Performance characteristics of a Pelton Turbine

AIM:
Performance characteristics (output and efficiency variation with speed) for different openings of the nozzle at a constant input head

EXPERIMENTAL SET-UP:
Experimental set-up consists of Pelton turbine, inlet pressure gauge, centrifugal pump, tachometer, calibrated orificemeter connected to mercury manometer, brake drum dynamometer with rope and mass loading arrangement.

THEORY
Pelton turbine is a high head impulse turbine. It is used for high head and low flow rate applications. Single jet Pelton turbines are built for specific speeds less than 35. The input pressure head is converted into high velocity jet by means of a nozzle. The jet impinges on the double cupped buckets mounted around the periphery of the runner disc, making the runner to rotate. The flow through the runner is at atmospheric pressure. Hence, the turbines are called constant pressure turbines.

EXPERIMENTAL PROCEDURE
Keep the spear rod full open position of the nozzle and adjust the inlet pressure P (at 2.8 kgf/cm^2 or 28.5 m of water column indicated by a Bourdan tube pressure gauge) by operating the bypass line valve. Note down the reading of the mercury manometer connected to calibrated orificemeter from which determine volume flow rate through the nozzle "Q" using the supplied calibration chart. Keep on loading the Pelton turbine by adding masses from 2kg upto 30 kg (or until the Pelton wheel stops) in steps of 2kg. At each loading, note down the rotational speed (rpm) of the turbine using a tachometer. Repeat the procedure for half opening of the nozzle, keeping each time supply head constant at 2.8 kgf/cm^2.

Observation Table
Density of water = ρ = 1000 kg/m^3
Brake drum diameter = D =0 .45 m
Rope diameter = d = 0.020m
Mass of hanger = 2 *kg*
Acceleration due to gravity g = 9.81 m/s^2
Calibration curve of the orifice plate

$$Q(m^3/s) = 0.0003(DP)^{0.5842} \quad DP \text{ in mm of Hg}$$

Observation Table 1 Fully open Nozzle position of Pelton Turbine

Sl No.	Nozzle opening	Mass added on the drum M (kg)	Spring balance reading S (kg)	Net mass acting on the drum M-S (kg)	Input head *H* in m of water column	Speed (rpm)	Orificemeter reading (mm of Hg)	Q (m^3/s)	Torque *T* (N.m)	Input power (Watts)	Output power (Watts)	Efficiency
I 1.	Fully open	2 kg										
I 2.		4 kg										
I 3.		6 kg										
I 4.		8 kg										
I 5.		10 kg										
I 6.		12 kg										
I 7.		14 kg										
I 8		16 kg										
I 9		18 kg										
I10		20 kg										
I 11		22 kg										
I 12		24 kg										
I 14		26 kg										
I 15		28 kg										
I 16		30 kg										

Name:	Roll No.:	Signature

Table 2 Half open Nozzle position of Pelton Turbine

Sl No.	Nozzle opening	Mass added on the drum M (kg)	Spring balance reading S (kg)	Net mass acting on the drum M-S (kg)	Input head *H* in m of water column	Speed (rpm)	Orificemeter reading (mm of Hg)	Q (m^3/s)	Torque *T* (N.m)	Input power (Watts)	Output power (Watts)	Efficiency
II 1.	Half open	2 kg										
II 2.		4 kg										
II 3.		6 kg										
II 4.		8 kg										
II 5.		10 kg										
II 6.		12 kg										
II 7.		14 kg										
II 8		16 kg										
II 9		18 kg										
II10		20 kg										
II 11		22 kg										
II 12		24 kg										
II 14		26 kg										
II 15		28 kg										
II 16		30 kg										

SPECIMEN CALCULATION

Input power = $\rho\, g\, Q\, H$

Torque $T = (M - S)g \times \frac{D+d}{2}$

Output power = $\frac{2\pi N T}{60}$

Efficiency = $\eta = \frac{output\ \ Power}{Input\ \ power}$

GRAPHS TO BE PLOTTED:

Graph 1: x-axis is Speed, Y-axis is output power and efficiency for fully open nozzle position

Graph 2: x-axis is Speed, Y-axis is output power and efficiency for half open nozzle position

CONCLUSIONS/DISCUSSION ON THE RESULTS

1. Write down the observations
2. Try to explain the observations from the theory studied in turbomachines course

Graph 1: x-axis is Speed, Y-axis is output power and efficiency for fully open nozzle position

Graph 2: x-axis is Speed, Y-axis is output power and efficiency for half open nozzle position