CENTRIFUGAL PUMP – COMPONENTS – WORKING PRINCIPLE – TYPES OF IMPELLERS

CENTRIFUGAL PUMP

Working principle

If the mechanical energy is converted into pressure energy by means of centrifugal force acting on the fluid, the hydraulic machine is called centrifugal pump. The centrifugal pump acts as a reversed of an inward radial flow reaction turbine

Performance Characteristics of Pumps

The fluid quantities involved in all hydraulic machines are the flow rate (Q) and the head (H), whereas the mechanical quantities associated with the machine itself are the power (P), speed (N), size (D) and efficiency (h). Although they are of equal importance, the emphasis placed on certain of these quantities is different for different pumps. The output of a pump running at a given speed is the flow rate delivered by it and the head developed. Thus, a plot of head and flow rate at a given speed forms the fundamental performance characteristic of a pump. In order to achieve this performance, a power input is required which involves efficiency of energy transfer. Thus, it is useful to plot also the power P and the efficiency h against Q.

Over all efficiency of a pump (h) = Fluid power output / Power input to the shaft = rgHQ / P

Type number or Specific speed of pump, nS = NQ1/2 / (gH)3/4 (it is a dimensionless number)

Centrifugal pump Performance

In the volute of the centrifugal pump, the cross section of the liquid path is greater than in the impeller, and in an ideal frictionless pump the drop from the velocity V to the lower velocity is converted according to Bernoulli's equation, to an increased pressure. This is the source of the discharge pressure of a centrifugal pump.

If the speed of the impeller is increased from N1 to N2 rpm, the flow rate will increase from Q1 to Q2 as per the given formula:

Characteristic curves

Pump action and the performance of a pump are defined interms of their characteristic curves. These curves correlate the capacity of the pump in unit volume per unit time versus discharge or differential pressures. These curves usually supplied by pump manufacturers are for water only.

These curves usually shows the following relationships (for centrifugal pump).

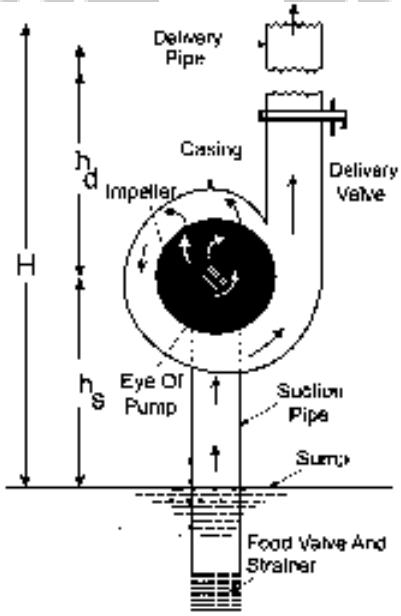
· A plot of capacity versus differential head. The differential head is the difference in pressure between the suction and discharge.

· The pump efficiency as a percentage versus capacity.

· The break horsepower of the pump versus capacity.

The net poisitive head required by the pump versus capacity. The required NPSH for the pump is a characteristic determined by the manufacturer.

Centrifugal pumps are usually rated on the basis of head and capacity at the point of maximum efficiency.



Line Diagram Of Centrifugal Pump

Impeller

The impeller consists of a disc with blades mounted perpendicularly on its surface. The blades may of three different orientations.

These are (*i*) Radial, (*ii*) Backward curved, and (*iii*) Forward curved.

Backward and forward refers to the direction of motion of the disc periphery. Of these the most popular one is the backward curved type, due to its desirable characteristics, which reference to the static head developed and power variation with flow rate.

A simple disc with blades mounted perpendicularly on it is called open impeller. If another disc is used to cover the blades, this type is called shrouded impeller. This is more popular with water pumps. Open impellers are well adopted for use with dirty or water containing solids. The third type is just the blades spreading out from the shaft.

These are used to pump slurries. Impellers may be of cast iron or bronzes or steel or special alloys as required by the application. In order to maintain constant radial velocity, the width of the impeller will be wider at entrance and narrower at the exit. The blades are generally cast integral with the disc. Recently even plastic material is used for the impeller. To start delivery of the fluid the casing and impeller should be filled with the fluid without any air pockets. This is called priming.

If air is present the there will be only compression and no delivery of fluid. In order to release any air entrained an air valve is generally provided

The one way foot value keeps the suction line and the pump casing filled with water.

3 Classification

As already mentioned, centrifugal pumps may be classified in several ways. On the basis of speed as low speed, medium speed and high speed pumps.

On the basis of direction of flow of fluid, the classification is radial flow, mixed flow and radial flow. On the basis of head pumps may be classified as low head (10 m and below), medium head (10-50 m) and high head pumps.

Single entry type and double entry type is another classification. Double entry pumps have blades on both sides of the impeller disc. This leads to reduction in axial thrust and increase in flow for the same speed and diameter.

When the head required is high and which cannot be developed by a single impeller, multi staging is used. In deep well submersible pumps the diameter is limited by the diameter of the bore well casing. In this case multi stage pump becomes a must. In multi stage pumps several impellers are mounted on the same shaft and the outlet flow of one impeller is led to the inlet of the next impeller and so on. The total head developed equals the sum of heads developed by all the stages.