Problems

1) The impeller of a centrifugal pump is 0.5m in diameter and rotates at 1200 rpm. Blades are curved back to an angle of 30 ° to the tangent at outlet tip. If the measured velocity of flow at outlet is 5 m/s, find the work input per kg of water per second. Find the theoretical maximum lift to which the water can be raised if the pump is provided with whirlpool chamber which reduces the velocity of water by 50%.

(Ans. 72.78m, 65.87m)

2) The impeller of a centrifugal pump is 0.3m in diameter and runs at 1450rpm. The pressure gauges on suction and delivery sides show the difference of 25m. The blades are curved back to an angle of 30 ° . The velocity of flow through impeller, being constant, equals to 2.5m/s, find the manometric efficiency of the pump. If the frictional losses in impeller amounts to 2m, find the fraction of total energy which is converted into pressure energy by impeller. Also find the pressure rise in pump casing.

(Ans. 58.35%, 54.1%, 1.83m of water)

3) A centrifugal pump is required to work against a head of 20m while rotating at the speed of 700 rpm. If the blades are curved back to an angle of 30 ° to tangent at outlet tip and velocity of flow through impeller is 2 /s, calculate the impeller diameter when (a) all the kinetic energy at impeller outlet is wasted and (b) when 50% of this energy is converted into pressure energy in pump casing.

(Ans. 0.55m, 0.48m)

4) During a laboratory test on a pump, appreciable cavitation began when the pressure plus the velocity head at inlet was reduced to 3.26m while the change in total head across the pump was 36.5m and the discharge was 48 litres/s. Barometric pressure was 750 mm of Hg and the vapour pressure of water 1.8kPa. What is the value of σ_c ? If the pump is to give the same total head and discharge in location where the normal atmospheric pressure is 622mm of Hg and the vapour pressure of water is 830 Pa, by how much must the height of the pump above the supply level be reduced?

(Ans. 0.084, 1.65m)

Model Solution

Problem 1

1) The peripheral speed at impeller outlet

$$U_2 = \frac{\pi \times 0.5 \times 1200}{60} = 31.4 \mathrm{m/s}$$

$V_{f2} = 5 \mathrm{m/s}$ (given)

Work input per unit weight of

Water = $\dfrac{V_{w2} U_2}{g} = \dfrac{(31.4 - 5\cot 30^o) \times 31.4}{9.81}$

=72.78m

Under ideal condition (without loss), the total head developed by the pump = 72.78 m

Absolute velocity of water at the outlet

$$V_2 = \sqrt{(31.4 - 5\cot 30^o)^2 + 5^2}$$

=23.28 m/s

At the whirlpool chamber,

The velocity of water at delivery = 0.5 ´ 23.28m/s

Therefore the pressure head at impeller outlet

=72.78 - $\dfrac{(0.5 \times 23.28)^2}{2 \times 9.81}$

= 65.87m

Hence, we theoretical maximum lift = 65.87m