

PUMP

- A **pump** is a device used to move fluids **Liquid or gases** sometimes **slurries** by mechanical action.
- There are **two** main categories of pumps and they are **Kinetic Pump** and **Positive displacement Pumps**.

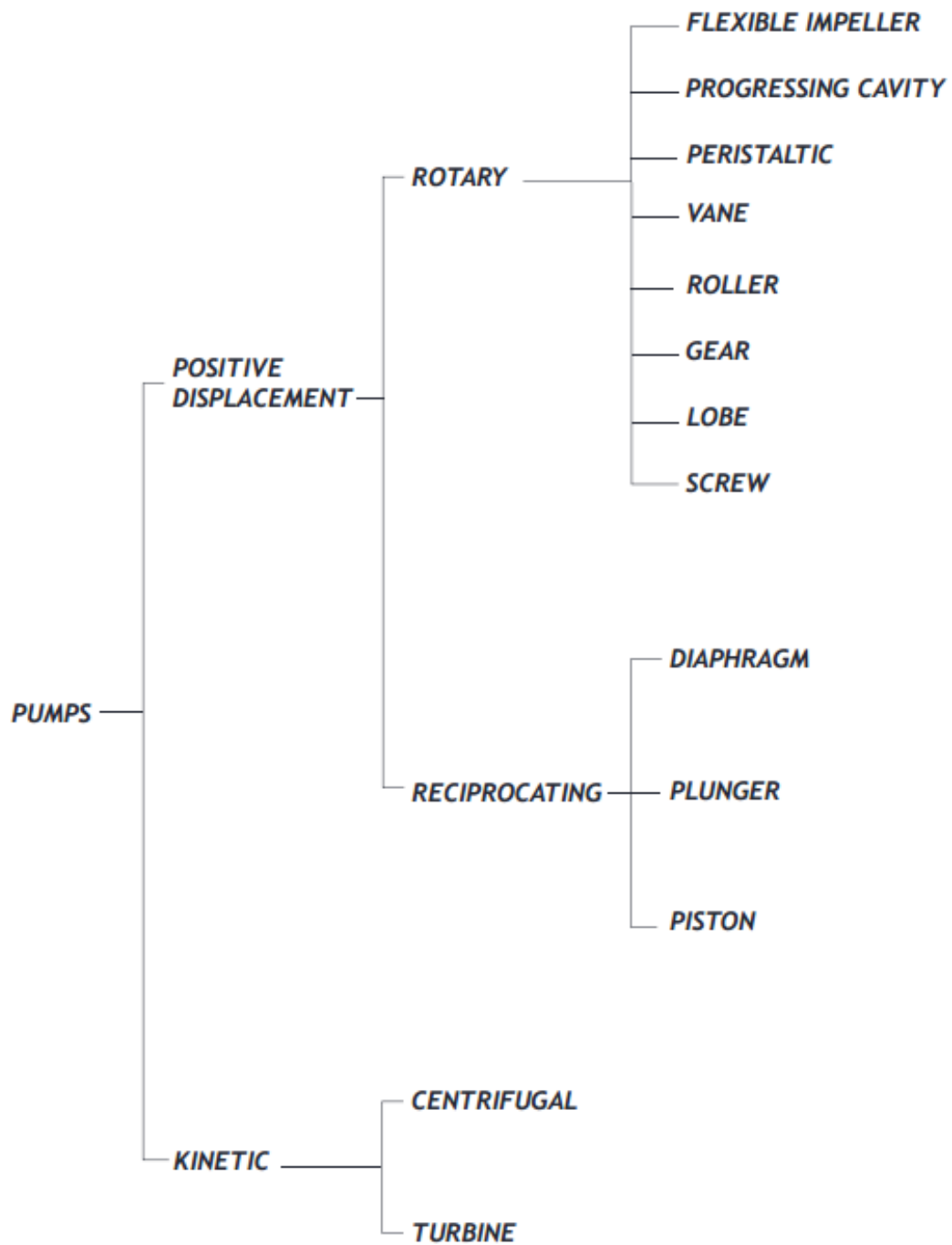
WHAT ARE SOME IMPORTANT FACTORS IN DECIDING ON THE RIGHT PUMP?

- The selection of the pump class and type for a certain application is influenced by **system requirements, system layout, fluid characteristics, intended life, energy cost, and materials of construction**.

PUMP USES

- **Drainage** - Used to control the level of water in a protected area.
- **Sewage** - Used in the collection and treatment of sewage.
- **Irrigation** - Used to make dry lands agriculturally productive.
- **Chemical Industry** - Used to transport fluids to and from various sites in the chemical plant.
- **Petroleum Industry** - Used in every phase of petroleum production, transportation, and refining.
- **Medical Field** - Used to pump fluids in and out of the body.
- **Steel Mills** - Used to transport cooling water.

CLASSIFICATION OF PUMP



CENTRIFUGAL PUMP

Main parts of the centrifugal pump are

- Impeller
- Volute
- Shaft
- Bearing
- Wear Rings
- Packing
- Suction Pipe with valve and strainer

CENTRIFUGAL PUMP CONSTRUCTION AND WORKING PRINCIPLE

► 19.2 MAIN PARTS OF A CENTRIFUGAL PUMP

The followings are the main parts of a centrifugal pump :

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

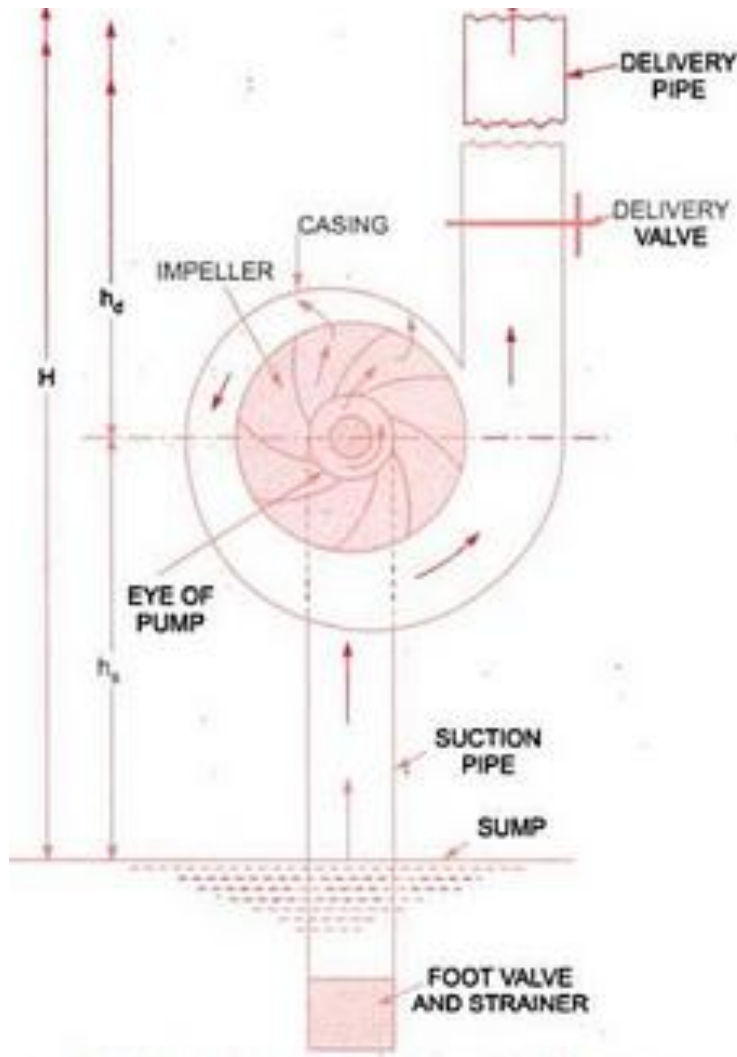
All the main parts of the centrifugal pump are shown in Fig. 19.1.

1. **Impeller.** The rotating part of a centrifugal pump is called 'impeller'. It consists of a series of backward curved vanes. The impeller is mounted on a shaft which is connected to the shaft of an electric motor.

2. **Casing.** The casing of a centrifugal pump is similar to the casing of a reaction turbine. It is an air-tight passage surrounding the impeller and is designed in such a way that the kinetic energy of the water discharged at the outlet of the impeller is converted into pressure energy before the water leaves the casing and enters the delivery pipe. The following three types of the casings are commonly adopted :

- (a) Volute casing as shown in Fig. 19.1.
- (b) Vortex casing as shown in Fig. 19.2 (a).
- (c) Casing with guide blades as shown in Fig. 19.2.(b).

(a) **Volute Casing.** Fig 19.1 shows the volute casing, which surrounds the impeller. It is of spiral type in which area of flow increases gradually. The increase in area of flow decreases the velocity of flow. The decrease in velocity increases the pressure of the water flowing through the casing. It has been observed that in case of volute casing, the efficiency of the pump increases slightly as a large amount of energy is lost due to the formation of eddies in this type of casing.



(b) **Vortex Casing.** If a circular chamber is introduced between the casing and the impeller as shown in Fig. 19.2 (a), the casing is known as Vortex Casing. By introducing the circular chamber, the loss of energy due to the formation of eddies is reduced to a considerable extent. Thus the efficiency of the pump is more than the efficiency when only volute casing is provided.

(c) **Casing with Guide Blades.** This casing is shown in Fig. 19.2 (b) in which the impeller is surrounded by a series of guide blades mounted on a ring which is known as diffuser. The guide vanes are designed in which a way that the water from the impeller enters the guide vanes without stock. Also

the area of the guide vanes increases, thus reducing the velocity of flow through guide vanes and consequently increasing the pressure of water. The water from the guide vanes then passes through the surrounding casing which is in most of the cases concentric with the impeller as shown in Fig. 19.2 (b).

3. Suction Pipe with a Foot - valve and a Strainer. A pipe whose one end is connected to the inlet of the pump and other end dips into water in a sump is known as suction pipe. A foot valve which is a non-return valve or one-way type of valve is fitted at the lower end of the suction pipe. The foot valve opens only in the upward direction. A strainer is also fitted at the lower end of the suction pipe.

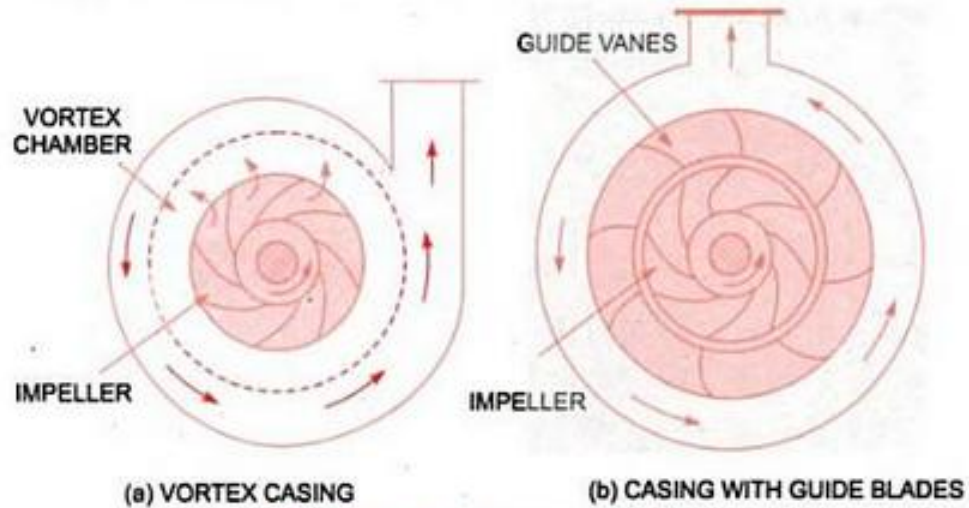


Fig. 19.2 Different types of casing.

4. Delivery pipe. A pipe whose one end is connected to the outlet of the pump and other end delivers the water at a required height is known as delivery pipe.

Centrifugal Pump Classification by Flow

Centrifugal pumps can be classified based on the manner in which fluid flows through the pump. The manner in which fluid flows through the pump is determined by the design of the pump casing and the impeller. The three types of flow through a centrifugal pump are **radial flow**, **axial flow**, and **mixed flow**.

Radial Flow Pumps

In a radial flow pump, the liquid enters at the center of the impeller and is directed out along the impeller blades in a direction at right angles to the pump shaft. The impeller of a typical radial flow pump and the flow through a radial flow pump are shown in Figure 6.

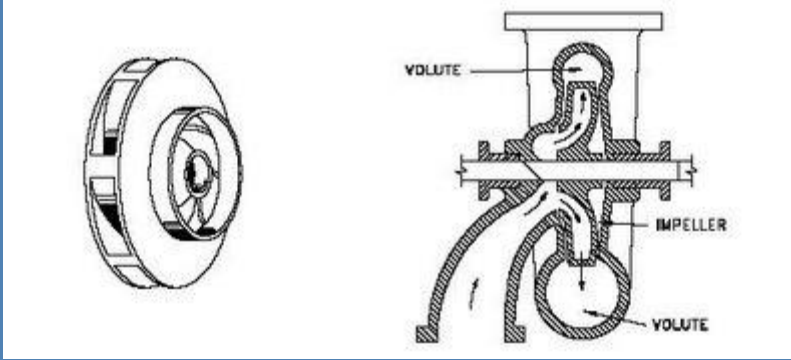


Fig 6 Radial Flow Centrifugal Pump

Axial Flow Pumps

In an axial flow pump, the impeller pushes the liquid in a direction parallel to the pump shaft. Axial flow pumps are sometimes called propeller pumps because they operate essentially the same as the propeller of a boat. The impeller of a typical axial flow pump and the flow through a radial flow pump are shown in Figure 7.

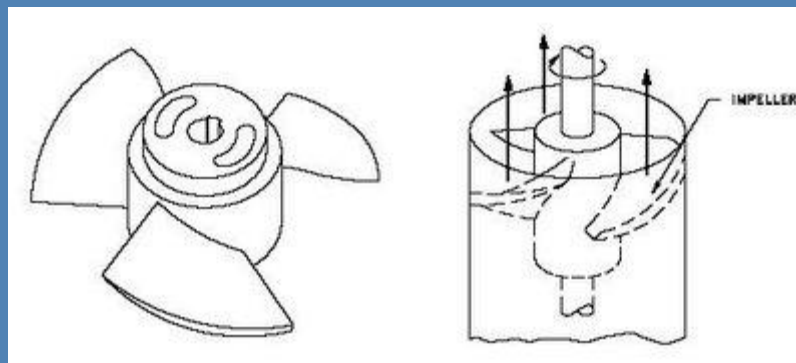


Fig 7 Axial Flow Centrifugal Pump

Mixed Flow Pumps

Mixed flow pumps borrow characteristics from both radial flow and axial flow pumps. As liquid flows through the impeller of a mixed flow pump, the impeller blades push the liquid out away from the pump shaft and to the pump suction at an angle greater than 90° . The impeller of a typical mixed flow pump and the flow through a mixed flow pump are shown in Figure 8.

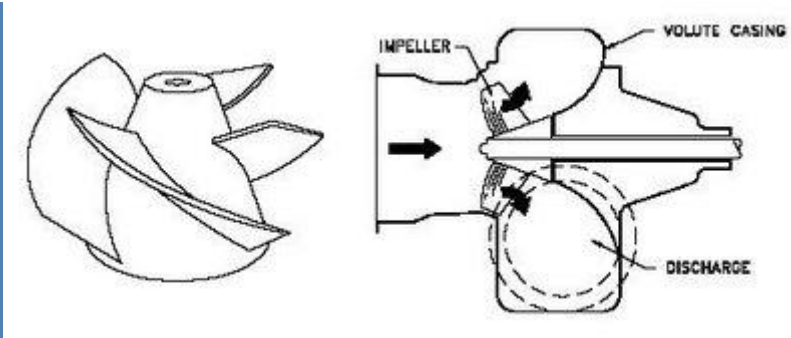


Fig 8 Mixed Flow Centrifugal Pump

Multi-Stage Centrifugal Pumps

A centrifugal pump with a single impeller that can develop a differential pressure of more than 150 psid between the suction and the discharge is difficult and costly to design and construct. A more economical approach to developing high pressures with a single centrifugal pump is to include multiple impellers on a common shaft within the same pump casing. Internal channels in the pump casing route the discharge of one impeller to the suction of another impeller.

Figure 9 shows a diagram of the arrangement of the impellers of a four-stage pump. The water enters the pump from the top left and passes through each of the four impellers in series, going from left to right. The water goes from the volute surrounding the discharge of one impeller to the suction of the next impeller.

A pump stage is defined as that portion of a centrifugal pump consisting of one impeller and its associated components. Most centrifugal pumps are single-stage pumps, containing only one impeller. A pump containing seven impellers within a single casing would be referred to as a seven-stage pump or, or generally, as a multi-stage pump.

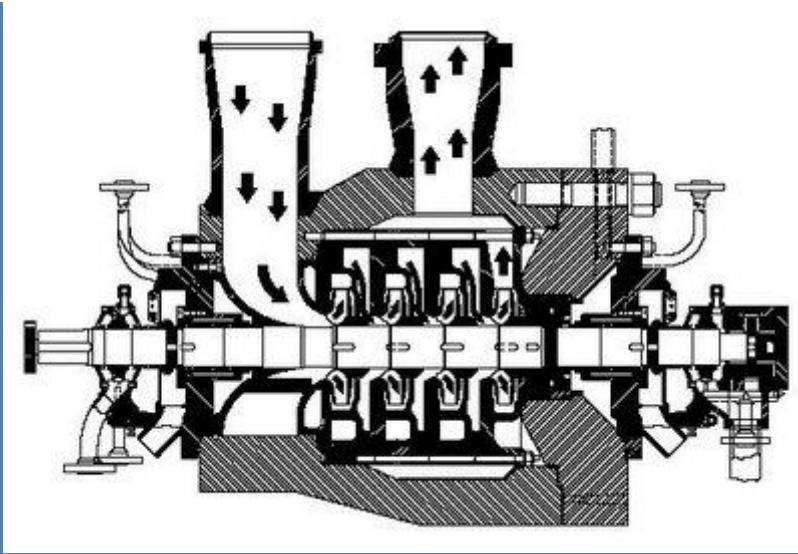


Fig 9 Multi Stage Centrifugal Pump

► 20.1 INTRODUCTION

In the last chapter, we have defined the pumps as the hydraulic machines which convert the mechanical energy into hydraulic energy which is mainly in the form of pressure energy. If the mechanical energy is converted into hydraulic energy, by means of centrifugal force acting on the liquid, the pump is known as centrifugal pump. But if the mechanical energy is converted into hydraulic energy (or pressure energy) by sucking the liquid into a cylinder in which a piston is reciprocating (moving backwards and forwards), which exerts the thrust on the liquid and increases its hydraulic energy (pressure energy), the pump is known as reciprocating pump.

► 20.2 MAIN PARTS OF A RECIPROCATING PUMP

The followings are the main parts of a reciprocating pump as shown in Fig. 20.1 :

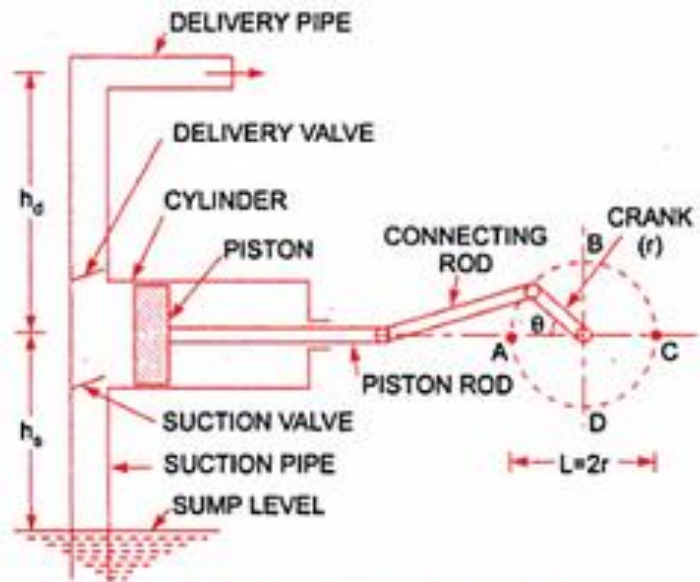


Fig. 20.1 Main parts of a reciprocating pump.

Reciprocating pump is a positive displacement pump. The given pump is single acting single cylinder pump with air vessel. It can be used for less discharge at higher heads. Priming is not required because it is a positive displacement pump. Reciprocating pumps are used in pumping water in hilly areas. Reciprocating pumps has lower efficiency compared to centrifugal pumps

CONSTRUCTION:

The Main Parts of Reciprocating Pump are:

1. CYLINDER

It is made of cast iron or steel alloy. The piston reciprocates inside the cylinder. The movement of piston is obtained by a connecting rod which connects piston and rotating crank.

2. SUCTION PIPE

It connects the source of water and cylinder, the water is sucked.

3. DELIVERY PIPE

Water sucked by pump is discharged into delivery pipe.

4. SUCTION VALVE

It adjusts the flow from the suction pipe into delivery pipe.

5. DELIVERY VALVE

It admits the flow from the cylinder in to delivery pipe.

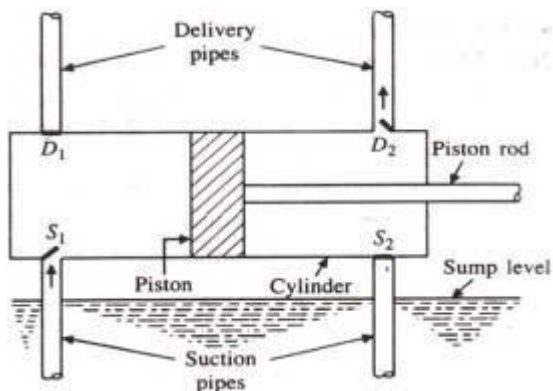
6. AIR VESSEL

It is a cast iron closed chamber having an opening at its pass through which the water flows into vessel.

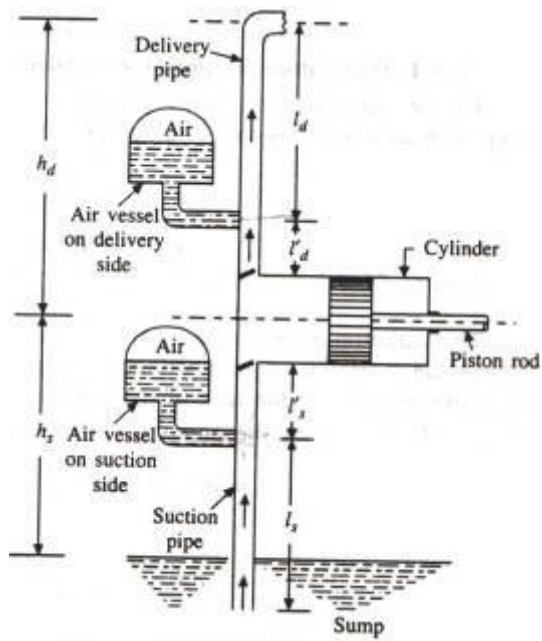
WORKING:

During the suction stroke the piston moves left thus creating vacuum in the Cylinder. This vacuum causes the suction valve to open and water enters the Cylinder. During the delivery stroke the piston moves towards right. This increasing pressure in the cylinder causes the suction valve to close and delivery to open and water is forced in the delivery pipe. The air vessel is used to get uniform discharge.

SINGLE ACTING RECIPROCATING PUMP



DOUBLE ACTING SINGLE ACTING RECIPROCATING PUMP



RECIPROCATING PUMP FITTED WITH AIR VESSEL AT BOTH SUCTION AND DELIVERY SIDE

Classification of reciprocating pump

1. DIAPHRAGM

2. PLUNGER TYPE

3. PISTON TYPE

1. DIAPHRAGM

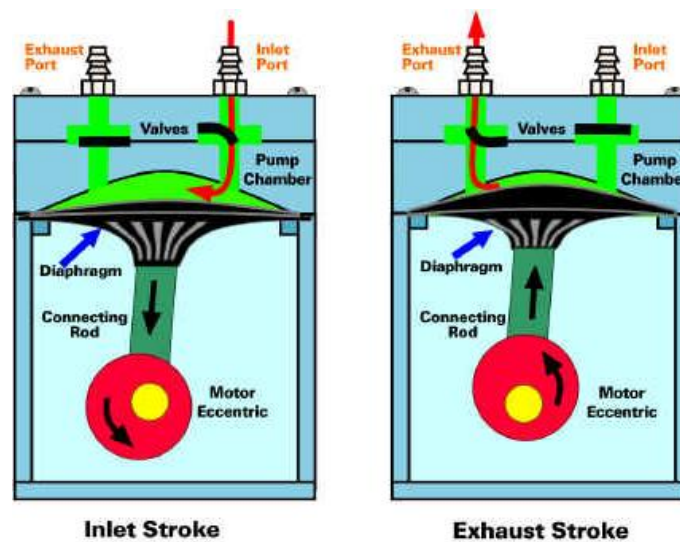


Figure 1 Operation of a liquid diaphragm pump.

Operation of Liquid Diaphragm Pumps

Diaphragm liquid pumps operate by means of an eccentric that moves a diaphragm up and down, inside a chamber. On the down stroke, liquid is drawn into the chamber through a non-return valve. The valve closes as soon as the diaphragm starts to move in the upwards direction and this movement then compresses the liquid and forces it out of the chamber through another non-return valve, thus producing flow (Figure 1). This pumping concept is equally effective handling liquid or gases with the typical pump design providing self-priming, mixed media pumping capability, as well as the ability to operate dry (without liquid) indefinitely. The final design is mechanically simple and permits the pump designer the ability to select the pump wetted parts to be in chemically inert materials, a major advantage of diaphragm style pumps.

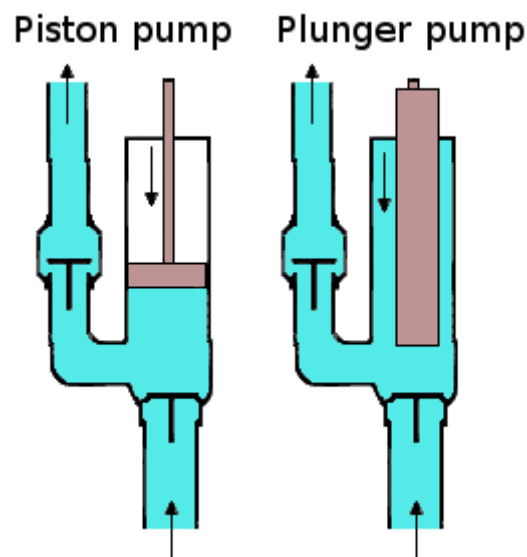
2. PISTON TYPE

REFER PAGE 9 AND 10 FOR CONSTRUCTION AND WORKING

3. PLUNGER TYPE

REFER PAGE 9 AND 10 FOR CONSTRUCTION AND WORKING

**IN THIS TYPE INSTEAD OF PISTON PLUNGER WILL USED OF THE
RECIPROCATING MOTION**

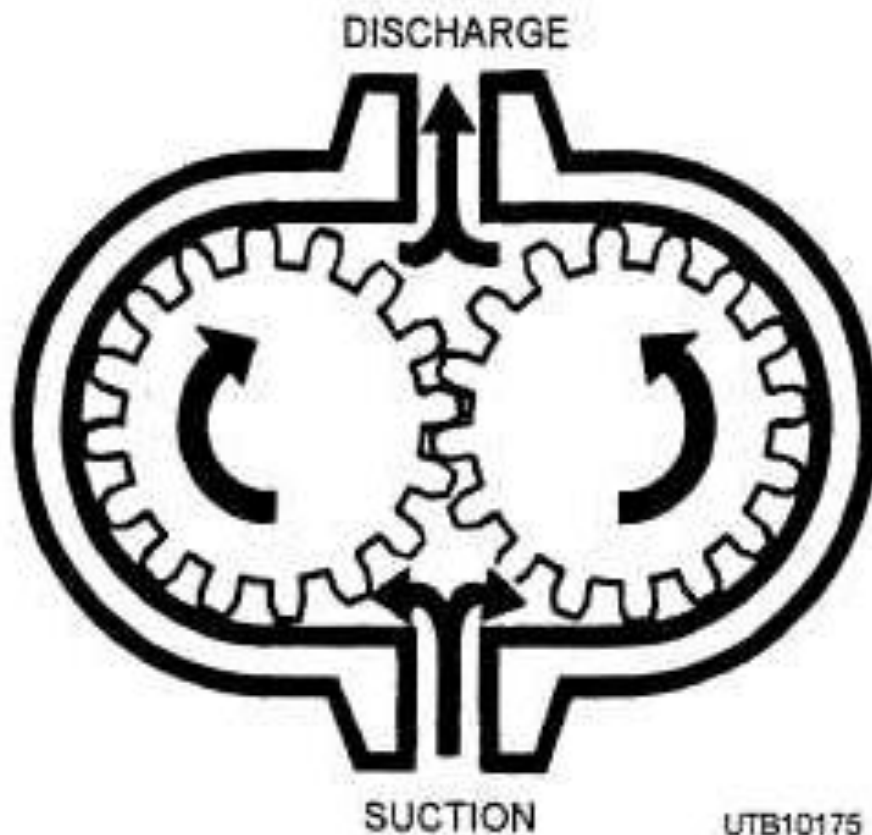


What is a gear pump?

Gear pumps are positive displacement pumps that pump fluid by gears coming in and out of mesh to create a non-pulsating pumping action. Gear pumps are able to pump at high pressures and excel at pumping high viscosity liquids efficiently.

How does a gear pump work?

1. On the intake side of the pump the gears become unmeshed. Since the gears become unmeshed a suction action is created forcing the fluid into the volume pockets.
2. The fluid is then transported to the discharge side of the pump.
 - a. In an external gear pump the fluid is trapped and carried to the discharge side of the pump between the gear teeth and interior pump casing.
 - b. For an internal pump the fluid is trapped and carried between the external and internal gears teeth to the discharge side.
3. The meshing of gears on the discharge side of the pump forces the fluid out under pressure.



Construction

The gear pump consists of two identical intermeshing gears rotating with close clearance inside suitable pump housing. One of the gears called the driver gear is connected to the input by a

driver shaft. The other gear called the idler gear is mounted on a pin and is free to rotate around the axis of the pin. Power is supplied to the driver gear while the idler gear rotates relatively due to the close intermeshing. The pump is provided with airtight inlet and outlet pipes.

Working

When the pump is operated the driver gear rotates and drives the idler gear and the movement pushes the liquid out of the chamber due to the differential pressure created on either side of the pump.

During operation vacuum spaces are formed as each pair of meshing teeth separates and atmospheric pressure forces the liquid inward to fill the gap. The liquid filling the space between two adjacent teeth is carried along with the teeth as they rotate and is forced out through the discharge opening. The liquid being pumped cannot short circuit back because of the close intermeshing of the two gears.

Advantages

The advantages of this pump are low cost, simplicity in design and construction, uniform flow of fluid, silent operation and low maintenance cost. The only disadvantage is that the pump cannot be used for fluid with solid particles in them.

Generally used in:

- Petrochemicals: Pure or filled bitumen, pitch, diesel oil, crude oil, lube oil etc.
- Chemicals: Sodium silicate, acids, plastics, mixed chemicals, isocyanates etc.
- Paint and ink.
- Resins and adhesives.
- Pulp and paper: acid, soap, lye, black liquor, kaolin, lime, latex, sludge etc.
- Food: Chocolate, cacao butter, fillers, sugar, vegetable fats and oils, molasses, animal food etc.

ROTARY VANE PUMP:

It moves the fluid through the pump using a rotating assembly in the pumping chamber. These are positive displacement pumps. It usually takes two or more rotating vanes to move the gas or fluid from the inlet to the outlet. As the volume of the fluid is transferred by the rotary vane pump the end of the vane barely brushes the housing part and creates a seal from the inlet to the outlet.

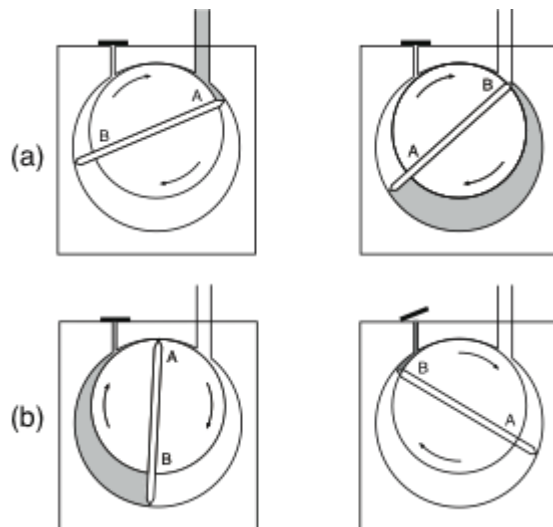
Working of Rotary Vane Pump:

- 1) A slotted rotor is eccentrically supported in a cycloidal cam. The rotor is located close to the wall of the cam so a crescent - shaped cavity is formed. The rotor is sealed into the cam by two side plates. Vanes or blades fit within the slots of the impeller. As the rotor rotates and fluid enters the pump, centrifugal force, hydraulic pressure , and/or push rods push the vanes to the walls of the housing. The tight seal among the vanes, rotor, cam and side plate is the key to the good characteristics common to the vane Pumping principle.

The housing and the cam force fluid in to the pumping chamber through holes in the cam. Fluid enters the pockets created by the vanes, rotor, cam and side plate.

- 3) As the rotor continues around , the vanes sweep the fluid to the opposite side of the crescent where it is squeezed through discharge holes of the cam as the vane approaches the point of the crescent. Fluid then exists through the discharge point.

Principle of Rotary Vane Pump:



- (a) gas from the vacuum system is expanded into the pump and

(b) the gas is pushed through the pump exhaust.

The operation principle of Rotary Vane Pump is simple. It works in two stages on the vacuum system as

The rotary vane pump will work fine when the pressure is high enough to ensure a gas flow through the pump but hopeless when the free path of the molecules is very long.