

TUTORIAL ON CENTRIFUGAL PUMP - 2

ME2011D FLUID MACHINERY

- Q 1 A centrifugal pump is required to discharge 600 litres of water per second and develop a head of 15m when the impeller rotates at 750 rpm. The manometric efficiency is 80. The loss of head in the pump due to fluid resistance being assumed to be $0.027 V^2$ m of water, where V is the velocity with which water leaves the impeller. Water enters the impeller without shock or whirl and the velocity of flow is 3.2m/s. Determine:
- (i) Impeller diameter and outlet area
 - (ii) Blade angle at outlet
- Q 2 A centrifugal pump lifts water under a static head of 36 m of water of which 4 m is suction lift. Suction and delivery pipes are both 150 mm in diameter. The head loss in suction pipe is 1.8 m and in delivery pipe 7 m. The impeller is 380 mm in diameter and 25 mm wide at mouth and revolves at 1200 r.p.m. Its exit blade angle is 35° . If the manometric efficiency of the pump is 82 percent, determine:
- (i) The discharge through the pump, and
 - (ii) The pressure at the suction and delivery branches of the pump
- Q 3 A centrifugal pump is required to discharge 0.2 m^3 of water per second against a head of 22 m when the impeller rotates at a speed of 1500 r.p.m. The manometric efficiency is 75 percent. The loss of head in pump in metres due to fluid resistance is $0.03 V_2^2$ where V_2 m/s is the velocity of water leaving the impeller. The area of the impeller outlet surface is $1.2 D_2^2 \text{ m}^2$, where D is the impeller diameter in m. Determine:
- (i) The impeller diameter, and
 - (ii) The outlet vane angle
- Assume that the water enters the impeller without whirl.
- Q 4 A three - stage centrifugal pump has impeller 400 mm in diameter and 20 mm wide. The vane angle at outlet is 45° and the area occupied by the thickness of the vanes may be assumed 8 percent of the total area. If the pump delivers 3.6 m^3 of water per minute when running at 920 r.p.m. determine:
- (i) Power of the pump,
 - (ii) Manometric head, and
 - (iii) Specific speed.
- Assume mechanical efficiency as 88 % and manometric efficiency as 77 percent.
- Q 5 A centrifugal pump is delivering $0.15 \text{ m}^3/\text{s}$ of water against a head of 12.5 m; the speed of rotation of impeller being 600 r.p.m. The diameters at outer and inner periphery of the impeller are 500 mm and 250 mm respectively. The area of flow is constant at 0.07 m^2 from inlet to outlet of impeller. If the vanes of the impeller are bent at an angle of 35° to the tangent at exit, determine:
- (i) Manometric efficiency,
 - (ii) Inlet vane angle, and
 - (iii) Loss of head at inlet to impeller when the discharge is reduced by 40 percent.
- Q 6 3 m^3 of water per second is lifted to a height of 30 m with an efficiency of 75 percent by single - stage centrifugal pump. The impeller diameter is 300 mm and it is rotating at 2000 r.p.m. Find the number of stages and diameter of each impeller of a similar multi-stage pump to lift 5 m^3 of water per second to a height of 200 m when rotating at 1500 r.p.m.

- Q 7 A single-stage centrifugal pump runs at 600 r.p.m. and delivers $360 \text{ m}^3/\text{min.}$ of water against a head of 144 m. The pump impeller is 2.4 m in diameter and it has a positive suction lift (including the velocity head and friction) of 3.6 m. Laboratory tests are to be conducted on a model with 0.54 m diameter impeller and on a reduced head of 114 m. Calculate the speed, discharge and suction lift for the laboratory tests. Assume atmospheric head = 10.18 m of water and vapour head = 0.32 m of water.
- Q 8 The impeller of a centrifugal pump is of 300 mm diameter and 50 mm width at the periphery, and has blades whose tip angle incline backwards 60° from the radius. The pump delivers $17 \text{ m}^3/\text{min.}$ of water and the impeller rotates at 1000 r.p.m. Assuming that the pump is designed to admit radially, calculate:
- (i) Speed and direction of water as it leaves the impeller,
 - (i) Torque exerted by the impeller on water and
 - (ii) Shaft power required
- Take, mechanical efficiency = 95% and hydraulic efficiency = 75%.
- Q 9 The impeller of a centrifugal pump has an outer diameter of 250 mm and an effective area of 0.017 m^2 . The blades are bent backwards so that the direction of outlet relative velocity makes an angle of 148° with the tangent drawn in the direction of impeller rotation, the diameters of suction and delivery pipes are 150 mm and 100 mm respectively. The pump delivers $0.031 \text{ m}^3/\text{s}$ at 1450 r.p.m. when the gauge points on the suction and delivery pipes close to the pumps show heads of 4.6 m below and 18.0 m above atmosphere respectively. The head losses in the suction and delivery pipes are 2.0 m and 2.9 m respectively. The motor driving the pump delivers 8.67 kW. Assuming that water enters the pump without shock and whirl, determine the overall and manometric efficiency of the pump