

Classification positive displacement non positive displacement engineering essay



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A reciprocating pump is a positive displacement plunger pump which is often used where relatively small quantity of liquid is to be handled and where delivery pressure is quite large.

A reciprocating pump is consists of a piston moving to and forward in a cylinder. The piston is driven by a crank shaft giving the power by prime mover such as an electric motor. Small portable reciprocating pumps may be hand operated.

The reciprocating pumps are operating by using a reciprocating piston or diaphragm and the liquid enters a pumping chamber through an inlet valve and is pushed out through an outlet valve by the action of the piston or diaphragm. They are very efficiency and ideal for high heads at low flows.

There is another option that can be done by this reciprocating pump which is it can draw liquid from the lower place from the pump and it can suction without the suction pipe. It delivers discharge flow and it is more efficiency compare to the other pumps which also not tolerate to the other particles. Using accumulators it can provide even more smooth flow without providing flows.

Most of the reciprocating pumps designed for delivering high pressures must include methods for releasing excessive fluid pressures. The pumps include for built in relief valves or relief valves should be included in the fluid circuit which can't be isolated from the pump. This feature is not required for safety for the air operated diaphragm valve.

Piston Pumps /Plunger pumps

Piston pump or plunger pumps can be described as a single piston or parallel pistons. Using the crankshafts or cam these pistons can be driven and stroke is generally adjustable. And also these pumps can be delivering up to 100 bars even largest sizes of pistons pumps deliver the flow rate of 40m³ per hour. Metering the flow rate fluids at an average pressures are one of the methods that can be done using this option in chemical process plant and lab works. By using these pumps explosive media or transferring toxic is not suitable.

There are two main of suctions in both pumps which are single acting independent suction which discharge strokes and double acting discharge stroke which discharge in both ways. Air, steam or electric motor is one the power we can use to operate the pump. Now a days reciprocating pumps are used for pumping highly viscous fluids such as concrete and heavy oils and some applications like low flow rate against high flow rate.

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Field of applications

Reciprocating pumps are designed for reliable high energy and heavy duty service in some special applications which each pump is engineered to provide more operation over twenty year design life with maintenance.

There are several of hydraulic, materials and mechanical options available at present. These pumps can be constructed to get specific characteristics of most of the applications such as abrasive slurries and high viscosity liquids which is more valuable for flexibility and we can reduce the cost as well.

Applications

There are some main applications in reciprocating pumps which we can divided into some categories as below

Oil and gas production, pipeline, chemical processing primary metal processing refinery, power mining, hydro testing and general industry.

The main applications of the reciprocating pump are the light oil pumping, feeding small boiler condensate return and pneumatic pressure system.

Classification

According to the water being in contact with piston we can divide as,

Single acting pump

Double acting pump

According to the no of cylinders we can divide as,

Single cylinder pump

Double cylinder pump

Triple cylinder pump

The main parts of a Reciprocating Pump (Fig 1)

A cylinder with Piston, Piston rod, Connecting rod and a crank

Suction pipe

Delivery pipe

Suction valve

Delivery valve

C: UsersKalanaDesktoppump (1). gif

Figure 1

Working of the Reciprocating pump

The piston reciprocates in a cylinder

The movement of the piston is obtained by the crank and connecting rod mechanism

The suction pipe connects the liquid source (pump) and the cylinder

The delivery pipe connects the cylinder and the pump outlet

The suction valve admits the flow from the suction pipe into cylinder

The delivery valve admits the flow the cylinder into the delivery pipe

Single – Acting pump

In this pump, liquid acts on one side of the piston only

It has only one suction pipe and one delivery pipe

It is usually placed above the liquid level in the sump

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Figure 2

Figure 3

Suction stroke

Initially the crank is at the inner dead centre (IDC) and the crank rotates in the clockwise direction

When the crank rotates clockwise from inner dead centre to outer dead centre (ODC) the piston moves outward to the right and a vacuum is created on the left side of the piston

This vacuum causes a suction valve to open and liquid is forced from the sump into the left side of the piston

When the crank is at outer dead centre, the suction stroke is completed and the left side of cylinder is full of liquid

Figure 4

Double acting pump is more complex design which the piston can discharge the fluid during both forward and back stroke as well as which result nearly twice the flow per cycle.

Delivery stroke

The crank rotates from ODC to IDC the piston moves inward to the left and a high pressure is built up in the cylinder

The increased pressure causes a suction valve to close and the discharge valve open

Thus the liquid is carried to the discharge tank through the delivery pipe

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The delivery stroke is completed when the crank occupies the IDC position

In the same way, the suction and delivery strokes are carried out alternatively and thus the liquid is pumped from the sump to the discharge tank.

Figure 5

Working of Double – Acting Reciprocating Pump

In this pump, the liquid is acting on both sides of the piston

They require two suction pipes and two delivery pipes

The right side of the cylinder having the piston rod is known as crank end

The left side of the cylinder known as cover end

Figure 6

Forward stroke

When the crank rotates from IDC to ODC (0 to 180) a vacuum is created on the cover side of and the liquid is sucked from the sump through suction valve suction 1.

At the same time, the liquid on the right side of the piston is pressed and high pressure causes the delivery valve D2 to open and the liquid is passed on the discharge tank.

The operation continues till the crank reaches ODC.

Return stroke

When the crank rotates from ODC to IDC (180 to 360) the liquid is sucked in from the sump through the suction valve S2 and is delivered to the discharge tank through delivery valve D1

When the crank reaches IDC, the piston is in the left extreme left position and thus one cycle of operation is completed

Thus for one complete revolution of the crank there are two delivery strokes and liquid is delivered to the pipes by the pump during these two delivery strokes.

Slip of Reciprocating Pump

Slip of a pump is defined as the difference between the theoretical discharge and actual discharge of the pump.

Percentage slip is given by

C_d is called co-efficient discharge.

Negative slip of reciprocating pump

If the actual discharge is greater than the theoretical discharge, then the slip of the pump is negative

Negative slip occurs when delivery pipe is short, suction pipe is long and pump is running at high speed.

Dual Piston Pumps

Dual piston pumps are more efficiency. They can provide a stable and pulse free flow. These pumps are use of dual handed reciprocating pumps. Using a same motor these pump chambers can be driven via common eccentric cam which allows one piston to the other piston while other is refilling. Because of that the two flows are overlap each other by reducing the pulsation downstream of the pump.

These pumps use eccentricity shaped cams to obtain the best overlapping of the pressure curves and to obtain smooth flow. http://hplc.chem.shu.edu/NEW/HPLC_Book/Instrumentation/dpist_pm.gif

Figure 7

Options and Technical data

Materials Options

- Carbon, alloy and stainless steels
- High-strength bronzes
- Duplex and super duplex stainless steels
- Light reactive alloys

Sealing Options

- Spring loaded packing
- Vaporous box
- Flushed box

- Lubricated box
- Atmospheric contamination protection designs

Power End Options

- Splash lubrication
- API 674 lubrication oil system
- Forced feed lubrication
- Gravity feed lubrication
- High-suction pressure fit

Drive Options

- Gear
- V-belt
- Variable speed

Driver Options

- Electric motor
- Engine
- Turbine
- Hydraulic motor
- Top mounted motor

Efficiency

There are two main efficiency concerns about in pumps. They are volumetric efficiency and mechanical efficiency.

Volumetric efficiency

This type of efficiency is a percentage of the theoretical pump flow which is measure of pump's volumetric losses.

Volumetric efficiency =

Mechanical efficiency

Mechanical efficiency is an efficiency which compared the theoretical horsepower with the operating horse power. It is also known as the amount of energy loss in a hydraulic component.

The efficiency of a pump in general we can mentioned as below

Efficiency =

Using the volumetric flow rate and head of the pump we can draw a graph and find out the efficiency of a pump as below. By plotting system demand and pump characteristic on the same graph, we can find out operating point. By using that operating point pump efficiency can be determined.

Losses

In this reciprocating pump, there are two main efficiency losses. They are volumetric losses and mechanical losses.

There are two main heads in a pump. They are static head and demand head. The main losses are obtained because of the losses of these two main things. Volumetric efficiency loss is induced by slippage through valves, ratio of liquid chamber volume at end of stroke to plunger or piston displacement volume, and liquid compressibility.

Mechanical efficiency loss occurs while overcoming mechanical friction in bearing and speed reduction.

When we talk about the overall efficiency we can say that in general these reciprocating pumps has got 85 percentages of overall performance thoughts the whole operating system but it can't operate more than 90 percentages because most of the pumps in mechanical industry operate below 90 in practically but volumetric efficiency can be higher than 90% of the overall performance.

Advantages / Disadvantages

There are some advantages as well as disadvantages in reciprocating pumps which are the unlimited solvent reservoir allowing long term unattended use and quick changeover and clean out capability. But in manufacturing process we have face some disadvantages such as cost of the product can be higher compare to the other pumps in the market. Labour cost goes into to be adding to the product so the product price going to be increased.

These pumps enable charged and dirty liquids to be processed without need for fine filtration to protect the reciprocating pump.

It needs little maintenance and can operate at continuous duty at high pressure.

Pulsation is low, so dampeners may not be required for most reciprocating pumps

Reciprocating pumps can handle solids up to 500 microns or more. They can be pumped without fine filtration. System costs are reduced and maintenance is simplified.

Most pumps can operate at any pressure from 1 bar up to at least 70 bars. Some are up to 170 bars.

Reciprocating pumps are tolerant of small solids, resistant to chemical and corrosive attack.

Energy savings. Compact and highly efficient (80-85%). These pumps can be fitted with a smaller motor than would be required by many much bigger reciprocating pumps for equivalent flows and pressures.