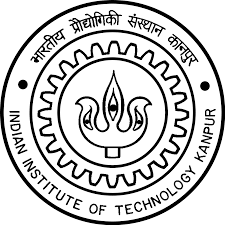
ME 401

LAB REPORT



Group B1

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**Title: Pelton Turbine Experiment**

**OBJECTIVE:**

* To learn the design and function of a Pelton Turbine.
* To determine characteristics curves of a Pelton Turbine.

**INDTODUCTION:**

Pelton wheel turbine is an impulse type water turbine that extracts energy from the impulse of a moving water. The Pelton’s Turbine design is more efficient than traditional overshot water wheel which uses water’s dead weight to generate energy. The Pelton’s wheel uses a specific paddle geometry to split the water beam and deflect it an angle around 170 degree utilizing most of the water’s momentum making the turbine very efficient.

Pelton wheels are used in hydro-power turbine where the available water source has relatively high hydraulic head at low flow rates.

**Experimental Setup**

The setup consists of a needle nozzle with water flow control spear that projects the water towards the Pelton wheel turbine and a band break for loading the turbine. The impeller is housed in a transparent housing to avoid splashing. The impeller operated under atmospheric pressure only. The water tank collects the water and can be used to measure the volume flow rate to measure the flow rate. The pressure bar indicated the hydraulic pressure. The weighing scales measures the frictional forces and are used to vary the load.

**Working Principle**

Nozzle is used to direct forceful, high-speed stream of water against a series of spoon-shaped buckets known as impulse blades. These impulse blades are mounted around the outer rim of a drive wheel which is called runner. As the water jet hits the blades, the direction of water velocity is changed to follow the contours of the blades. The impulse energy of the water jet exerts torque on the bucket and wheel system, rotating the wheel. The water jet does a "u-turn" and exits at the outer sides of the bucket at low velocity. In this process, the water jet's momentum is transferred to the wheel and hence to a turbine. Therefore, the "impulse" energy does work on the turbine. Maximum power and efficiency are achieved when the velocity of the water jet is twice the velocity of the rotating buckets.

A very small percentage of the water jet's original kinetic energy will remain in the water, which causes the bucket to be emptied at the same rate it is filled, and thereby allows the high-pressure input flow to continue uninterrupted and without waste of energy. Typically two buckets are mounted side-by-side on the wheel, with the water jet split into two equal streams; this balances the side-load forces on the wheel and helps to ensure smooth, efficient transfer of momentum from the water jet to the turbine wheel.

Because water is nearly incompressible, almost all of the available energy is extracted in the first stage of the hydraulic turbine. Therefore, Pelton wheels have only one turbine stage, unlike gas turbines that operate with compressible fluid.

The hydraulic power is the function of volumetric flow rate and head

**Phyd**= f(Q,H)

Thus the hydraulic power is given by,

**Phyd** = ρ.g.H.Q

The head can be written in terms of pressure and hence the formula becomes,

**Phyd**= p.Q\*105 / 1000 [W]

Torque M at the shaft is given by,

**Torque(M)** = Force(F)\*Lever arm radius

**Force(F)** = (T1-T2) [N]

where lever arm radius D = 0.05m

**Power Pav** at the turbine shaft is given by,

**Power** = Torque\*Angular velocity

**Pav** = M\*2πN/60 [W]

**Efficiency**

**η** = Shaft Power(Pav) / Hydraulic Power(Phyd) = T.ω / ρ.g.H.Q

Efficiency can be enhanced still further if allowance is made from the outlet for the internal friction torque of approximately 0.012 N-m.

**Results and Discussion**

We can get an idea an idea of the torque, power and efficiency characteristics at different spear positions from the following graphs.

1. **SPEAR POSITIONED AT 0**
2. **SPEAR POSITIONED AT 1**
3. **SPEAR POSITIONED AT 3**

**Comparison Between Three Spear Positions**

**DISCUSSIONS AND CONCLUSION**

* As can be seen, the Torque in general decreases with increase in RPM where as the power output attains a peak and then decreases with increasing RPM.
* Since the hydraulic power depends only in the head and the nozzle area, the peak for both power and efficiency appears at the same RPM for a given poition

**SOURCES OF ERROR**

* The water leaking from the sides of the transparent caging contributes to measurement error.
* At low RPMs, the vibration in the scale adds to error in reading.
* Human error in measuring time and water level reading as well as parallax error.
* Error in RPM reading because of high fluctuation in tachometer reading.

**Sample Calculations: (Position 0)**

Volume of Water (L)= 10

Time (s) = 19.7

Pressure(bar) = 0.3

Phyd = ρ.g.H.Q = p.Q\*105 / 1000 = 15.22 W

N(RPM) = 770

F1 = 0.2 N

F2 = 1.8 N

Force(F) = (F2-F1) = 1.6 N

D(Lever arm) = 0.05m

Torque(M) = Force(F)\*D/2= 0.4 N-m

Average Power

Pav = M\*2πN/60 = 3.22 W

Efficiency

η = Pav / Phyd = 0.757/18 \* 100 = 21.15 %

Enhanced Efficiency

η’ = (T+0.012).ω / Phyd = 1.901/18\*100 % = 27.5 %

**References:**

* ME 401 Lab Manual

● Pelton wheel wiki : https://en.wikipedia.org/wiki/Pelton\_wheel