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Module - 5
Fluid Valves Part - 1

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Module-5 (Fluid Valves)

Introduction to Hydraulics and Pneumatics, Definition of Pascal law,
Pressure, Force, viscosity. Description, symbols and application, Gear pump-Internal & External, single acting, double acting & Double ended cylinder; Directional control valves-2/2, 3/2, 4/2, 4/3 way valve, Pressure relief valve, Non return valve, Flow control valve used

Pneumatic Symbols, Description and function of air Reciprocating Compressor,
Function of Air service unit (FRL-Filter, Regulator & Lubricator)

Classification of rotary pumps- Construction and operation- repairing procedure
Brief description of turbine & stage pumps, positive displacements and their advantages.
Meaning of priming and its effect. Installation Techniques of rotary pump- procedure, tools and equipment required. Pipes and pipe fittings. Pipe Joints. Pipe Gauging.

Introduction to Hydraulics & Pneumatics

Hydraulics meaning

. The word Hydraulics is a term related to water or fluids, It is a branch of science that deals with practical applications of fluids.

. The main advantage of fluids are which is incompressible i.e. it does not change its volume when a pressure is applied.

. Hydraulic systems use liquids or fluids like water and oil to transmit power.

. Hydraulic energy is used to produce mechanical functions, such as the operations of various machines,pumps,engines etc

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Pneumatics meaning

. Pneumatics is the study of air and gases and the relationship between volume, pressure and temperature of the air or gases.

. Pneumatic power is the power that is basically using the air pressure/air flow.

. Pneumatic energy is used to produce mechanical functions, such as the operations of various machines,pumps,engines etc

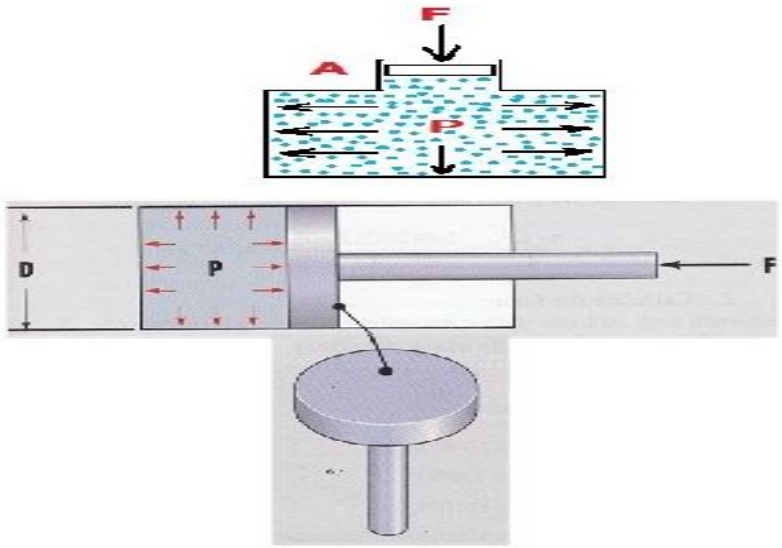
. The term pneumatic is derived from the Greek word pneuma its meaning is wind or breath.

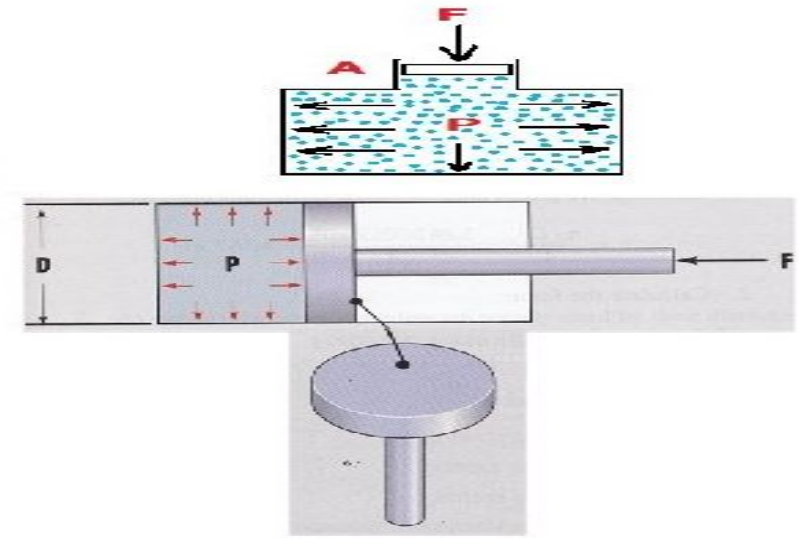
Basic laws of fluid power

Pascal's law (Blase Pascal 1623-1662)

. Pascal's law states that the pressure applied to an enclosed fluid is transmitted equally in all directions and to all parts of the enclosing vessel.

. It is the central law for the development of a number of hydraulic machines, Hydraulic brakes, Hydraulic jacks, Hydraulic steering etc

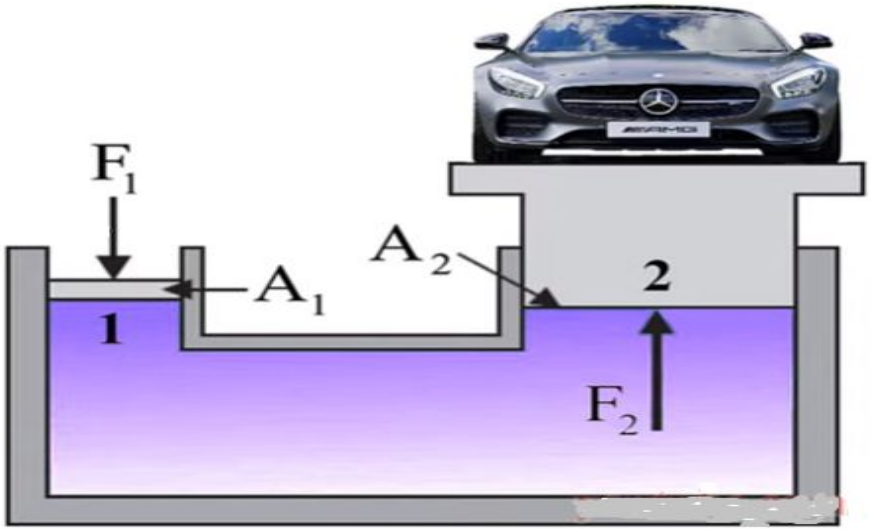




A force (F) is applied to the oil through the piston, when the oil is pushed its pressure (P) Increases, this pressure is directly proportional to applied force and inversely proportional to the piston area (A) i.e. P = F/A

Application of Pascal's Law

Hydraulic Lift



According to Pascal's law pressure is transmitted throughout the liquid.

Then pressure, $P = \frac{F_1}{A_1} = \frac{F_2}{A_2}$

Since the two pistons are on the same horizontal level floating above the fluid,

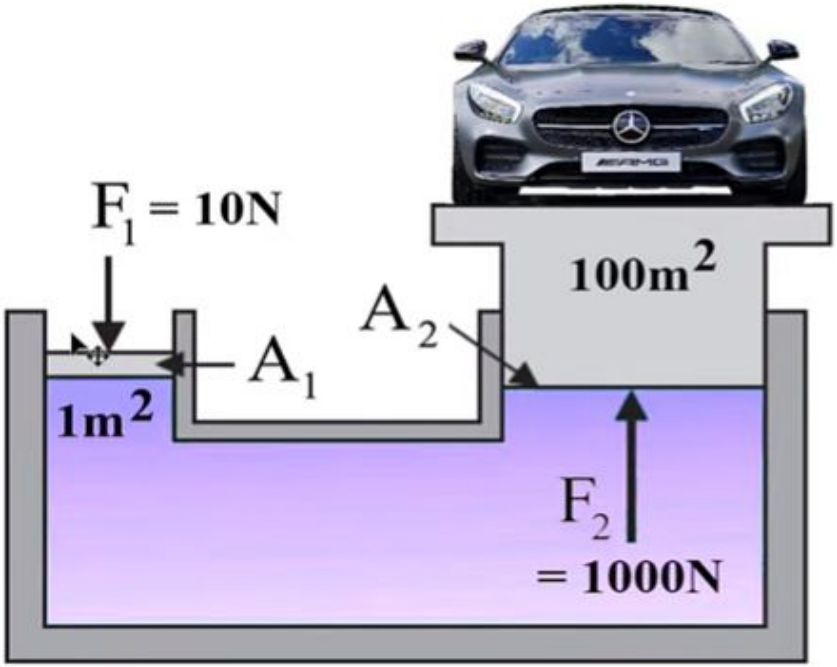
$\therefore \quad p_1 = p_2$

$\therefore \quad \frac{F_1}{A_1} = \frac{F_2}{A_2}$

$\therefore \quad \frac{F_2}{F_1} = \frac{A_2}{A_1}$

or $\boxed{F_2 = \frac{A_2}{A_1} F_1}$

Thus depending on $\frac{A_2}{A_1}$ the force F_1 becomes amplified by the factor $\frac{A_2}{A_1}$



$$F_2 = F_1\left(\frac{A_2}{A_1}\right)$$

$$F_2 = 10\left(\frac{100}{1}\right) = 1000N$$

Fluid Pressure

. It is the resistance offered by the fluid to compression when an incompressible fluid medium is squeezed by the application of a force. this term is called pressure.

. According to Pascal's law this pressure is transmitted equally throughout the medium in all directions. It is defined as force per unit area.

Pressure Formula

Simply the pressure formula is. $P = F / A$.

P = Pressure (Pascal)

F = Force act on the object Newton (N)

A = Area on which the force act (m^2)

In SI system of units N/m^2 is known as Pascal

. There are many units of pressure, Some of the most important units are follows

1 Pascal = 1 N/m^2

1 bar = 10^5 Pa = 100 kPa

1 bar = 14.5 psi (Pounds per square inch)

1 bar = 1.02 kgf/cm^2

1 kgf/cm^2 = 0.981 bar

Fluid Power

. Fluid power is the energy transmitted and controlled by means of a pressurized fluid, either liquid or gas

. Fluid power is also defined as the technology that deals with the generation, control and transmission of power using pressurized fluids.

Hydraulic power = Pressure x Flow rate

If pressure is in Pascals (N/m^2) and the flow rate is in m^3/second then

Hydraulic power = Pressure x Flow rate - (Nm/s) = Watts

It is usual to give flow rate in litres/minute and pressure in bars. To use these units in the calculation the following conversion has to be made.

$$kW = \frac{\text{Flow Rate (L /min)} \times \text{Pressure (bar)}}{600}$$

$$hp = \frac{\text{Flow Rate (gpm)} \times \text{Pressure (psi)}}{1714}$$

1.The Hydraulic power developed by a fluid having pressure of 800 bar and flow rate is 30 l/min. according to the equation

Pressure = 800 bar

Flow rate = 30 l/min

$$= \frac{30 \times 800}{600} = 240 \text{ KW}$$

2. What is the Hydraulic horsepower delivered by pump at 400 gallons per minute at 3000 psi. according to the equation

Pressure = 3000 psi

Flow rate = 400 gpm

$$= \frac{400 \times 3000}{1714} = 700 \text{ HP}$$

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The advantage of fluid power

1. flexibility and the ability to multiply forces efficiently.
2. It provide fast and accurate response to controls.
3. It can produce more power than electrical and mechanical systems of equal size.
4. It can produce a force of thousands of tones.
5. Higher pressure can be operated
6. Less noisy
7. Accurate speeds are possible
8. Vibration and shock are reduced
9. Maintenance is simple and less costly

Applications Of Fluid Power

1. Hydraulic lift
2. Hydraulic jack
3. Hydraulic brakes
4. Hydraulic steering
5. Hydraulic press
6. Construction machineries
7. Mining machineries
8. Locomotives
9. Ships
10. Aero planes
11. Space craft

Hydraulic lift

Hydraulic lift

Hydraulic brakes

Hydraulic jack