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RESEARCH ARTICLE

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EXPERIMENTAL INVESTIGATION THE IMPACT OF THE JET ON FLAT PLATE

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ABSTRACT

The main objective of Impact of Jet laboratory exercise is to experimentally determine the impact force of the jet deflected through a flat plate and to compare the experimental results to predictions from a control volume analysis of a viscous fluid. In this experiment we find the velocity of the jet and the experimental reaction force is determined and then compare to the theoretical reaction force using control volume analysis

INTRODUCTION

Water turbines are widely used throughout the world to generate power. In the type of water turbine referred to as a Pelton wheel, one or more water jets are directed tangentially on to vanes or buckets that are fastened to the rim of the turbine disc. The impact of the water on the vanes generates a torque on the wheel, causing it to rotate and to develop power. Although the concept is essentially simple, such turbines can generate considerable output at high efficiency. To predict the output of a Pelton wheel, and to determine its optimum rotational speed, we need to understand how the deflection of the jet generates a force on the buckets, and how the force is related to the rate of momentum flow in the jet. In this experiment, we measure the force generated by a jet of water striking a flat plate, and compare the results with the computed momentum flow rate in the jet.

Background Theory

Force can be defined as the rate at which momentum changes in a system, F=. When a fluid is deflected by a solid surface the fluid momentum changes because the direction changes and it therefore exerts a force on that surface.

A control volume analysis can be used to determine the impact force of the jet, as shown in below equation, $F = \rho A v^2$

Where, A is the cross-sectional area of the jet, ρ is fluid density, and v is fluid velocity.

Description of Apparatus

The experimental apparatus consists of a water nozzle, a flat plate, balancing lever, movable weight, and plumbing for recirculating the water. As shown in fig 1.

Fig 1. Impact of jet Apparatus

The pump draws water from the collection tank and provides sufficient head for the water to flow through the nozzle. The jet of water from the nozzle impinges on the impact surface. The balance beam attached to impact surface allows measurement of the force necessary to deflect the water jet

Theory of the Experiment

The momentum equation based on Newton's 2nd law of motion states that the algebraic sum of external forces applied to control volume of fluid in any direction equal to the rate of change of momentum in that direction. If a vertical water jet moving with velocity 'V' made to strike a target (Vane) which is free, to move in vertical direction, force will be exerted on the target by the impact of the jet.

Applying momentum equation, force exerted by the jet on the vane, F is given by

$$F = \rho Q (v_{out} - v_{in})$$

For flat plate, $v_{out} = 0$

$$F = \rho Q (0 - v)$$

$$F = \rho A v^2$$

Where Q= Discharge from the nozzle (Calculated by volumetric method)

v = Velocity of jet = (Q/A)

Calculations & Results

Observation Table

Sr. No.	Nozzle diameter (mm)	Tim for 10lit rise of water (s)	Distance of sliding weight (cm)
1	6	33.19	14.1
2	6	32.39	14.2
3	6	31.16	15.8
4	6	30.54	16.3

Calculations

For reading no.1

Diameter of Jet = d = 6*10-3 ^{m}

Area of Jet = A = $(\pi/4)*(d^2)$, m^2

= 2.827*10-5 m^2

Discharge = Q = (v/t)

= 2.7116*10-4 m^3/s

Velocity of Jet = v = (Q/A)

= 9.5920 m/s

Thus Theoretical Force (F^{th}) exerted on Flat plate is given as,

F^{th} = 2.6010 N

Now, Practically Force (F^{ex}) is calculated as,

Fex11 = w*d

Where, w = movable weight = mg

= 0.200 *9.81

Fex11 = 0.200*9.81*14.1

Fex= 2.5149 N

RESULT

Sr No.	Discharge 10^{-4} (m3/sec)	Velocity of the jet (m/sec)	Fth (N)	Fex (N)
1.	2.7116	9.5920	2.60	2.515
2.	2.7786	9.8289	2.73	2.633
3.	2.8883	10.217	2.95	2.818
4.	2.9469	10.4243	3.07	2.907

CONCLUSION

Thus, with the results and graphs we concluded that as the discharge increases the value of force exerted also increases.

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