Def:

The hydraulic machines which Convert the mechanical energy into hydraulic energy are Called pumps.

Mechanical Energy → Hydraulic Energy.

✓ Hydraulic energy is in the form of Pressure energy.

Major types:

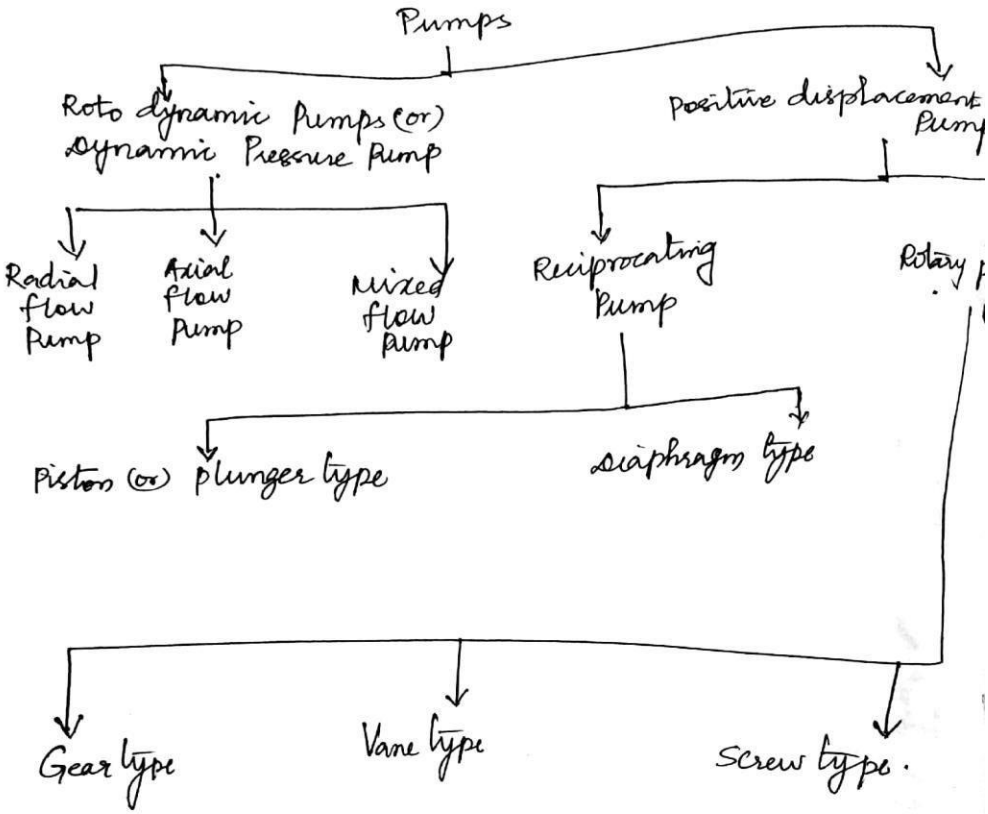
1. Centrifugal pump

when the mechanical energy is Converted into Pressure energy by means of Centrifugal force acting on the fluid, the hydraulic m/c is Called Centrifugal pump.

2. Reciprocating pump.

Mechanical Energy is Converted into hydraulic energy or Pressure energy by Sucking the ligiid into a cylinder in which a piston is reciprocating (moving backwards and forwards), which exerts the thrust on the liquid and increases its hydraulic energy (Pressure energy)

Classification of pumps:
According to the design and principle of operation, Pumps are classified as follows.



- The Centrifugal pump acts as a reverse of an inward radial flow reaction turbine.
- The flow in centrifugal pumps is in the radial outward directions.
- The Centrifugal pump works on the principle of forced vortex flow which means that when a certain mass of liquid is rotated by an external torque., the rise in Pressure head of the rotating liquid takes place.
- The rise in Pressure head at any point of the rotating liquid is proportional to the square of tangential velocity of the liquid at that point

  Rise in Pressure head $= \frac{V^2}{2g}$ (or) $\frac{w^2 r^2}{2g}$

- Thus at the outlet of the impeller, where radius is more, the rise in pressure head will be more and the liquid will be discharged at the outlet with a high pressure head.
- Due to this high Pressure head, the liquid can be lifted to high level.

MAIN PARTS OF A CENTRIFUGAL PUMP

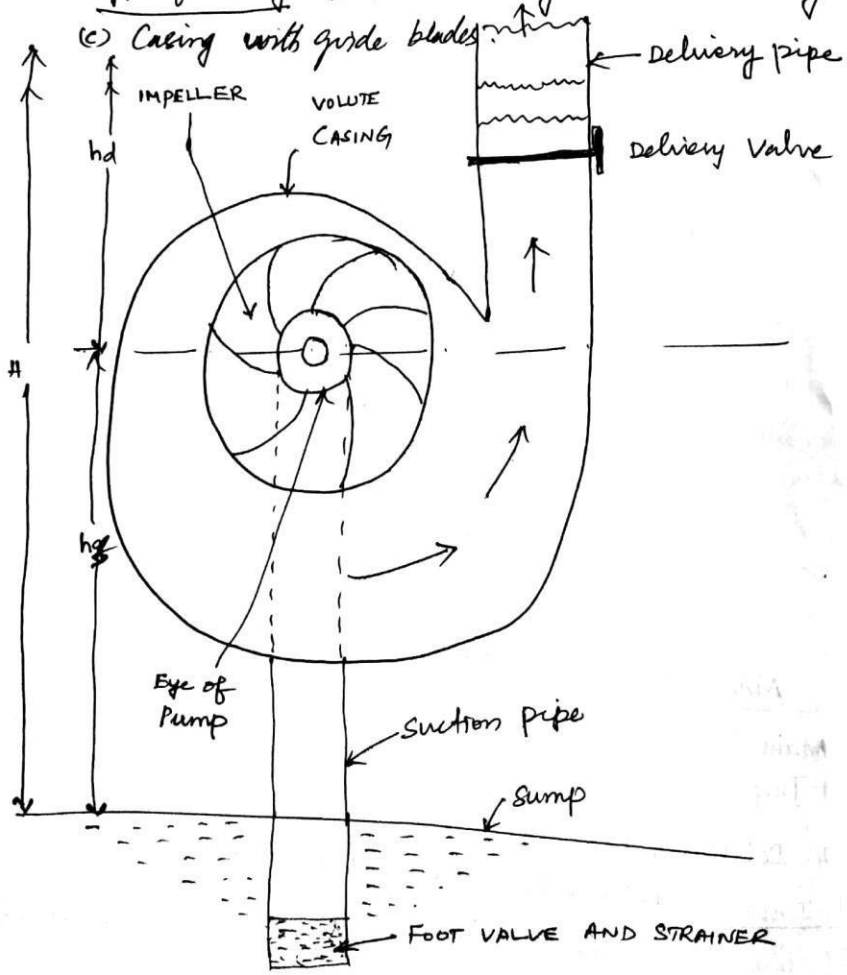
Main Parts:
1. Impeller 2. Casing 3. Suction pipe with a foot valve a Strainer
4. Delivery pipe.

1. Impeller: Rotating Part of a Centrifugal pump is Called impeller It Consists of a backward Curved Vanes. The impeller is mounted

on a shaft which is connected to the shaft of an electric motor.

2. Casing: It is similar to the casing of a reaction turbine. It is an air-tight passage surrounding the impeller and is designed in such a way that the kinetic energy of the water discharge at the outlet of the impeller is converted into pressure energy before the water leaves the casing and enters the delivery pipe.

Types of casing: (a) Volute casing (b) Vortex casing (c) Casing with guide blades.



VOLUTE CASING: Volute Casing, which Surrounds the impeller. It is of spiral type in which area of flow increases gradually. The increase in area of flow decreases the velocity of flow.

The decrease in velocity increases the Pressure of the water flowing through the Casing. It has been observed that in case of volute Casing, the efficiency of the pump increases slightly as a Large amount of energy is lost due to the formation of eddies in this type of Casing

(b) vortex Casing: If a circular chamber is introduced between the Casing and the impeller as the Casing is known as vortex Casing
The η of the pump is more than the efficiency when only volute Casing is provided.

(c) Casing with Guide Blades: The impeller is Surrounded by a Series of guide blades mounted on a ring which is known as diffuser.

(3) Suction pipe with a foot valve and a Strainer:
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 fitted at the lower end of the Suction pipe. The foot valve opens only in the upward direction. A strainer is also fit at the lower end of the Suction pipe.

(4) 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.

DEFINITIONS OF HEAD AND EFFICIENCIES OF A CENTRIFUGAL PUMP

(1) Suction Head (h_s): It is the vertical height of the Centre line of the Centrifugal pump above the water Surface in the tank or pump from which water is to be lifted This is also Called as Suction Lift.

(2) Delivery Head (h_d): The Vertical distance between the Centre line of the pump and the water Surface in the tank to which water is delivered is known as delivery head

(3) Static Head (H_s): The Sum of Suction head and delivery head is known as static head. This is represented by

$$H_s = h_s + h_d. \quad \text{——— (3)}$$

(4) Manometric Head (H_m): The manometric head is defined as the head against which a Centrifugal pump has to work. It is denoted by (H_m). Expressed as

(a) H_m = Head imparted by the impeller to the water — Loss of head in the pump

$$H_m = \frac{V_{w_2} u_2}{g} \text{ — Loss of head in impeller and Casing} \quad \text{——— (4)}$$

$$H_m = \frac{V_{w_2} u_2}{g} \text{ if loss of pump is Zero} \quad \text{——— (5)}$$

(b) H_m = Total head at outlet of the pump — Total head at the inlet of the pump.

$$= \left(\frac{P_o}{\rho g} + \frac{V_o^2}{2g} + Z_o\right) - \left(\frac{P_i}{\rho g} + \frac{V_i^2}{2g} + Z_i\right) \quad \text{— (6)}$$

where $\frac{P_o}{\rho g}$ = Pressure head at outlet of the pump hd

$\frac{V_o^2}{2g}$ = velocity head at outlet of the pump

= velocity head in delivery pipe $\frac{V_d^2}{2g}$

Z_o = vertical height of the outlet of the pump from datum line

$\frac{P_i}{\rho g}, \frac{V_i^2}{2g}, Z_i$ = Corresponding values of Pressure head, velocity head and datum head at the inlet of the pump.

i.e h_s $\frac{V_s^2}{2g}$ and Z_s respectively

(c) $H_m = h_s + h_d + h_{f_s} + h_{fd} + \frac{V_d^2}{2g}$ ——————(7)

where h_s = Suction head h_d = Delivery head
h_f = Frictional head loss in Suction pipe
h_{fd} = Frictional head loss in delivery pipe
V_d = Velocity of water in delivery pipe

(5) Efficiencies of a Centrifugal pump : In case of a Centrifugal Pump, the Power is transmitted from the shaft of electric motor to the shaft of the pump and then impeller.

From the impeller, the Power is given to the water. Power is decreasing from the shaft of the pump to impeller and then to the water. The following are the important efficiencies of a centrifugal pump

(a) Manometric efficiency η_{mano} (b) Mechanical efficiency η_m

(c) overall efficiency η_o.

(a) η_{man} = Manometric head / Head imparted by impeller to water

$$= \frac{H_m}{\left(\frac{V_{w_2} u_2}{g}\right)} = \frac{g H_m}{V_{w_2} u_2} \quad \text{——————— (8)}$$

(b) η_m = Power at the impeller / Power at the shaft.

$$= \frac{\frac{W}{g}\left(\frac{V_{w_2} \cdot u_2}{1000}\right)}{S.P} \quad \text{——————— (9)}$$

(c) η_o = Weight of water Lifted $\times H_m / 1000 = \frac{W H_m}{1000}$

$\eta_o = \eta_{man} \times \eta_m$.