

EXPERIMENT NO 10

Aim:- (a) To verify the momentum equation experimentally.
 (b) Comparison of change in force exerted due to shape of the vane. (flat, inclined or curved)

Apparatus Used:- Collecting tank, Transparent cylinder, Two nozzles of dia 10 mm & 12mm, Vane of different shape (flat, inclined or curved)

Theory:- Momentum equation is based on Newton's second law of motion which states that the algebraic sum of external forces applied to control volume of fluid in any direction is equal to the rate of change of momentum in that direction. The external forces include the component of the weight of the fluid & of the forces exerted externally upon the boundary surface of the control volume. If a vertical water jet moving with velocity is made to strike a target, which is free to move in the vertical direction then a force will be exerted on the target by the impact of jet, according to momentum equation this force (which is also equal to the force required to bring back the target in its original position) must be equal to the rate of change of momentum of the jet flow in that direction.

Formula Used:-

$$F' = \rho Q v (1 - \cos\beta)$$

$$F' = \rho Q^2 (1 - \cos\beta) \quad \text{as } v = Q/a$$

Where F' = force (calculated)
 ρ = density of water

β = angle of difference vane

V = velocity of jet angle

Q = discharge

A = area of nozzle $(\pi/4d^2)$

(i) for flat vane $\beta = 90^\circ$

$$F = \rho Q^2 / a$$

(ii) for hemispherical vane $\beta = 180^\circ$

$$\text{for \% error} = \frac{F - F'}{F'} \times 100$$
$$F = 2 \frac{Q^2}{a}$$

F = Force (due to putting of weight)

Procedure:-

1. Note down the relevant dimension or area of collecting tank, dia of nozzle, and density of water.
2. Install any type of vane i.e. flat, inclined or curved.
3. Install any size of nozzle i.e. 10mm or 12mm dia.
4. Note down the position of upper disk, when jet is not running.
5. Note down the reading of height of water in the collecting tank.
6. As the jet strike the vane, position of upper disk is changed, note the reading in the scale to which vane is raised.
7. Put the weight of various values one by one to bring the vane to its initial position.
8. At this position finds out the discharge also.
9. The procedure is repeated for each value of flow rate by reducing the water supply.
10. This procedure can be repeated for different type of vanes and nozzle.

Precautions:-

1. Water flow should be steady and uniform.
2. The reading on the scale should be taken without any error.
3. The weight should be put slowly & one by one.
4. After changing the vane the flask should be closed tightly.

Viva Questions:-

1. Define the terms impact of jet and jet propulsion?
2. Find the expression for efficiency of a series of moving curved vane when a jet of water strikes the vanes at one of its tips?