy load.
- 3.Pump efficiency decreases.
- 4.Increased temperatures resulting from leakage losses.

# THE POWER SUPPLY UNIT

# HYDRAULICS POWER SUPPLY UNIT

## FUNCTIONS OF THE HYDRAULIC POWER SUPPLY UNIT

GENERATES THE POWER NEEDED BY THE HYDRAULIC SYSTEM.

THE MAIN COMPONENTS ARE;

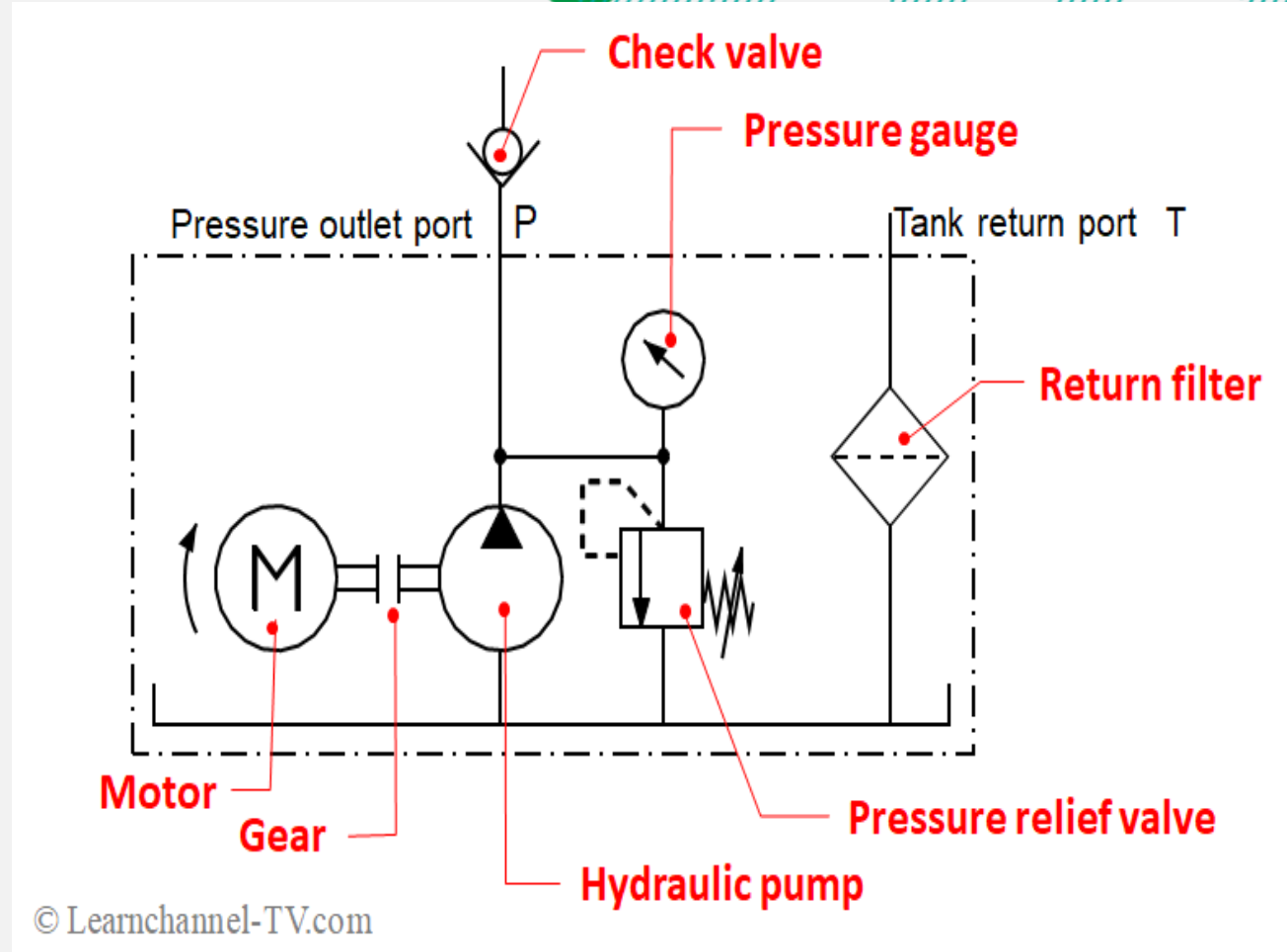
THE ELECTRIC MOTOR OR THE INTERNAL COMBUSTION ENGINE

THE HYDRAULIC PUMP

THE PRESSURE RELIEF VALVE

THE TANK OR RESERVOIR

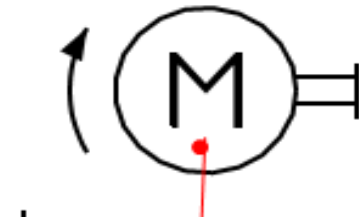
THE FILTER



# THE ELECTRIC MOTOR

IT DRIVES THE PUMP

SYMBOL OF THE ELECTRIC MOTOR

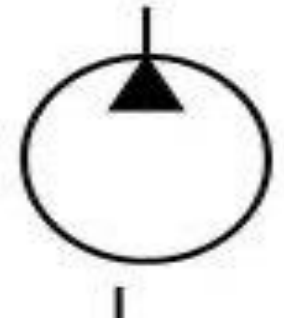


IT IS USED TO POWER THE PUMP.

# THE HYDRAULIC PUMP

FOR CREATING THE FLOW OF THE HYDRAULIC FLUID.

## SYMBOL OF THE PUMP

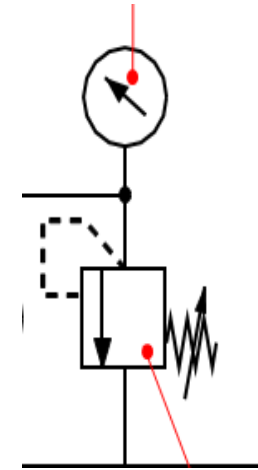
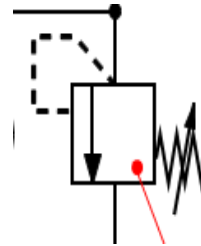


THE PUMP GENERATES THE PRESSURE ENERGY NEEDED BY THE HYDRAULIC SYSTEM.

# THE PRESSURE RELIEF VALVE

A SAFETY DEVICE FOR PROTECTING THE PUMP

PRESSURE RELIEF VALVE PRESSURE RELIEF VALVE WITH PRESSURE GAUGE



IT IS ALSO CALLED PRESSURE LIMITING VALVE, A PRESSURE GAUGE IS ALWAYS ATTACHED TO IT TO DISPLAY THE PRESSURE.



# THE TANK OR RESERVOIR

## FOR

- STORAGE
- SEPARATING UNIT
- COOLING

## SYMBOL FOR THE TANK



Vented reservoir



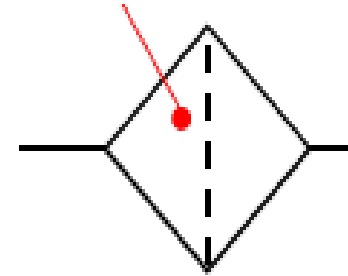
Pressurized reservoir

THE TANK CAN BE AN OPEN I.E VENTED  
TANK OR CLOSED TANK I.E  
PRESSURIZED.

# THE FILTER

FOR  
SEPARATING  
CONTAMINANTS

SYMBOL OF THE FILTER



IT SEPARATES IMPURITIES CALLED  
CONTAMINANTS FROM THE OIL.

# HYDRAULICS SYSTEM IN WASTE MANAGEMENT



## REVIEW OF THE HYDRAULICS POWER SUPPLY UNIT

**THE ELECTRIC MOTOR :IT POWERS THE HYDRAULIC PUMP**

**THE HYDRAULIC PUMP: IT CREATES THE FLOW OF THE HYDRAULIC FLUID TO THE DRIVE SECTION**

**THE PRESSURE RELIEF VALVE : IT IS A SAFETY DEVICE USED TO PROTECT THE PUMP FROM DAMAGE CAUSED BY EXCESSIVE PRESSURES.**

**THE TANK OR RESERVOIR: IT HAS THREE USES**

- 1. STORAGE OF THE FLUID**
- 2. SEPARATING UNIT- FOR SEPARATING CONTAMINANTS**
- 3. COOLING OF THE HYDRAULIC FLUID**

**THE FILTER ; USED FOR SEPARATING CONTAMINANTS FROM NON-CONTAMINANTS**

# HYDRAULICS SYSTEM IN WASTE MANAGEMENT



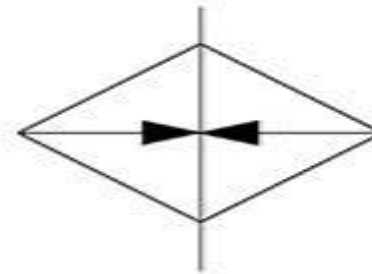
OTHER ACCESSORIES OF THE HYDRAULIC POWER UNIT ARE;  
THE OIL CONDITIONERS:  
THE HEATER – FOR HEATING THE HYDRAULIC OIL  
THE COOLER – FOR COOLING THE HYDRAULIC OIL

THE INDICATORS IN THE POWER SUPPLY UNIT :  
FOR PRESSURE – THE PRESSURE GAUGE  
FOR TEMPERATURE – THERMOMETER  
FOR LEVEL- LEVEL INDICATOR  
FOR FLOW- FLOWMETER

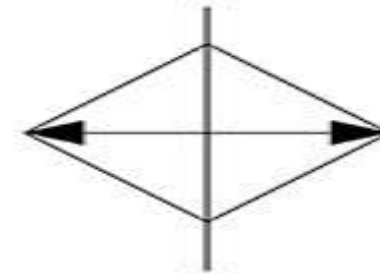
# THE CONDITIONERS

FOR  
CONDITIONING THE  
HYDRAULIC FLUID.

## SYMBOLS OF THE OIL CONDITIONERS



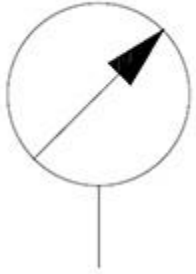
Heater



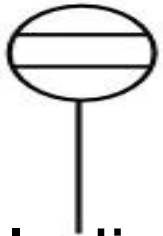
Cooler

THE HEATER BRINGS HEAT TO THE FLUID.  
THE COOLER TAKES OUT OF THE FLUID.

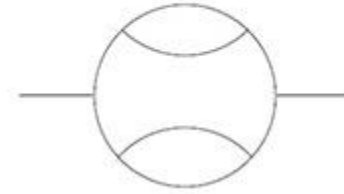
# THE INDICATORS



Pressure  
Gauge



Level Indicator



Flow Meter



Thermometer

# QUIZ

THIS IS TO TEST  
YOURSELF AND CHECK IF  
YOU HAVE REALLY  
LEARNT.

## QUIZ

- 1.LIST THE THREE UNITS OF THE HYDRAULIC SYSTEM
- 2.WHAT ARE THE MAIN COMPONENTS OF THE POWER SUPPLY UNIT ?

LEARNING IS BEAUTIFUL WHEN YOU  
MAKE EFFORT.

# LEARN MORE

ON HYDRAULIC POWER  
SUPPLY UNIT

CHECK THIS LINK

[www.youtube.com/watch?v=IXG5cZx8Vaw](https://www.youtube.com/watch?v=IXG5cZx8Vaw)

WATCH THIS TO GET BETTER  
UNDERSTANDING ON YOUR OWN



# THE POWER CONTROL UNIT

# THE POWER CONTROL UNIT

THIS COMPRISES VALVES

## VALVES

VALVES ARE DEVICES FOR CONTROLLING ENERGY FLOW IN A HYDRAULIC SYSTEM.

TYPES OF VALVES IN A HYDRAULIC CIRCUITS ARE;

- DIRECTIONAL CONTROL VALVES
- NON RETURN VALVES
- FLOW CONTROL VALVES
- PRESSURE CONTROL VALVES

VALVES ARE LIKE THE SWITCHES THAT  
TURNS ON OUR LIGHT AT HOME.

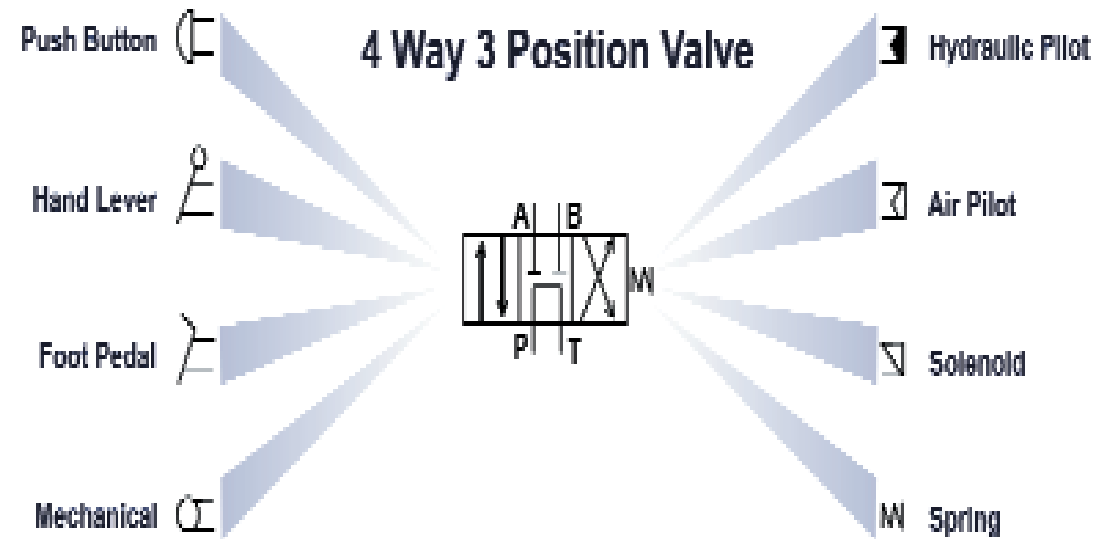
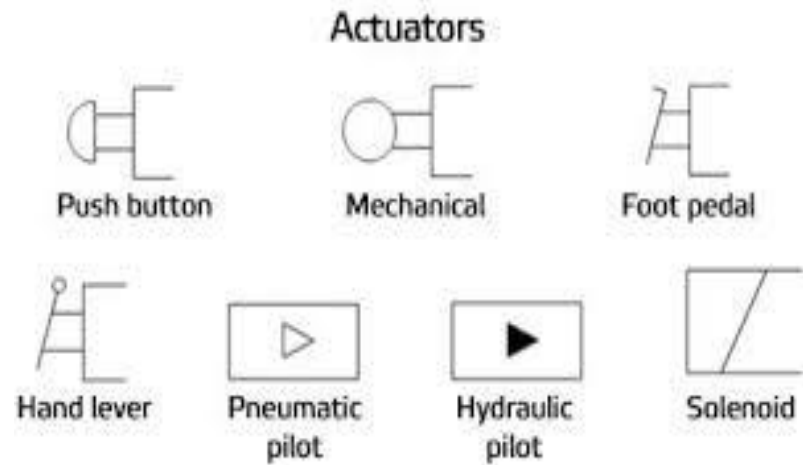
# DIRECTIONAL CONTROL VALVES

These are valves for controlling the direction of flow of the hydraulic fluid in the system. They have a particular naming system.

4 key things in this order.

1. No of ports (i.e. number of openings).
2. No of switching positions (i.e. number of boxes).
3. Direction of flow, based on the state of the supply port (p) on the Right Hand Side of the Valve.
4. Type of Actuation and Reset on the valve. Actuation; means of operating the valve. Reset; means of returning the valve to its original position.

# VALVE ACTUATION MECHANISMS



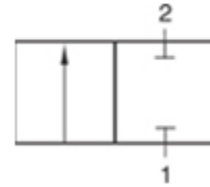
## 2/2 way valves and 3/2 way valves

These two types of directional control valves have the same naming pattern.

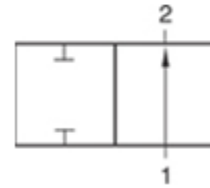
At point (P)(1) it is either the RHS is in normal position closed or normal position open.

# 2/2 way valves

2/2-way valve



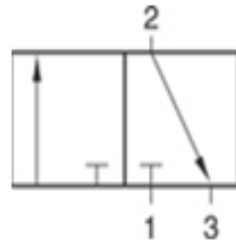
Normally closed



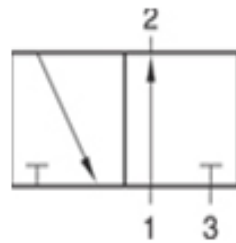
Normally open

# 3/2 way valves

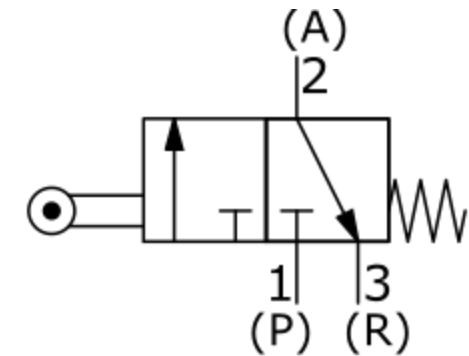
3/2-way valve



Normally closed

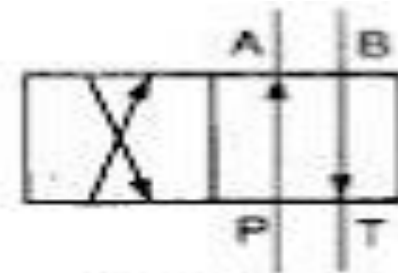
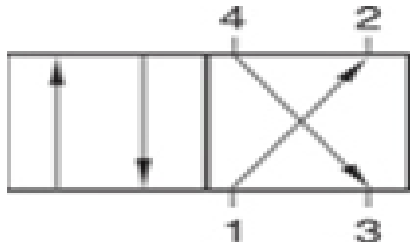


Normally open



# 4/2 way valves

You do not say the RHS is in normal position closed or normal position open but you say flow normal position flow from (starting from port P).



(a) 4/2 valve

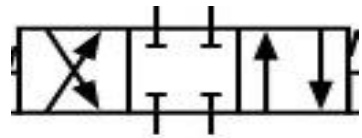


## 4/3 way valves

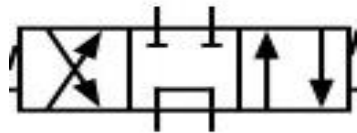
These are called POSITIONAL directional control valves they allow your actuator to stop at any position; i.e. intermediate positions.

They are named based on their middle position usually called mid-position.

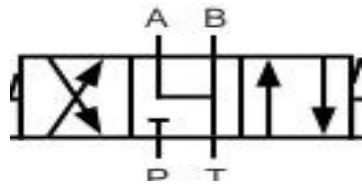
# 4/3 way valves



4/3 way valve mid-position closed

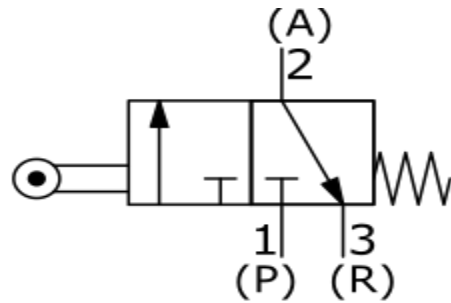


4/3 way valve mid-position recirculating



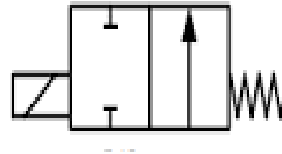
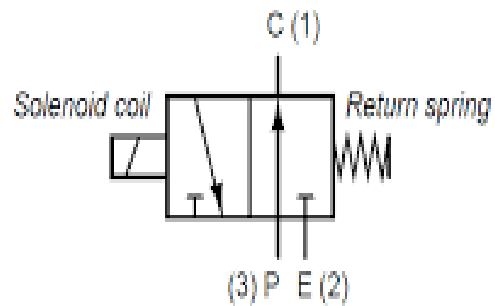
4/3 way valve mid-position depressurised

# Quiz: Name these valves



1

4

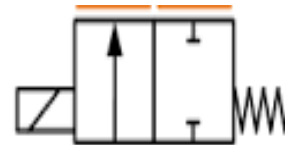


2

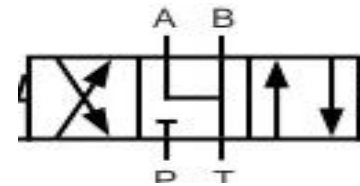
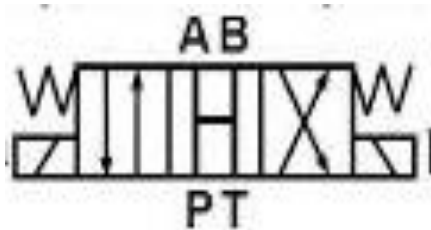
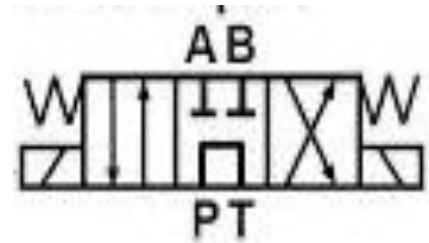
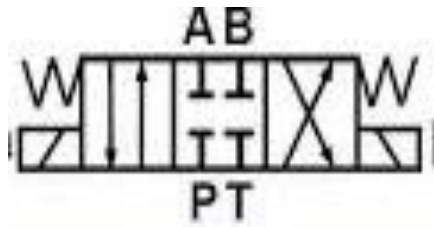
5



3



# Quiz: Name these 4/3 way valves



## NON RETURN VALVES

They permit flow in one direction and there is no flow in the other direction.

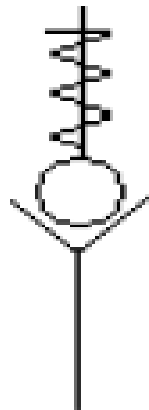
### Types of Non Return Valve

1. Weight loaded: The weight of the ball blocks the valve.



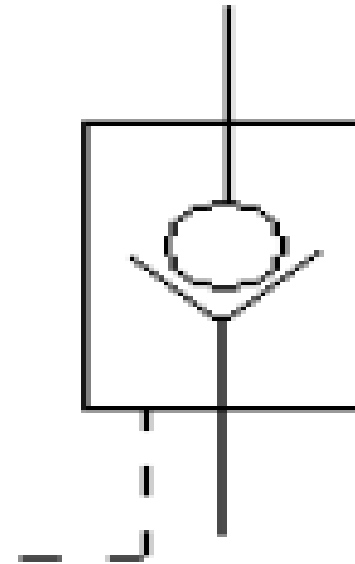
# NON RETURN VALVES

2. Spring loaded: The spring retracts to allow flow and returns when there is no force.



# NON RETURN VALVES

2. Piloted: It uses external pressure for operating the valve.



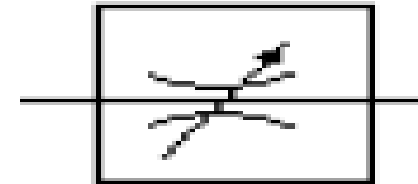
## FLOW CONTROL VALVES (TWO WAY VALVE)

It regulates the volumetric flow of the fluid in the system. It permits flow in both directions.

### 1. FLOW CONTROL VALVE



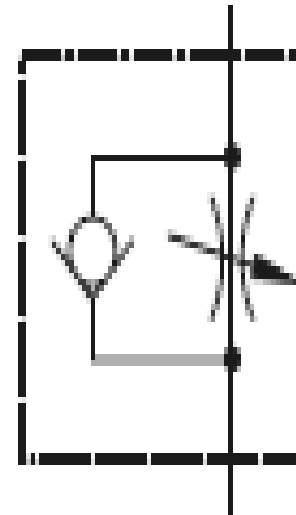
### 2. ADJUSTABLE FLOW CONTROL VALVE





### 3. ONE WAY FLOW CONTROL VALVE

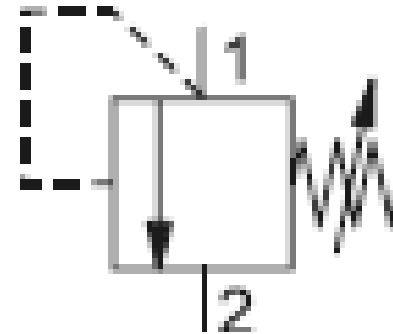
It is for speed control of the actuator.  
It is mounted close to the actuator.



# PRESSURE CONTROL VALVES

They are valves for controlling pressure. There are 3 types:

**1. Pressure Relief Valve (Safety Valve):** It prevents the maximum pressure from been exceeded.



# PRESSURE CONTROL VALVES

2. Two-Way Pressure Regulating Valve

3. Three-Way Pressure Regulating Valve

Both are called **Pressure Regulating Valves**; they keep the pressure constant in the system. The 3-Way type is more efficient than the Two-Way type.

## PRESSURE CONTROL VALVES

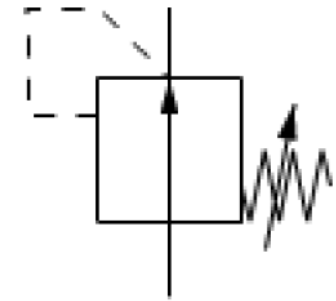
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# PRESSURE CONTROL VALVES

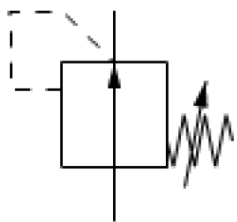
2. Two-Way Pressure Regulating Valve



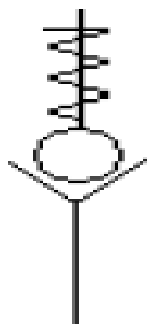
3. Three-Way Pressure Regulating Valve



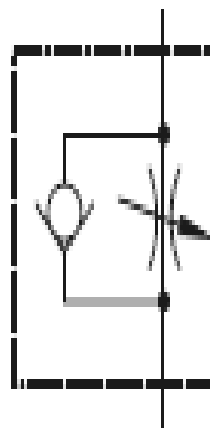
# Quiz :Can you recognize the following symbols:



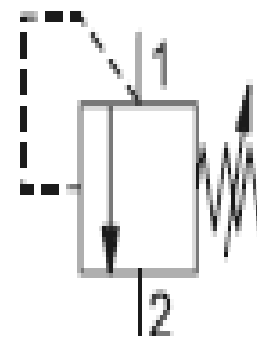
1



2



3



4

# THE DRIVE UNIT

# THE DRIVE UNIT

THIS COMPRISES THE WORKING DEVICES

THE DRIVES OR ACTUATORS ARE DEVICES FOR CARRYING OUT WORK IN A HYDRAULIC SYSTEM.

TYPES OF ACTUATORS ARE:

LINEAR ACTUATORS; THEY CARRY OUT WORK IN A STRAIGHT LINE.

ROTARY ACTUATORS; THEY CARRY OUT WORK USING ROTARY MOTION.

THESE ARE CALLED THE DRIVES, OR ACTUATORS OR FINAL WORKING ELEMENTS.



## **THE DRIVE UNIT (FINAL WORKING ELEMENTS)**

Actuators: These are devices used in carrying out work.

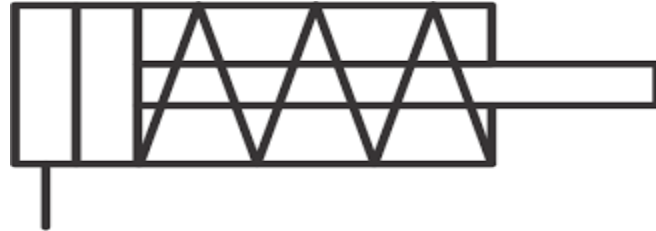
There are 2 types :

- 1.Linear actuators
- 2.Rotary actuators

## LINEAR ACTUATORS (CYLINDERS)

They are actuators that move in a straight line. They are cylinders. We have two types of cylinders;

### 1. Single Acting Cylinder



### 2. Double Acting Cylinder



## DIFFERENCES BETWEEN SINGLE & DOUBLE ACTING CYLINDERS

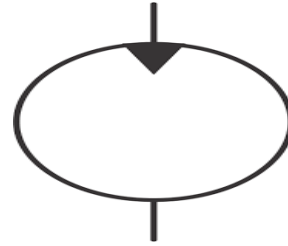
SINGLE ACTING CYLINDER	DOUBLE ACTING CYLINDER
Has one working port.	Has two working ports.
Works in only one direction.	Works in two directions.
Spring loaded.	Not spring loaded.
Has a shorter stroke length.	Has a longer stroke length.
Works with 3/2 way valves.	Works with 4/2 and 4/3 way valves.
Its return stroke is by in-built spring or external force.	

# ROTARY ACTUATORS

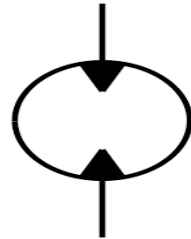
These carry out rotary motion. They can be

**1. Hydraulic Motor** : Their motion is in multiples of 360 degrees. They can be

a. Unidirectional Hydraulic Motor



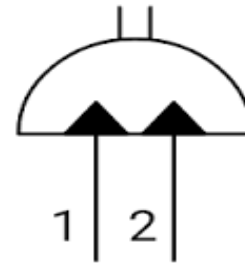
b. Bi-directional (Reversible) Hydraulic Motor.



# ROTARY ACTUATORS

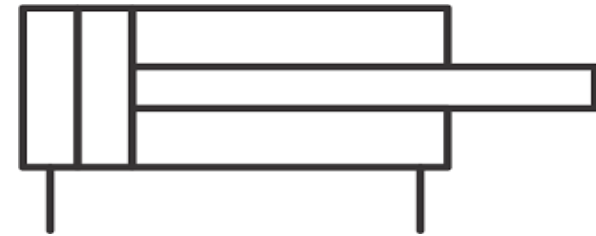
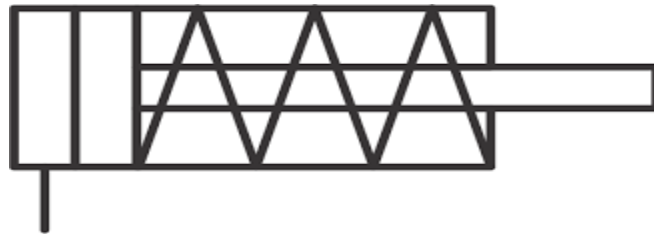
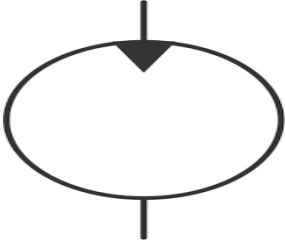
## 2. Swivel drive or Semi- Rotary drive:

There motion is never up to 360 degrees. They work like the wiper in a vehicle.



# QUIZ

What do hydraulic actuators do ?  
Do you recognize these symbols ?



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