What is a piston pump? its working, types, advantages & disadvantages with PDF

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The pumps have become a most vital part of all household and industrial applications. Multiple types of pumps are available in the market, and **piston pump** is one of them. Piston pumps use a piston for fluid compression. This article mainly explains various aspects of the piston pump.

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What is a Piston Pump?

The pump which uses a piston to pump the fluid from one place to the other is known as a piston pump. It is a famous type of reciprocating pump. In this pump, the piston moves up and down in the compression cylinder. This piston is connected with a crankshaft which gets power by the electric motor and drives the piston.

The piston pump contains inlet and outlet check valves, connecting rods, crankshaft, and a piston. The hand pump is the most common example of the piston pump. The hand pump uses a piston to suck and draw water.

This piston is linked with the handle of the pump. As the handle moves down, it forces the piston to move down and sucks water into the cylinder.

Similarly, when the handle operates moves the handle up, the piston also moves up, opens the discharge valve, and discharges the water.

Working of the Piston pump

A piston pump works on the positive displacement principle. A piston pump works in the following way:

- First of all, an electric motor or engine supplies power to the crankshaft.
- As the crankshaft gets power, it turns and delivers its rotary motion to the connecting rod.
- The connecting rod receives rotary motion by the crank, transforms it into the reciprocating motion, and sends this reciprocating motion to the piston.
- As the piston receives reciprocating motion, it starts moving in a downward direction (from TDC to BDC).
- During this downward motion, the piston creates a vacuum inside the pump cylinder.
- A pressure difference between the cylinder's inner pressure and outer pressure creates due to the creation of a vacuum.
- As the cylinder's inner pressure becomes lower than the pressure of the reservoir, the inlet valve opens, and fluid starts entering into the cylinder.
- As the suction process completes, the inlet valve closes, and the piston starts moving upward for pressurizing the fluid.
- During the piston's upward motion, the cylinder inner area starts decreasing due to that fluid compresses.
- During the compression process, the pressure and temperature of the fluid become very high.
- As the fluid pressure becomes equal to the desired pressure, the discharge valve opens, and fluid is transferred to the desired place.
- After this first stroke of the piston, the crank again forces the piston to move downward, and the whole process repeats.

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Types of Piston Pumps

The piston pump has the following major types:

1. Lift piston pump
2. Force piston pump
3. Axial piston pump
    - Straight axis piston pump
    - Bent axis pump
4. Radial piston pump

1) Lift Piston Pump

This type of piston pump works by drawing fluid from the suction valve to the bottom section of the cylinder. During the upward stroke, the piston moves upward thus creating suction. This causes the fluid to enter the cylinder through the valve.

Now during the downward stroke, the piston moves downward creating pressure on the fluid. There are valves present in the piston that let the fluid pass through the piston to the other side.

Again during the upward stroke, the fluid in the upper part of the cylinder is forced out whereas, in the lower part of the cylinder, the fluid is drawn in.

Thus it takes 3 strokes of the piston to pull and deliver the fluid.

This is how the lift piston pump works.

2) Force Pump

The working of the force pump is very identical to the lift pump. In this pump, the upward motion of the piston sucks fluid into the cylinder via an inlet valve. After the compression process, the downstroke expels the fluid from the pump into the discharge pipe via an outlet valve.

The **main difference between a forced pum**p and a lift pump is that the lift pumps require an **additional upstroke** to discharge the fluid, while a force pump doesn't require this additional stroke.

The force pumps need only one upward stroke to suck the fluid and one downward stroke to discharge it. The power pump only needs one upstroke to fill in water and one downstroke to expel the medium.

The lift pumps discharge the fluid with the **second upstroke** while a force pump discharges the fluid with the **first downstroke.**

The well-known "hand pump" is a type of force piston pump.

3) Axial Piston Pump

This pump has a series of pistons that are settled parallel to the drive crankshaft. The axial pumps can use as fixed or variable displacement pumps.

In these pumps, the cylinder and pistons alternate around the central vertical axis. The shoe and pistons reciprocate inward and outward the cylinder as they slide on a fixed swash plate with a variable angle.

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When the piston rotates, it alternates between suction and discharge valves. When the piston passes through the suction valve, the liquid is introduced into the cavity of the piston. As it moves over the discharge valve, it drains liquid from the piston cavity.

The rotation speed of the piston regulates via the mechanical rotation input of the crankshaft. The amount of liquid sucked inside the compression cylinder during piston rotation is regulated via the swash block angle.

The axial piston pumps can be further classified as:

- Straight axis piston pump

- Bent axis piston pump

4) Radial Piston Pump

Radial piston pumps have a series of pistons in a cylindrical block that surrounds the rotor hub. The cylinder consists of a shaft, a piston, and a rotor. The pintle moves the fluid in and out of the cylinder.

Image source – Hydrowatt

The rotor is eccentrically attached to the pump housing. As the piston rotates in and out of the cylinder, hydraulic oil is drawn into the cylinder cavity and drained from the cylinder cavity.

The pump inlet and outlet are located in the valve on the central shaft. Each piston connects to the inlet when it begins to expand and to the outlet when it contracts.

Radial piston pumps are used in applications with high pressures (working pressures from 400 bar to over 700 bar) such as presses, machines for processing plastics, machine tools for maintaining the oil pressure.

They have many advantages, such as high efficiency, high-pressure capacity up to 1,000 bar or 14,000 psi, low flow and pressure fluctuations, low noise development, very high load at minimum speed, high reliability, and much more.

The disadvantage is that it is more significant than an axial pump due to its large radial dimensions and is therefore not always available in applications with limited space.

Advantages of Piston Pumps

1. These pumps have a wide range of pressure.
2. These have capability to move sludges and high viscosity fluids.
3. They don’t need priming.
4. Priming is not required in this pump.
5. They are most efficient than plunger pumps.

Disadvantages of Piston Pumps

- These pumps provide pulsating fluid.
- They have lower power than centrifugal pumps.
- These have high maintenance cost.
- These cant handle lesser flow.

Applications of Piston Pumps

1. The piston pumps are used to handle very low flow at high pressure.
2. These pumps are used to deliver high viscosity fluids.
3. They use to pump hydraulics oil.

4. The piston pump also uses for high pressure cleaning.
5. These pumps use for industrial processing devices.