Mechanical Engineering Fundamentals

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Mechanical Engineering Fundamentals

(MEC103)

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Content

1) Fundamental Concepts of Thermodynamics
2) Laws of Thermodynamics
3) Pressure and its Measurement
4) Heat Transfer
5) **Power Absorbing Devices**
6) Power Producing Devices
7) Principles of Design
8) Power Transmission Devices and Machine Elements

Lecture No. - 2

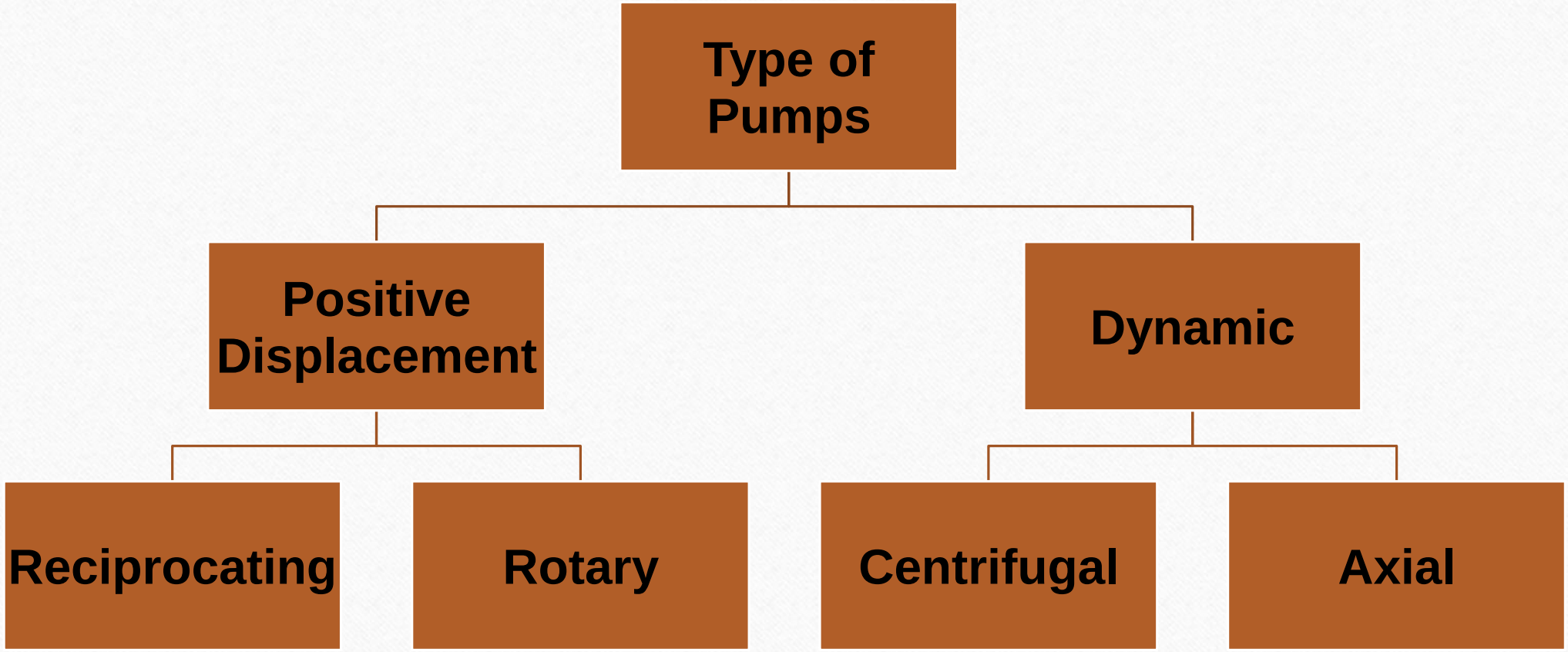
- Positive displacement Pumps

Power Absorbing Devices

The equipment's or devices that consume power for the working are called power absorbing devices.

Examples: Pumps, Compressor, Refrigerators etc.

Classification of Pumps

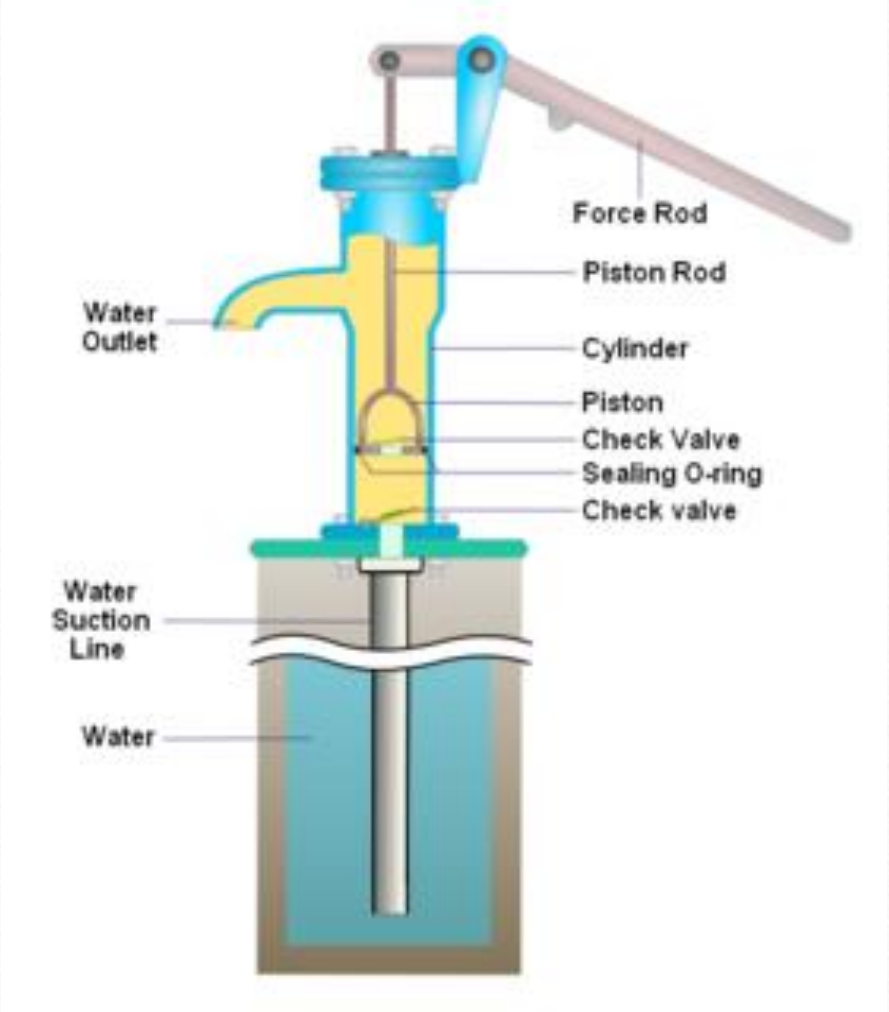


Positive Displacement vs Dynamic Pumps

S. No.	Parameter	Positive Displacement Pumps	Dynamic Pumps
1	Flow Rate	Low flow rate	High flow rate
2	Pressure	High	Moderate
3	Priming	Very Rarely	Always
4	Viscosity	Virtually No effect	Strong effect
5	Energy added to fluid	In positive displacement pumps, the energy is added periodically to the fluid.	In dynamic pumps, energy is added to the fluid continuously through the rotary motion of the blades.

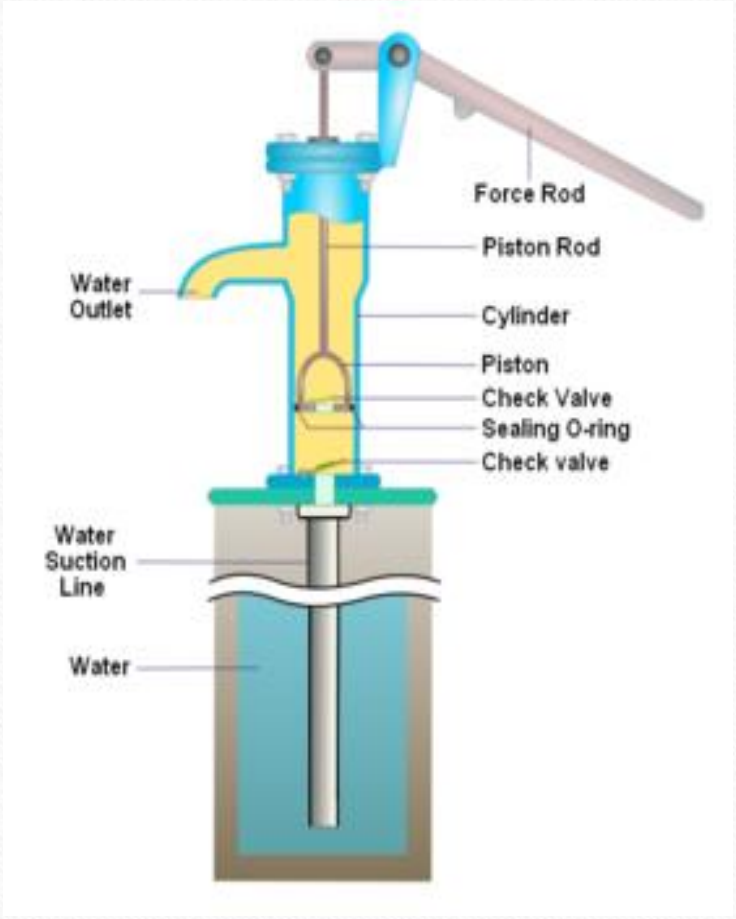
Reciprocating Pump

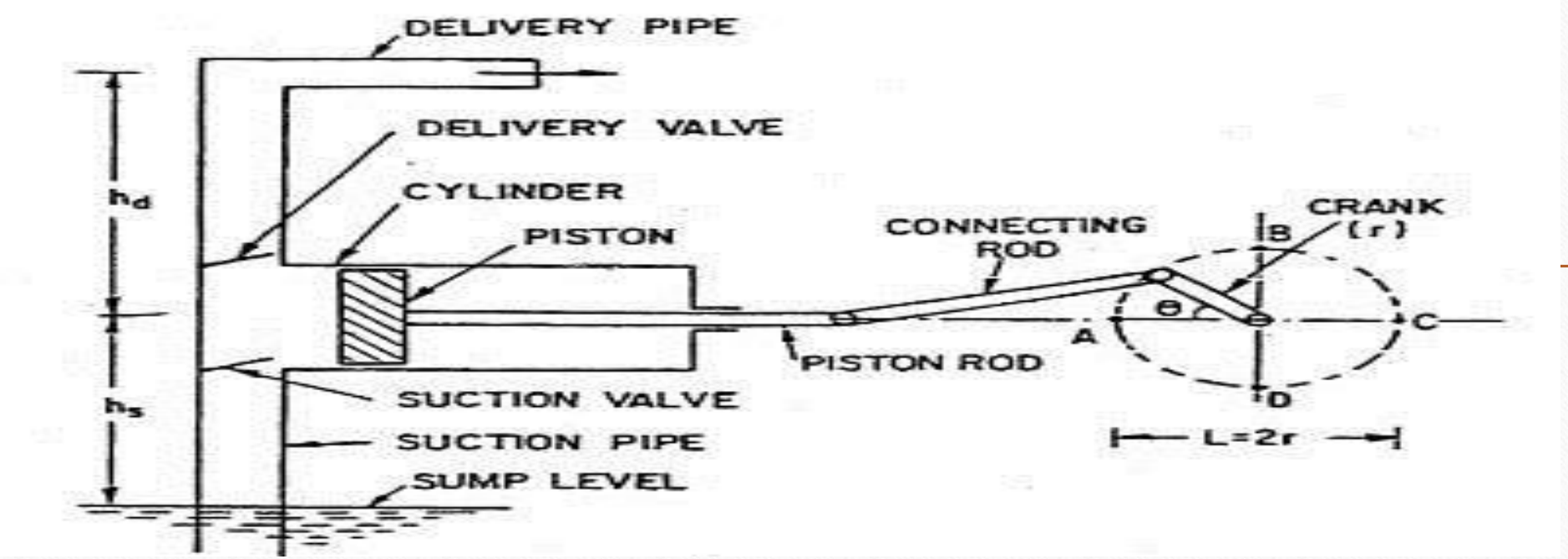
- Reciprocating pumps are positive displacement pumps thus for the functioning of these pumps **no priming** (No need to fill the cylinder with liquid before starting) is required in their starting.
- High pressure is the main characters of this pump.



Reciprocating Pump

- In reciprocating pumps, the chamber in which the liquid is trapped or entered, is a stationary cylinder that contains piston or plunger or diaphragm.
- Reciprocating pumps are used in limited applications because they require lots of maintenance.
- Piston pump, plunger pumps, and diaphragm pumps are examples of reciprocating pump.





Following are the parts of the reciprocating pump:

- Cylinder/piston or plunger or diaphragm
- Suction Pipe
- Delivery Pipe
- Suction/inlet valve
- Delivery/discharge valve

- **Note:** It is to be noted that the reciprocating pump is a positive displacement pump which means that the fluid can only move in one direction and can never reverse back.
- So due to this the pump is always started with the **outlet valve open otherwise** the pressure will keep on building and this will lead to rupture of the pipeline or even the pump itself. But if relief valve is fitted then this pressure will come down.

Reciprocating pumps are available in many configurations

- The four most widely used are horizontal, vertical, horizontal balance-opposed and tandem
- Air-cooled or water-cooled
- Lubricated and non-lubricated
- May be packaged
- Provide a wide range of pressure and capacity selections.

Uses of Reciprocating Pump

- Reciprocating positive displacement pumps are widely used in chemical, cosmetic, petrochemical, refinery, pharmaceutical, food industry and water treatment industry where a high degree of accuracy and reliability under a range of conditions are required.

Advantage and Disadvantages of Reciprocating Pumps

Advantages of Reciprocating pump

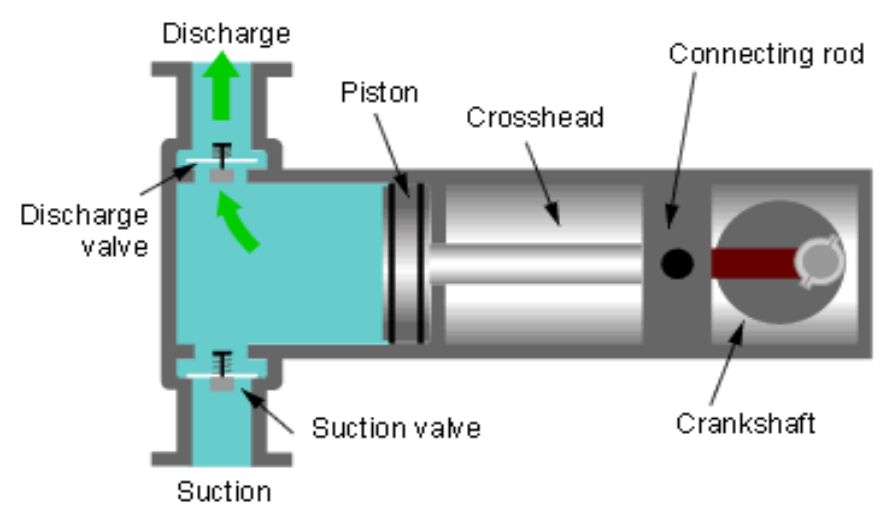
- Gives constant discharge.
- Gives high pressure at the outlet.
- Gives high suction lift.
- Priming is not required in this pump.

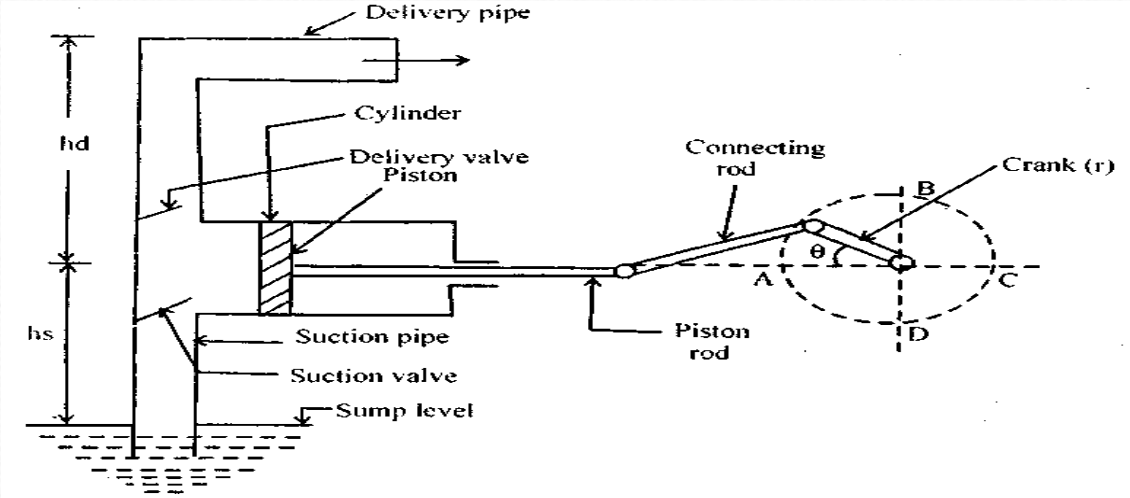
Disadvantages of Reciprocating pump

- High wear and tear, so requires a lot maintenance
- The flow is very less and cannot be used for high flow operations.
- More heavy and bulky in shape.
- Require large space for installation.
- The initial cost is much more in this pump.

Reciprocating Pump
1. Piston Pump

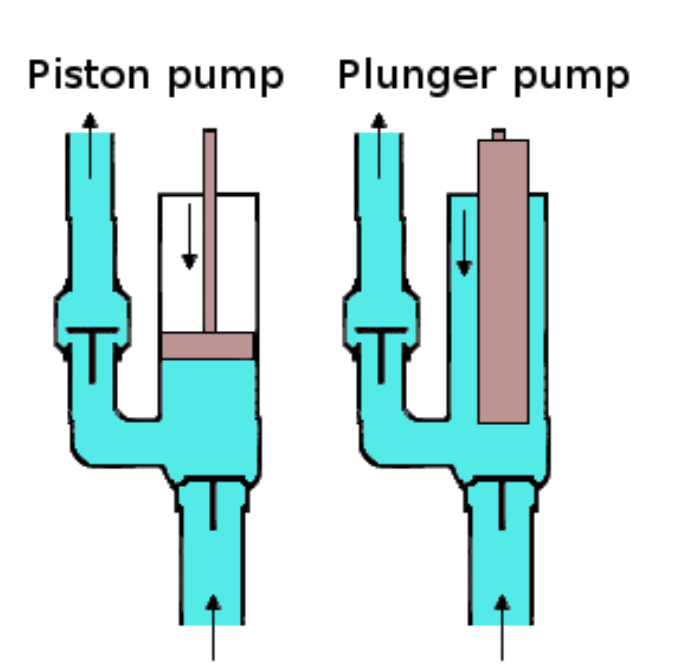
A Piston Pump is a type of reciprocating pump. The construction and working of piston pump is same as discussed in reciprocating pump. **The basic pumping action in piston pump is obtained by reciprocating motion of a piston in a cylinder.**





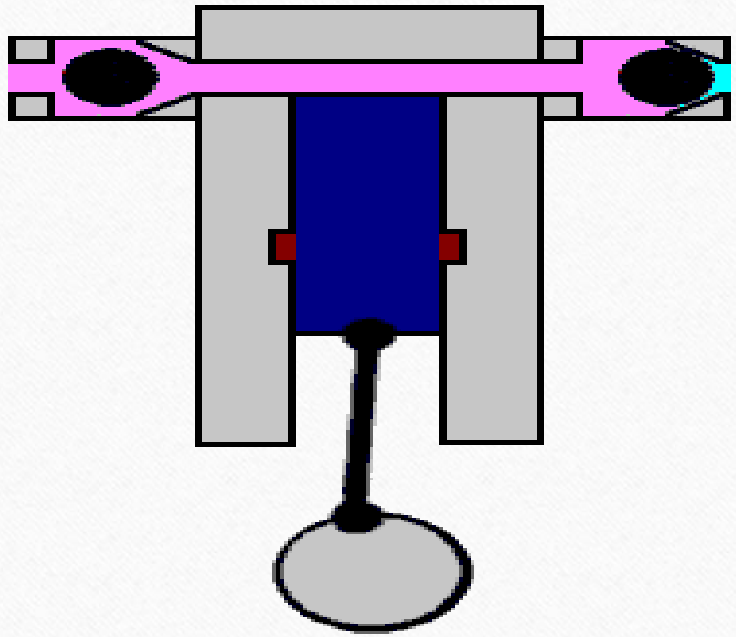
2. Plunger Pump

- A Plunger Pump is also a type of reciprocating pump.
- There is no difference between piston pump and plunger pump except that in a plunger pump, plunger or ram is used in place of piston.
- Plunger pumps are generally used for **rough work** and can produce pressures up to **200MPa,** while piston pumps produce pressure at a maximum of **150Mpa.**



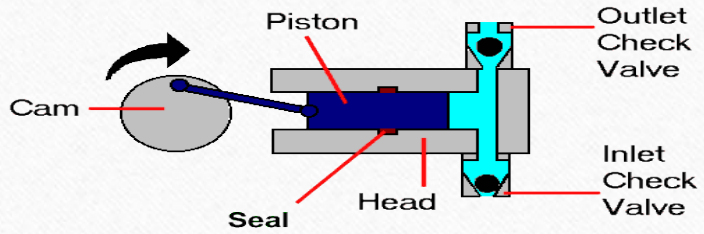
Single Acting Piston Pump

- It contains single suction and single delivery pipe in single cylinder.
- In single acting piston pump only one side of the piston have liquid chamber and the valve arrangement and the liquid is discharged from that side of the cylinder once in a crankshaft cycle i.e. only in the forward stroke of the piston.



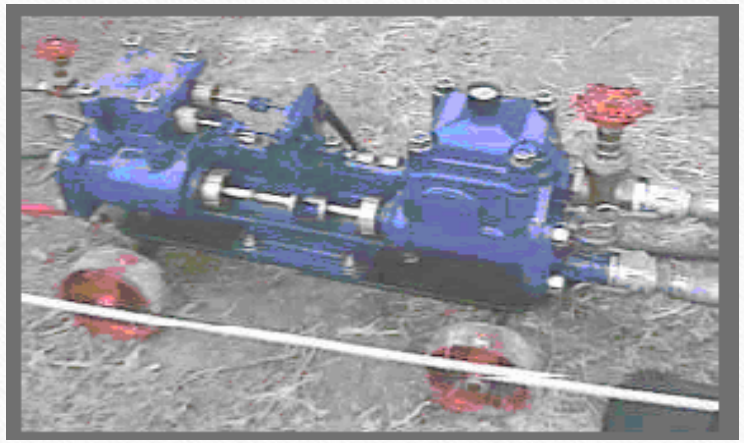
Single Acting Pumps are of different types:

- **Single Acting- Simplex Pump**



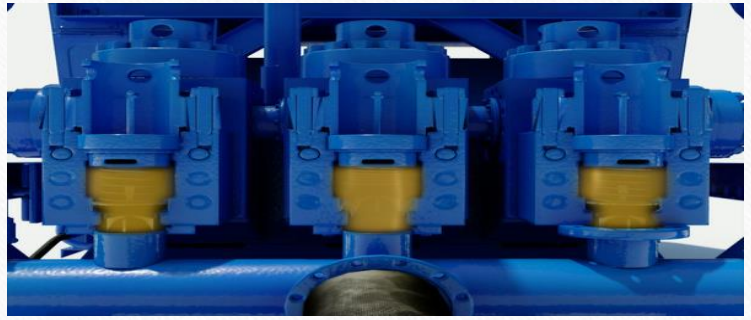
- **Single Acting- Duplex Pump**

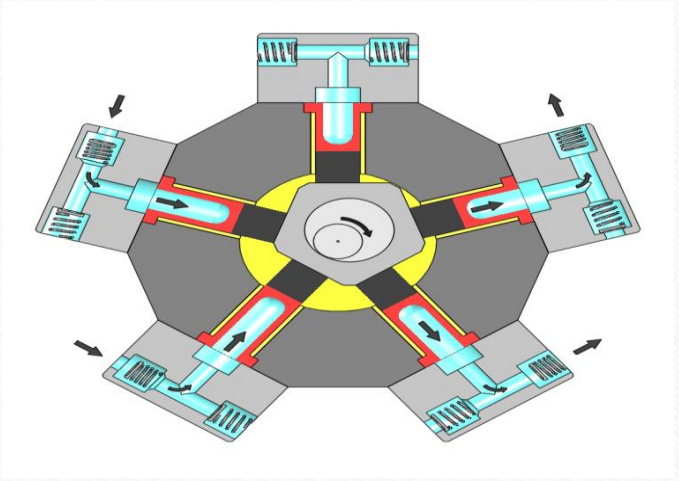
  (Two single acting cylinders connected with single crank shaft).



Single Acting Pumps are of different types:

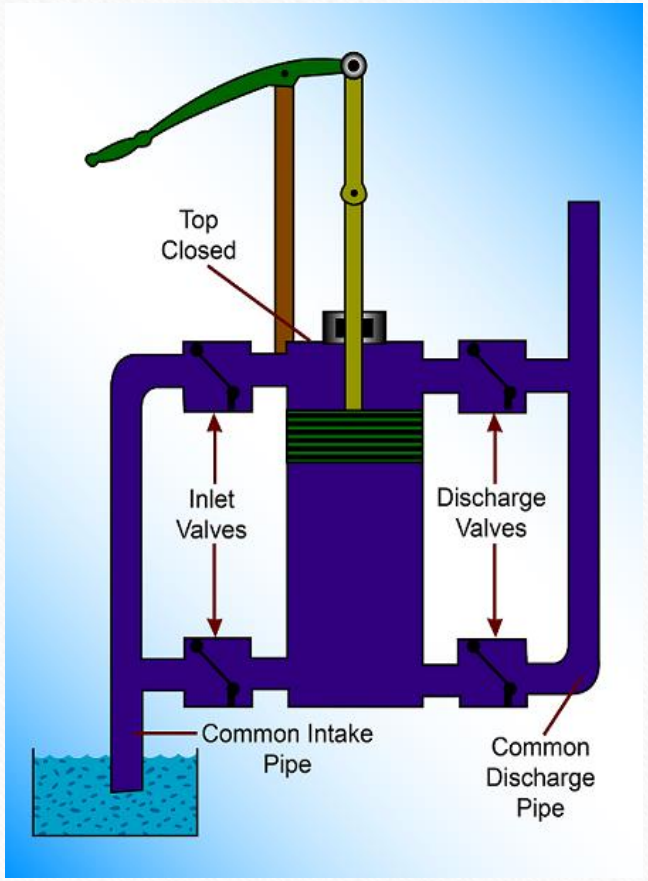
- **Single Acting- Triplex Pump** (Three single acting cylinders connected with single crank shaft).
- **Single Acting- Multiplex Pump** (Multiple single acting cylinders connected with single crank shaft).





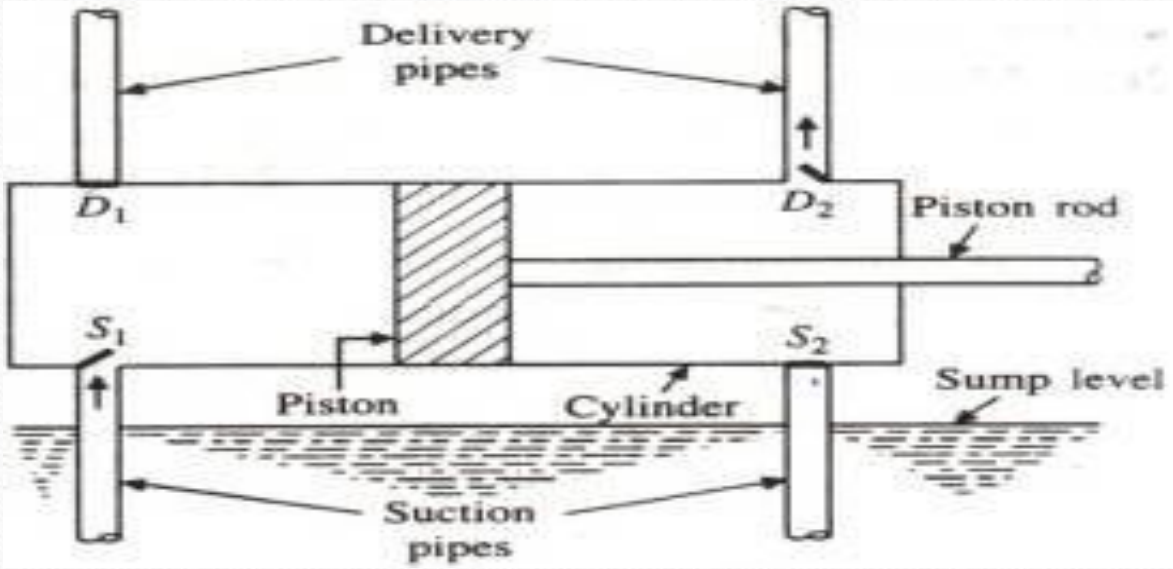
Double Acting Piston Pump

- It contains two suction and two delivery pipes in single cylinder.
- In double acting piston pump both sides of the piston have liquid chamber and the valve arrangement.
- Liquid is discharged from both the sides from one side in the first half of the cycle and from the other side in the second half of the crankshaft cycle.



Double Acting Piston Pump

- As the liquid is discharged in both the forward and backward stroke, **the discharge is more per cycle and also smooth as compared to the Single Acting pump.**

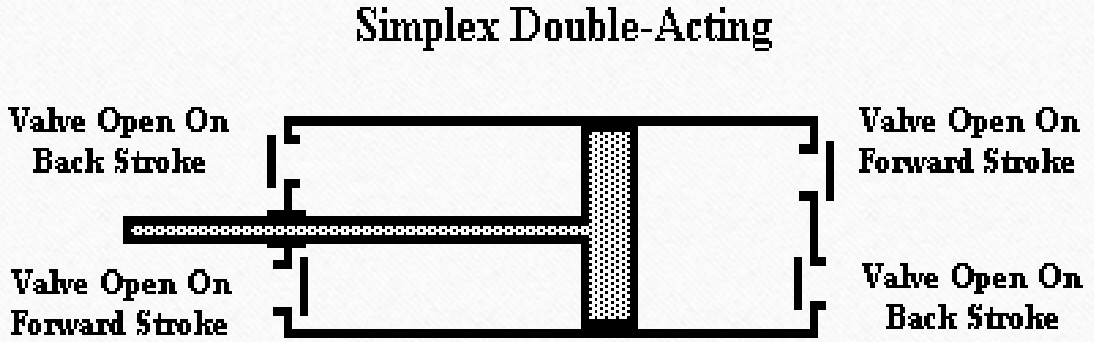


Double Acting Pumps are of different types

- Double Acting-Simplex Pump (Single double acting cylinder)
- Double Acting-Duplex Pump (Two double acting cylinder)
- Double Acting-Triplex Pump (Three double acting cylinder)
- Double Acting-Multiplex Pump (Multiple double acting cylinder)

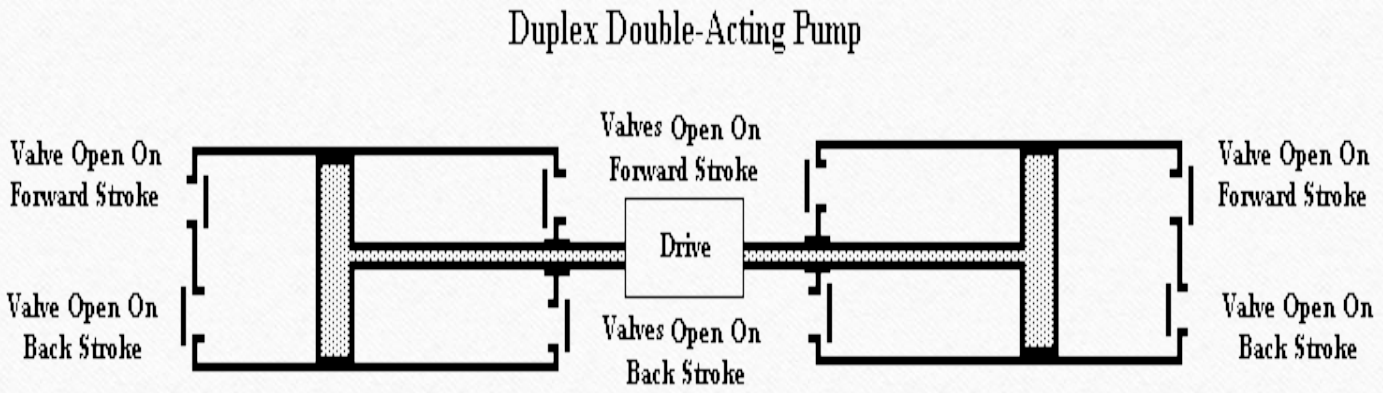
Double Acting-Simplex Pump (Single double acting cylinder)

- There is one piston-cylinders assembly.



Double Acting-Duplex Pump (Two double acting cylinder)

- There are two piston-cylinders assemblies. Both the pistons are coupled to the single crankshaft through separate connecting rod of each.
- The connecting rods are coupled to the crankshaft at an angular distance of 180 degrees from each other.



Double Acting-Triplex Pump (Three double acting cylinder)

- There are three piston-cylinder assemblies. All the three pistons are coupled to the single crankshaft through the connecting rod of each.
- There is an angular separation of 120 degrees between any two adjacent connecting rod and crankshaft couplings.

Double Acting-Multiplex Pump (Multiple double acting cylinder)

- There are multiple piston-cylinder assemblies. All the pistons are coupled to the single crankshaft through the connecting rod of each.

3. Diaphragm Pump

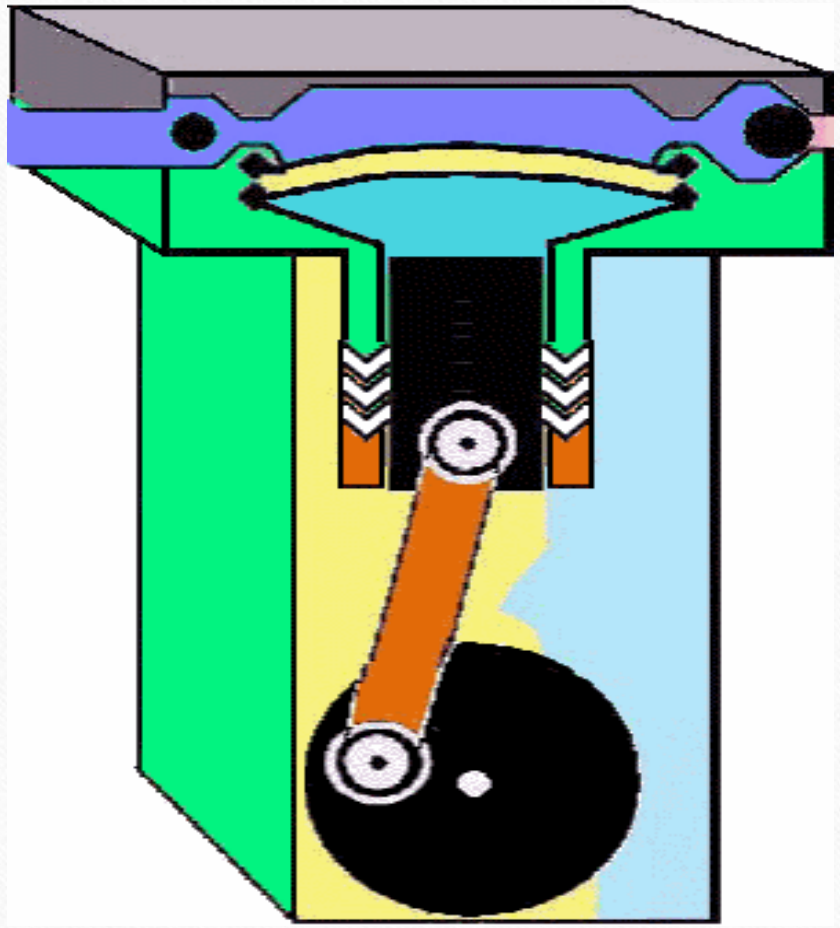
- A diaphragm pump is a type of reciprocating pump. The basic pumping action in obtained by the reciprocation of diaphragm in the cylinder.
- This pump is sometimes referred to as a membrane pump or air operated diaphragm pump or pneumatic diaphragm pump.
- Diaphragm pumps are self-priming and are ideal for viscous liquids.
- The diaphragm can be actuated by liquid or air. Accordingly pumps are called as hydraulically operated or air operated diaphragm pumps.

Characteristics of Diaphragm pump

- Good suction characteristics, some are **low pressure pumps with low flow rates**; others are capable of higher pressure, dependent on the effective working diameter of the diaphragm and its stroke length.
- Good dry running characteristics.
- Good efficiency.
- Self-priming capability.
- Capable of handling handle highly viscous liquids.

Construction and Working of the Diaphragm Pump

- The diaphragm has driving hydraulic fluid one side and the liquid to be pumped on the other side.
- The piston pumps the driving fluid which moves the diaphragm up and down and in turn pumps the liquid on the other side.
- The arrangement of valves and their functioning is same as that in the piston or plunger pumps.
- The diaphragm is coupled to an actuating part which moves the diaphragm.



- The diaphragm is reciprocated by the action of hydraulic fluid and the fluid itself is pumped by a reciprocating piston or plunger. Thus, one piston pump is making the other diaphragm pump work.
- In the downward stroke, the suction created in the pump chamber causes the inlet valve to open, allowing flow into the chamber.
- In the upward stroke, the pressure caused by the rising diaphragm causes the outlet valve to open, allowing flow out of the chamber.
- This arrangement avoids any contact between the pumping element and the liquid pumped.
- **This avoids leakage and makes the pump suitable for handling expensive, explosive or toxic liquid**.

THANK YOU