Hydraulic pump

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Hydraulic pump is the heart of a hydraulic system. Its function is to convert mechanical energy into hydraulic energy by pushing the hydraulic fluid into the system.

Classify hydraulic pumps.

: Hydraulic pumps are designed and manufactured over a wide range of constructions and capacities, to suit the particular requirement of the application. Pumps in general are classified on following basis,

1) Classifications based on principle of operation

Hydrostatic type pumps (Positive displacement): reciprocating pump & rotary pump

Hydrodynamic type pumps (Non - Positive displacement type): Centrifugal pump

2) Classification based on displacement

Constant displacement pumps.

Variable displacement pumps.

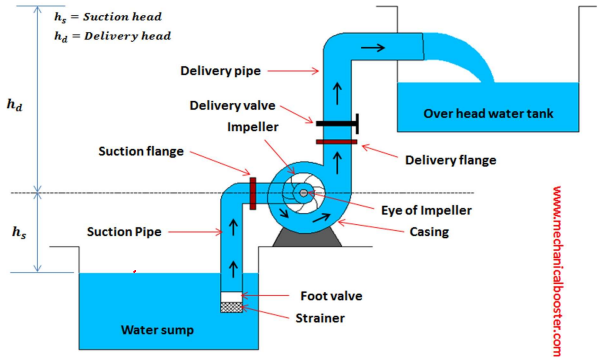
centrifugal pump

Construction and working

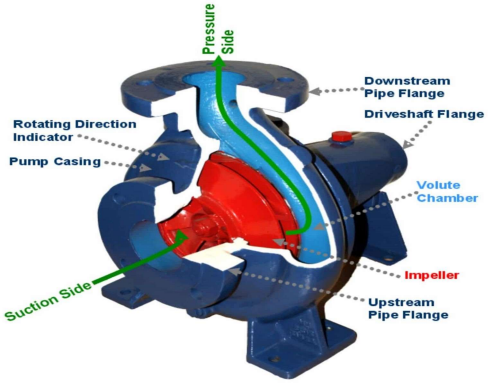
Working Principle

It works on the principle of forced vortex flow. The forced vortex flow means when a certain mass of fluid or liquid is allowed to rotate by an external torque than there is a rise in pressure head of the rotating liquid takes place. This rise in pressure head is used to deliver water from one location to another. It is centrifugal force acting on the fluid that makes it to flow within the casing.

The rise in the pressure head of the rotating liquid at any point is directly proportional to the square of the tangential velocity of the rotating liquid.



Centrifugal Pump Working



Main Parts

The various main parts of a centrifugal pump are:

1. Impeller
2. Casing
3. Suction pipe with a foot valve and strainer
4. Delivery pipe

Let's discuss about each one of them one by one

1. Impeller

It is the rotating part of the pump. The impeller is mounted on a shaft and the shaft of impeller is again connected with the shaft of an electric motor. It is rotated by the motor and consists of series of backward curved blades.

2. Casing

It is an air tight passage which surrounds the impeller. The design of the casing is done in such a way that it is capable of converting the kinetic

energy of the water discharging from the outlet of the impeller into pressure energy before it leaves the casing and enters into the delivery pipe

Commonly three types of casing are used in centrifugal pump and these are

(i). Volute Casing: It is a spiral type of casing in which the area of flow increases gradually. The increase in area of flow decreases the velocity ar increases the pressure of the liquid that flows through the casing. The volute casing is shown in figure above:

(ii). Vortex Casing: In vortex casing, a circular chamber is introduced in between the impeller and casing. This is done in order to prevent the lo of energy due to formation of eddies. The efficiency of the vortex casing is more than that of the volute casing.

(iii). Casing with Guide Blades: In this casing, the impeller is surrounded by series of guide blades. The guide blades are mounted on a ring wh is called as diffuser. The design of the guide vanes are kept as such that the water which is leaving the impeller enters the guides without shock. The area of the guide vanes increases; this helps to decrease the velocity of the liquid and increases its pressure. After guide vanes, water passe through the surrounding casing. In most of the cases, the casing remains concentric with the impeller.

3. Suction Pipe with Foot Valve and Strainer

A pipe whose one end is connected with the inlet of the impeller and the other end is dipped into the sump of water is called suction pipe. The suction pipe consists of a foot valve and strainer at its lower end. The foot valve is a one way valve that opens in the upward direction. The strain is used to filter the unwanted particle present in the water to prevent the centrifugal pump from blockage.

4. Delivery Pipe

It is a pipe whose one end is connected to the outlet of the pump and other end is connected to the required height where water is to be delivered.

Working Principle of Centrifugal Pump:

The Centrifugal pump acts as a reversed of an inward radial flow reaction turbine. This means that flow in a centrifugal pump is in the radial outward directions.

The centrifugal pump works on the principle of forced vortex flow which means that when a certain mass of liquid is rotated by an external torque, the rise in pressure head of the rotating liquid takes place.

The rise in pressure head at any point of the rotating liquid is proportional to the square of the tangential velocity of the liquid at that point.

Therefore the rise in **pressure head** is $v^2/2g$.

Thus at the outlet of the impeller, where the radius is more, the rise in pressure head will be more and the liquid will be discharged at the outlet with a high-pressure head.

Due to this high-pressure head, the liquid can be lifted to a high level.

Applications of Centrifugal Pumps are:

- Centrifugal pumps are used in buildings for pumping the general water supply, as a booster and for domestic water supplies.
- The design of a centrifugal pump makes them useful for pumping sewage and slurries.
- They are also used in fire protection systems and for heating and cooling applications.
- Beverage industry: Used to transfer juice, bottled water, etc.
- Dairy industry: Used to transfer dairy products such as milk, buttermilk, flavored milk, etc.
- Various industries (Manufacturing, Industrial, Chemicals, Pharmaceutical, Food Production, Aerospace, etc.) for the purposes of cryogenics and refrigerants.
- Oil Energy: pumping crude oil, slurry, mud; used by refineries, power generation plants.

Advantages of Pump:

These are some advantages of Pump:

- *As there is no drive seal so there is no leakage in the pump.*
- *There are very less frictional losses.*
- *The construction of the pump is Simple.*
- *Almost no noise.*
- *Minimum wear as compared to others.*

Disadvantages of Pump:

These are some disadvantages of Pump:

- Produce cavitation.
- Corrosion.

- Cannot be able to work at high speed.

Applications of Pump:

The main applications of the pump are:

- *As we already discussed Pumping Water from one place to another place.*
- *Aquarium and pond filtering*
- *This is also used for Water cooling and fuel injection in automobiles*
- *Pumping oil or gas and operating cooling towers in the energy industry.*
- *Uses in waste-water recycling, pulp, and paper, chemical industry, etc.*

So this is all about Pump, I hope you like my article, by the way, feel free to post your doubts on the co

Introduction of Reciprocating Pump:

Reciprocating Pump is a Positive Displacement type pump that works on the principle of movement of the piston in forwarding and backward directions whereas the Centrifugal pump uses the kinetic energy of the impeller to supply the liquid from one place to another place.

Who Invented Reciprocating Pump?

A Greek **inventor** and mathematician **Ctesibius** invents Reciprocating Pump in 200 BC.

Definition of Reciprocating Pump:

It is a machine that converts mechanical energy into hydraulic energy.

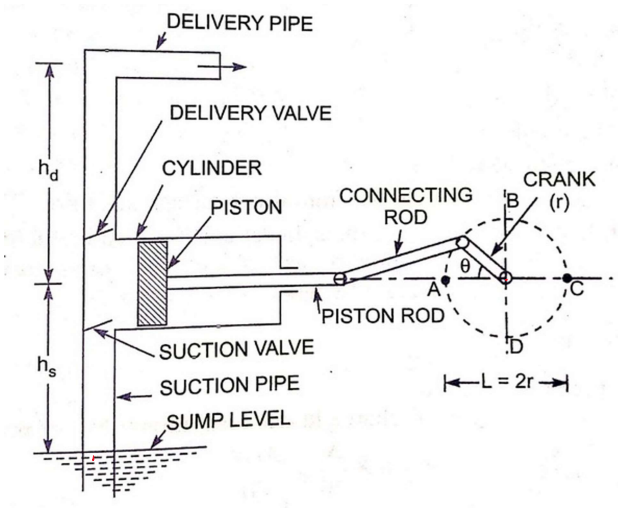
Reciprocating pumps are in use where a certain quantity of fluid (mostly sump) has to be transported from the lowest region to the highest region by the application of pressure.

For Example,

When you go to the water servicing of the bike, you can see that the water that is being used is collected from the sump only, and by the application of pressure via a nozzle, water is sprayed on to the vehicle.

Reciprocating Pump Diagram:

The diagram of Reciprocating Pump was displayed below.



Parts of Reciprocating Pump:

The Parts of Reciprocating Pump are as follows.

- Water Sump
- Strainer
- Suction Pipe

- Suction Valve
- Cylinder
- Piston and Piston rod
- Crank and Connecting rod
- Delivery valve
- Delivery pipe

An Explanation for the parts of Reciprocating Pump:

The explanation for the parts of Reciprocating pump are as follows.

Water Sump:

It is the source of water. From the sump, water is to be transported to the delivery pipes by the usage of the piston.

Strainer:

It acts as a mesh that can screen all the dirt, dust particles, etc. from the sump. If there is no

strainer, then the dirt or dust also enters into the cylinder which can jam the region and affects the working of the pump.

Suction Pipe:

The main function of the suction pipe is to collect the water from the sump and send it to the cylinder via a suction valve. The suction pipe connects the water sump and the cylinder.

Suction Valve:

It is a non-return valve which means it can take the fluid from the suction pipe and send it to the cylinder but cannot reverse the water back to it. In the sense, the flow is unidirectional.

This valve opens only during the suction of fluid and closes when there is a discharge of fluid to outside.

Cylinder:

It is a hollow cylinder made of cast iron or steel alloy and it consists of the arrangement of piston and piston rod.

Piston and Piston rod:

For suction, the piston moves back inside the cylinder and for discharging of fluid, the piston moves in the forward direction.

The Piston rod helps the piston to move in a linear direction i.e. either the forward or the backward directions.

Crank and Connecting rod:

For rotation, the crank is connected to the power source like engine, motor, etc. whereas the connecting rod acts as an intermediate between the crank and piston for the conversion of rotary motion into linear motion.

Delivery Pipe:

The function of the delivery pipe is to deliver the water to the desired location from the cylinder.

Delivery valve:

Similar to the suction valve, a delivery valve is also a Non-return valve. During suction, the delivery valve closes because the suction valve is in opening condition and during Discharge, the suction valve is closed and the delivery valve Is opened to transfer the fluid.

These are the various components of Reciprocating pump. Let’s understand the working principle of it.

Working Principle of Reciprocating Pump:

When the power supply is given to the reciprocating pump, the crank rotates through an electric motor.

The angle made by the crank is responsible for the movement of the piston inside the cylinder. By referring to the above diagram, the piston moves towards the extreme left of the cylinder when the crank meets position **A** i.e. **θ=0**.

Similarly, the piston moves towards the extreme right of the cylinder when the crank meets the position **C** i.e. **θ=180**.

A partial vacuum in the cylinder takes place when the piston movement is towards the right extreme position i.e. (**θ=0 to θ=180**.) and that makes the liquid enter into the suction pipe.

This is due to the presence of atmospheric pressure on the sump liquid which is quite less than the pressure inside the cylinder. Therefore, due to the difference in pressure, the water enters into the cylinder through a non-return valve.

The water which stays in the volume of the cylinder has to be sent to the discharge pipe via discharge valve and this can be done when the crank is rotating from **C** to **A** i.e. (**θ=180 to θ=360**) which moves the piston in the forward direction.

Due to the movement of the piston in a forward direction, the pressure increases inside the cylinder which is greater than the atmospheric pressure.

This results in the opening of the delivery valve and closing of the suction valve.

Once the water comes into the delivery valve, it cannot move back to the cylinder because it is a unidirectional valve or non-return valve.

From there, it enters into the delivery pipe so that it can be sent to the required position.

Therefore, in this way, the water is sucked and discharged from the sump to the desired location through the piston inside the cylinder.

Reciprocating Pump Advantages:

The advantages of Reciprocating Pump are as follows.

- No priming is needed in the Reciprocating pump compared to the Centrifugal pump.
- It can deliver liquid at high pressure from the sump to the desired height.
- It exhibits a continuous rate of discharge.
- It can work due to the linear movement of piston whereas the centrifugal pump works on the rotary velocity of the impeller.

Reciprocating Pump Disadvantages:

The disadvantages of Reciprocating Pump are as follows.

- The maintenance cost is very high due to the presence of a large number of parts.
- The initial cost of this pump is high.
- Flow rate is less
- Viscous fluids are difficult to pump.

Applications of Reciprocating Pump:

The applications of Reciprocating Pump are as follows.

- Gas industries
- Petrochemical industries
- Oil refineries
- Vehicle water servicing centers etc.

Property	**Centrifugal**	**Positive Displacement**
Effective Viscosity Range	Efficiency decreases with increasing viscosity (max. 200 Cp)	Efficiency increases with increasing viscosity
Pressure tolerance	Flow varies with changing pressure	Flow insensitive to changing pressure
	Efficiency decreases at both higher and lower pressures	Efficiency increases with increasing pressure
Priming	Required	Not required
Flow (at constant pressure)	Constant	Pulsing
Shearing (separation of emulsions, slurries, biological fluids, food stuffs)	High speed damages shear-sensitive mediums	Low internal velocity. Ideal for pumping shear sensitive fluids

Centrifugal pumps are commonly used for pumping water, solvents, organics, oils, acids, bases and any 'thin' liquids in both industrial, agricultural and domestic applications. In fact, there is a design of centrifugal pump suitable for virtually any application involving low viscosity fluids.

Type of centrifugal pump	**Application**	**Features**
Canned motor pump	Hydrocarbons, chemicals where any leakage is not permitted	Sealless; impeller directly attached to the motor rotor; wetted parts contained in can
Magnetic drive pump		Sealless; impeller driven by close coupled magnets
Pump Comparison: Centrifugal vs Positive Displacement Chopper/grinder pump	Waste water in industrial, chemical and food processing/ sewage	Impeller fitted with grinding teeth to chop solids
Circulator pump	Heating, ventilation and air conditioning	Inline compact design
Multistage pump	High pressure applications	Multiple impellers for increased discharge pressures
Cryogenic pump	Liquid natural gas, coolants	Special construction materials to tolerate low temperatures
Trash pump	Draining mines, pits, construction sites	Designed to pump water containing solid debris
Slurry pump	Mining, mineral processing, industrial slurries	Designed to handle and withstand highly abrasive slurries

Comparison of Centrifugal and Reciprocating Pumps

Centrifugal Pumps	Reciprocating Pumps
1. Steady and even flow	**1**. Intermittent and pulsating flow
2. For large discharge, small heads	**2**. For small discharge, high heads.
3. Can be used for viscous fluids e.g. oils, muddy water.	**3**. Can handle pure water or less viscous liquids only otherwise valves give frequent trouble.
4. Low initial cost	**4**. High initial cost.
5. Can run at high speed. Can be coupled directly to electric motor.	**5**. Low speed. Belt drive necessary.
6. Low maintenance cost. Periodic check up sufficient.	**6**. High maintenance cost. Frequent replacement of parts.
7. Compact less floors required.	**7**. Needs 6-7 times area than for centrifugal pumps.
8. Low head pumps have high efficiency	**8**. Efficiency of low head pumps as low as 40 per cent due to the energy losses.
9. Uniform torque	**9**. Torque not uniform.
10. Simple constructions. Less number of spare parts needed	**10**. Complicated construction. More number of spare parts needed.