Pumps

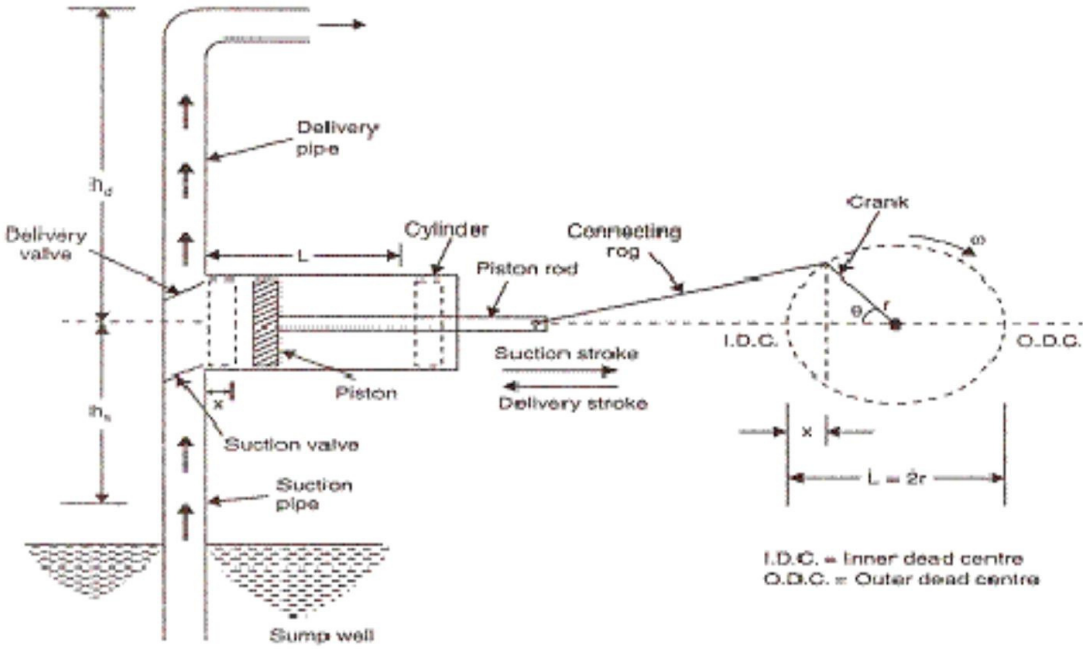
In general pumps may be defined as a mechanical device which when connected in a pipeline, converts the mechanical energy supplied to it from some external sources(normally electric motor) into hydraulic energy and transfer the same to the liquid through the pipeline. Thereby increasing the energy of flowing fluid. Normally pumps are used to transfer liquid from one place to another as well as lower level to higher level. Pumps broadly classified into two

1. Positive displacement pumps
2. Rotodynamic pumps

Positive displacement pumps are those pumps in which liquid is sucked and then it is pushed or displaced due to the thrust exerted on it, by a moving member. Most common example is
reciprocating pumps

The rotodynamic pumps have a rotating element, called impeller through which liquid passes. During this motion its angular momentum changes, due to which the pre. Energy of liquid is increased . here pump does not push the liquid as in the case of positive displacement pump. Eg: **centrifugal pump.**

Reciprocating pump:



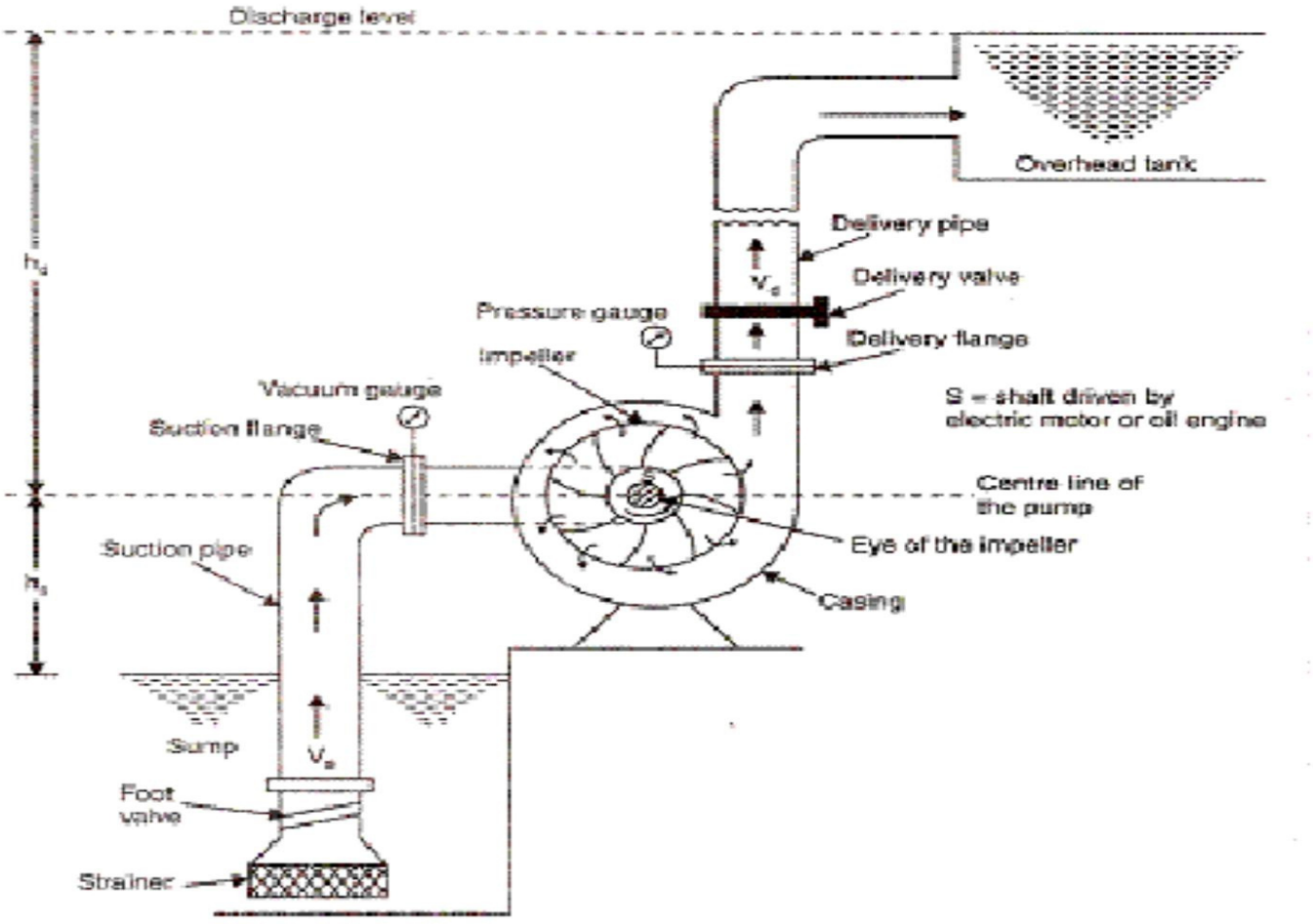
A reciprocating pump essentially consist of a piston or plunger which moves to and fro inside a cylinder. The cylinder is connected to suction and delivery tube each of which provide with a non return valve called suction valve and delivery valve. The piston connected to the crank by means of a connecting rod. Crank rotated by an engine or motor. When the crank rotates $\theta=0^\circ$ to $\theta=180^\circ$ piston moves from extreme left position to extreme right position

Working

During the motion of piston from left to right(refer fig.) a partial vacuum created inside the cylinder. Because of this low pressure water will rise from well through suction tube and fill the cylinder by forcing to open the suction valve. This operation is known as suction stroke.(motion of piston from left to right). In this stroke crank rotates θ=0˚ to θ=180˚. Also delivery valve will be closed and suction valve will be open during this stroke.

When the crank rotates from θ=180˚ to θ=360˚ piston moves inwardly from position right to left. Now piston exerts pressure on the liquid and due to which suction valve closes and delivery valve opens.the liquid is then foced up through delivery pipe. This stroke is known as delivery stroke. Now the pump has completed one cycle. The same cycle repeated as the crank rotates.

Centrifugal pumps:



The basic principle on which a centrifugal pump work is that when a certain mass of liquid is made to rotate by an external force. It is thrown away from the central axis of rotation and a centrifugal head is developed which enables it to rise to higher levels may be ensured. Since in these pumps the lifting of the liquid is due to the centrifugal action, these pumps are called centrifugal pumps. In addition to centrifugal action, liquid passes through revolving impeller, its angular momentum changes which also results in increasing the pressure of the liquid

Components and construction:

Impeller: it is a wheel or rotor which is provided with a series of backward curved blades or vanes. it is mounted on a shaft which is coupled to an external source of energy(electric motor)

Suction pipe: it is a pipe connects its upper end to the inlet of pipe and lower end dips into water

Delivery pipe: pipe which is connected at its lower end to the outlet of the pump and it delivers liquid to required height

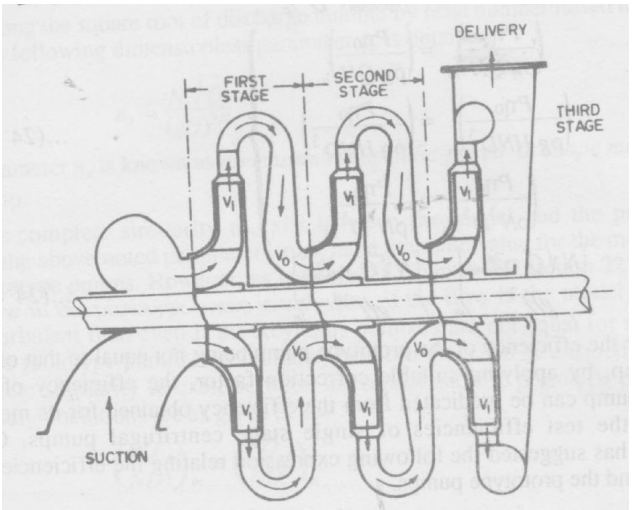
Working

The first step is priming. It is the operation in which suction pipe, casing of pump and portion of delivery tube are completely filled with the liquid which is to be pumped, so that all the air from this portion of the sump is driven out and no air pocket is left. If there is any air pocket, it result in no delivery of liquid from pump. The necessity of priming a centrifugal pump is due to the fact that the pressure generated in a centrifugal pump impeller is directly proportional to the density of fluid.

After the pump is primed, electric motor started to rotate the impeller. Due to rotation impeller rotation, produces a vortex which imparts a centrifugal head to liquid. Then the liquid starts to flow in an outward radial direction therby leaving the vanes of impeller. At the centr of impeller a partial vacuum is created , causes the liquid from sump or well to rush through suction pipe to the eye of impeller.

Multi-Stage Pump +

Normally a pump with a single impeller can be used to deliver the required discharge against a maximunhead of about 100m. but ifthe liquid is required to be delivered against a lrger head then it can be done by using two or more pums in series. This arrangement can be replaced by a multi stage pump.



A multistage pump consist of two or more identical impellers mounted on the same shaft and enclosed in the same casing. All impellers are connected in series so that liquid discharged with increased pressure.

Total head developed H= n X Hm

Where n= no of stages and Hm= head developed in each stage

Advantages of centrifugal pumps over reciprocating pumps

- Greater discharging capacity
- Centrifugal pump can pump high viscous fluids but reciprocating pumps can handle water or low viscous fluid
- Operated at very high
- Speed of reciprocating engine is limited
- Maintenance cost is low for centrifugal pump.

Pitch circle: it is an imaginary circle which by pure rolling action, would give the same motion as the actual gear

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Addendum circle: A circle drawn through the top of the teeth and is concentric with pitch circle.

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Root (or dedendum) circle: The circle drawn through the bottom of the teeth.

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Addendum: The radial distance between the pitch circle and the addendum circle.

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Dedendum: The radial distance between the pitch circle and the dedendum circle. **Clearance**: The difference between the dedendum of one gear and the addendum of the mating gear.

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Face of a tooth: That part of the tooth surface lying outside the pitch surface.

- **Flank of a tooth**: The part of the tooth surface lying inside the pitch surface. **Circular thickness** (also called the **tooth thickness**) : The thickness of the tooth measured on the pitch circle. It is the length of an arc and not the length of a straight line.

- **Tooth space**: The distance between adjacent teeth measured on the pitch circle. **Backlash**: The difference between the circle thickness of one gear and the tooth space of the mating gear.

- **Circular pitch** p: The width of a tooth and a space, measured on the pitch circle.

$$P_c = \frac{\pi}{D}$$

- **Diametral pitch** P: The number of teeth of a gear per inch of its pitch diameter. A toothed gear must have an integral number of teeth. The *circular pitch*, therefore, equals the pitch circumference divided by the number of teeth. The *diametral pitch* is, by definition, the number of teeth divided by the *pitch diameter*. That is,

$$P_d = \frac{T}{D}$$

- **Module** m: Pitch diameter divided by number of teeth. The pitch diameter is usually specified in inches or millimeters; in the former case the module is the inverse of

$$m = \frac{D}{T}$$

diametral pitch.

- **Fillet** : The small radius that connects the profile of a tooth to the root circle. **Velocity ratio**: The ratio of the number of revolutions of the driving (or input) gear to the number of revolutions of the driven (or output) gear, in a unit of time. **Pitch point**: The point of tangency of the pitch circles of a pair of mating gears.

- **Line of action**: A line normal to a pair of mating tooth profiles at their point of contact.