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International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

A Review on Centrifugal and Reciprocating Pumps

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A B S T R A C T

The main objective is to translate the fluid flow into a controlled discharge at pressure. In centrifugal pump, these are used to transport fluids by the conversion of rotational kinetic energy to the hydrodynamic energy of the fluid flow. An engine or electric motor is normally where the rotational energy comes from. They are a sub-class of dynamic axisymmetric work-absorbing turbo machinery and in reciprocating pump, collect and releases a designated amount of fluid within a piston-like mechanism. This is a reliable process that repeatedly captures a precise amount of the fluid in question.

Keywords:Centrifugal pump, reciprocating pump,

1. INTRODUCTION

A pump produces liquid movement or flow: it does not generate pressure. It generates the flow required for the creation of pressure, which is dependent on the system's fluid flow resistance.The pump is classified into two types according to operating principle. They are:

1. Centrifugal pump
2. Reciprocating pump

1.1. Centrifugal pump:

A hydraulic machine which converts the mechanical energy into hydraulic energy is called pumps. The hydraulic energy is in the form of pressure energy. If the fluid is subjected to centrifugal force, which transforms mechanical energy into pressure energy.

For better understanding the working principle of centrifugal pumps its convenient to cover the parts of centrifugal pump.

1.1.1. Components of centrifugal pump:

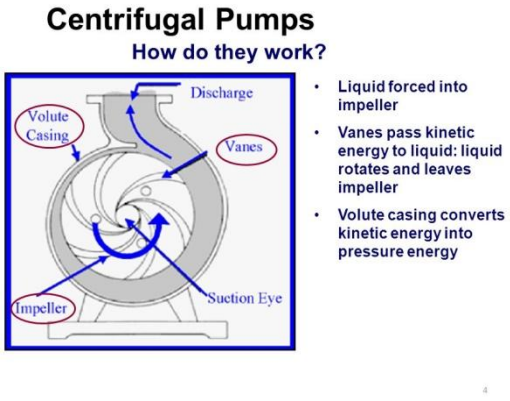

Fig 1 Centrifugal Pump

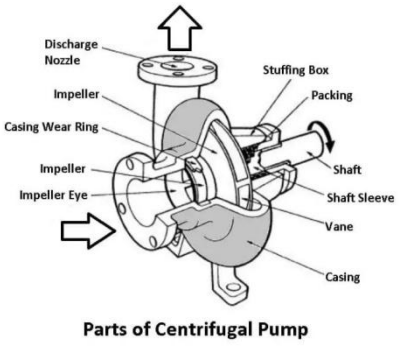

Fig 2 Parts of Centrifugal Pump

a. Impeller:

The rotating part of centrifugal pump is called impeller. It is made up of several inwardly bent vanes. The impeller is mounted on a shaft which is connected to the shaft of an electric motor.

b. Casing:

The casing of a centrifugal pump is like the casing of a reaction turbine. It is a very small passageway that surrounds the impeller and is made such that, before the water exits the casing and enters the delivery pipe, the kinetic energy of the water expelled at the impeller's outlet is turned into pressure energy. The following are the three types of the casings adopted:

i. Volute casing
ii. Vortex casing
iii. Casing with guide blades

c. Suction pipe:

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 filled 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.

d. 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. A regulating valve is provided on the delivery pipe to regulate the supply of water.

1.1.2. Working of centrifugal pump

It works on the principle that when a certain mass of fluid is rotated by an external source, it is thrown away from the central axis of rotation and a centrifugal head is impressed which enables it to rise to a higher level.It indicates that an increase in pressure head of the rotating liquid occurs when a mass of liquid is rotated by an external torque. Any point's increase in pressure head is inversely proportional to the liquid's velocity there. As a result, the pressure head rises more at the impeller's exit, where the liquid will discharge with a high-pressure head. As a result, the liquid's high-pressure head can be raised significantly. This pump is appropriate for discharges with low head. It typically appears at the top of 50 meters.

1.1.3. Efficiency of a centrifugal pump

There are three types of efficiencies. They are:

a. Manometric efficiency(η_{man})

The power at the Impeller of the pump is more than the power given to the water at outlet of the pump. The ratio of the power given to water at outlet of the pump to the power available at the impeller is known as manometric efficiency. Mathematically, manometric efficiency formula is written as:

η_{man} = manometric head / head imparted by impeller to water

$$= H_m / (V_{w2}\, u_2 / g)$$

$$\eta_{man} = g\, H_m / (V_{w2}\, u_2)$$

b. Mechanical efficiency (η_m):

Mechanical efficiency of a centrifugal pump is the ratio of the power available at the impeller to the power at the shaft of the centrifugal pump. The power at the shaft of the centrifugal pump is more than the power available at the impeller of the pump. Mathematically, mechanical efficiency formula is written as:

η_m= power at the impeller / power at the shaft

the power at the impeller in Kw

η_m= power done by impeller / 1000

$= (w/g) \times (V_{w2}\, u_2 / 1000)$

$$\eta_m = ((w/g) \times (V_{w2}\, u_2 / 1000)) / S.P$$

Where, S.P = shaft power

c. Overall efficiency (η_o):

Overall efficiency of a centrifugal pump is the ratio of the power output of the pump to the power input to the pump. The power output of the pump in kW.

Power input to the pump = Power supplied to the electric motor = S.P. of the pump

$$\eta_o = (W.\, H_m / 1000) / S.\, P$$

Therefore, $\eta_o = \eta_{man} \times \eta_m$

1.1.4. Application of Centrifugal Pump:

1. These pumps are popularly used in domestic applications like pumping water from one place to another.
2. They are also used in refrigerant and coolant recirculation.
3. This pump is also used for drainage, irrigation, and sprinkling.
4. Centrifugal pumps are widely used in gas and oil industries for pumping slurry, mud, and oil.
5. These pumps are also valuable for sewage systems.

1.2. Reciprocating pump:

In this case, the mechanical energy is converted inti hydraulic energy or pressure energy by sucking the liquid into a cylinder in which a piston is reciprocating (moving backward and forwards), which exerts the thrust on the liquid and increases in hydraulic energy, the pump is known as reciprocating pump

Fig 3 Reciprocating Pump

The reciprocating pump has been classified into two types. They are:

i. Single acting reciprocating pump:

This pump has a cylinder in which a piston oscillates back and forth. The connecting rod is used to reciprocate the piston. The revolving crank and the piston are joined by the connecting rod. An electric motor is used to turn the crank.The suction and delivery pipes with suction and delivery valve are arranged to the cylinder.

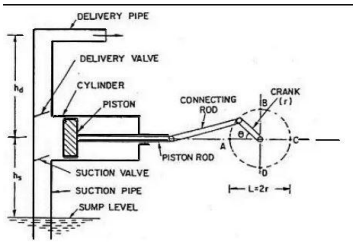

Fig 4 Single Acting Reciprocating Pump

As the crank rotates, during the first stroke of the piston (called suction stroke), the water enters the cylinder. During a suction stroke, the piston moves towards the right side of the cylinder as the crank rotates from A to C (from 0° to 180°). The cylinder creates a vacuum as a result. The suction valve opens as a result of the vacuum, allowing the water to enter the cylinder.

The water exits the cylinder during the subsequent stroke, known as the delivery stroke. During the delivery stroke, the piston moves to the left side of the cylinder while the crank rotates from C to A (from 180° to 360°). As a result, the liquid's pressure inside the cylinder rises. The delivery valve opens and the suction valve closes as a result of this pressure.Then the water is forced into the delivery pipe and raised to a required height.

i. Double acting reciprocating pump:

In this, the water is acting on both sides of the piston as shown in the figure.

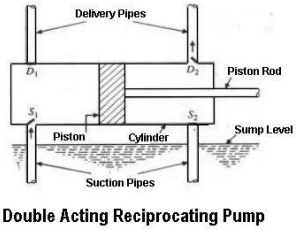

Fig 5 Double Acting Reciprocating Pump

Thus, two suction pipes and two delivery pipes are required for a double-acting pump. One side of the piston has a suction stroke, and the other side experiences a delivery stroke at the same time. As a result, there are two delivery strokes for every full rotation of the crank, and the pump delivers water to the pipes during these two delivery strokes.

1.2.1. Components of reciprocating pump:

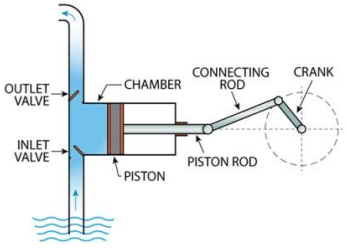

Fig 6 Piston Pump Diagram

a. Cylinder
b. Piston
c. Suction valve
d. Suction pipe
e. Delivery valve
f. Delivery pipe
g. Crank and rod mechanism operated by a power source.

1.2.2. Efficiency:

The total efficiency of a reciprocating pump is about 10 to 20 % higher than a comparable centrifugal pump.

1.2.3. Application of Reciprocating Pumps:

1. Oil drilling activities use reciprocating pumps.
2. Pneumatic pressure systems can benefit from it.
3. Mostly utilised for pumping light oil.
4. It serves as a condensate return for small boilers.

2. CONCLUSION

Centrifugal pumps have low efficiency and can run higher. A reciprocating pump has high efficiency and is unable to run at higher speeds. Centrifugal pumps require less maintenance costs as compared to reciprocating pumps.

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