LABORATORY MANUAL

ON

PELTON TURBINE TEST RIG

Prepared

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June 2014

1. OBJECTIVE: To Study the operation of a Pelton Turbine (1 kW).

2. AIM: To determine the output power of pelton turbine.

To determine the efficiency of the pelton turbine.

3. INTRODUCTION:

A turbine is a machine which converts the fluid energy into mechanical energy which is then utilized to run the electric generator of a power plant. Fluid used can be water or steam. The Pelton wheel is a tangential flow impulse turbine. The water strikes the bucket along the tangent of the runner. The energy available at the inlet of the turbine is only kinetic energy. The pressure at the inlet and outlet of the turbine is atmosphere. The turbine is used for high head.

4. THEORY:

Pelton turbine is a impulse turbine. In an impulse turbine, all the available energy of water is converted into kinetic energy or velocity head by passing it through a contracting nozzle provided at the end of the penstock. The water coming out of the nozzle is formed into a free jet, which strikes on a series of buckets of the runner thus causing it to revolve. The runner revolves freely in air. The water is contact with only a part of the runner at a time, and throughout its action on the runner.

5. DESCRIPTION:

The set up consists of centrifugal pump, turbine unit, and sump tank, arranged in such a way that the whole unit works as re-circulating water system. The centrifugal pump supplies the water from sump tank to the turbine. The loading of the turbine is achieved by rope brake drum connected with weight balance. The turbine unit can be Pelton Wheel Turbine Test Rig 2 visualize by a large circular transparent window kept at the front. A bearing pedestals rotor assembly of shaft, runner and brake drum, all mounted on suitable cast iron base plate.

6. UTILITIES REQUIRED:

- Electricity Supply: Three Phase, 420 V AC, 50 Hz, 32 Amp. MCB 4 Pole with earth connection.
- Water supply (Initial fill).
- Drain Required.
- Floor Area Required: 1.5 m x 0.75 m.
- Mercury (Hg) for manometer: 250 gms.
- Tachometer for RPM measurement.

7. EXPERIMENTAL PROCEDURE

Starting Procedure:

1. Close all the valves provided.

2. Fill sump tank ¾th with clean water and ensure that no foreign particles are there.

3. Fill manometer fluid i.e. Hg. in manometer by opening the valves of manometer and one PU pipe from pressure measurement point of pipe.

4. Connect the PU pipe back to its position and close the valves of manometer.

5. Open the by-pass valve and ensure that there is no load on the brake drum.

6. Switch ON the pump with the help of starter.

7. Close the by-pass valve.

8. Open pressure measurement valves of the manometer.

9. Open the air release valve provided on the manometer, slowly to release the air from manometer. (This should be done very carefully)

10. When there is no air in the manometer, close the air release valves.

11. Now turbine is in operation.

12. Load the turbine with the help of hand wheel attached on the top of weight balance.

13. Note the manometer reading and pressure gauge reading.

14. Measure the load applied and RPM of the turbine.

15. Repeat the experiment at different load.

16. Repeat the experiment for different discharge by regulating the nozzle position by the hand wheel provided for same.

Closing Procedure:

1. When the experiment is over, first of all remove the load on dynamometer.

2. Open the by-pass valve.

3. Close the ball valves provided on manometer.

4. Switch OFF Pump with the help of starter.

5. Switch OFF main power supply.

6. Drain the sump tank by the drain valve provided.

8. NOMENCLATURE:

A = Cross-sectional area of pipe, m^2.

C_v = Co-efficient of pitot tube.

D = Diameter of pipe, m.

d_B = Diameter of brake drum, m.

d_R = Diameter of rope, m.

E_i = Input power, kW.

E_o = Output power, kW.

g = Acceleration due to gravity, m/sec^2.

H = Total head, m.

h = Manometer difference, m.

h_1, h_2 = Manometer reading at both points, cm.

N = RPM of runner shaft.

P = Pressure gauge reading, kg/cm^2.

Re	=	Equivalent Radius, m.
Q	=	Discharge, m^3/sec.
T	=	Torque, N m.
V	=	Velocity of water, m/sec.
W_1	=	Spring balance weight, kg.
W_2	=	Adjustable weight, kg.
W_3	=	Weight of Rope, kg.
ρ_w	=	Density of Water, kg/m^3.
ρ_m	=	Density of Manometer fluid i.e. Hg, kg/m^3.
η_t	=	Turbine efficiency.

9. PRECAUTIONS & MAINTENANCE INSTRUCTIONS:

1. Never run the apparatus if power supply is less than 390 volts and above 420 volts.
2. To prevent clogging of moving parts, run pump at least once in a fortnight.
3. Always keep apparatus free from dust.

10. TROUBLESHOOTING:

1. If pump does not lift the water, the revolution of the motor may be reverse. Change the electric connection to change the revolutions.

2. If panel is not showing input, check the main supply.

11. OBSERVATION & CALCULATIONS:

DATA:

g = 9.81 m /sec^2

P_w = 1000 kg / m^3

P_m = 13600 kg / m^3

C_v = 0.98

D = 0.052 m

d_B = 0.2 m

d_R = 0.012 m

W_3 = ------ kg

OBSERVATION TABLE

S.NO.	N	P, kg/cm^2	h_1, cm	h_2, cm	W1, kg	W_2, kg
1.						
2.						

3.						

CALCULATIONS:

H = 10 x P, m of water = ---------- m

A= $\frac{\pi}{4}$ D^2, m^2 = ---------- m^2

h = $\frac{h1-h2}{100}$, m = ---------- m

V = C_V x $\sqrt{2gh\left(\frac{\rho_m}{\rho_w}-1\right)}$, m/sec = ---------- m/sec

Q = V x A, m^3/sec = ---------- m^3/sec

E_i= $\frac{\rho_w X g X Q X H}{1000}$, kW = ---------- Kw

R_e = $\frac{d_B+2d_R}{2}$, m = ---------- m

T = (W_1 +W_3 - W_2) x g x R_e, Nm = ---------- N m

E_o = $\frac{2 X \pi X N X T}{60 X 1000}$, kW = ---------- kW

n_i = $\frac{E_0}{E_i}$ x 100% = ---------- %

12. CONCLUSIONS: The experiment on Pelton Wheel Turbine was performed. The input and output power of the turbine was calculated. The efficiency of the turbine was found to be _____.