DESIGN AND FABRICATION OF PELTON WHEEL TURBINE

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Abstract: Hydropower turbines are revolving systems that transform potential energy into kinetic energy or useable kinds of energy like mechanical power or electric power. In general, Pelton Wheel Turbines are considered to be among the best for supplying low-flow power. To leverage the water velocity from an elevated tank, the design of a model Pico-size Pelton Wheel Turbine has been updated. An elevated tank and the altitude of the tank's bottom together provide sufficient head (Q) for the Pico turbine to revolve and subsequently produce a Pico watt of energy.

Key Words: Pelton Wheel, Pico Turbine, Structural Movement

INTRODUCTION

Turbines come in two forms: steam turbines and hydraulic turbines. The revolving hydraulic turbines convert potential energy into kinetic energy and alternative kinds of useable energy, such as mechanical energy or electrical energy. In hydraulic turbines, there are two basic types of turbines: reaction turbines and impulse turbines [1].

When water exits the end nozzle of the penstock in an impulse turbine, it is pushed to strike several buckets that are placed around the runner. Water is drawn into reaction turbines across all edges of the runner till it is discharged into the tail race through the draught tube [2].

The Pelton Wheel turbine represents the ideal example of an impulse turbine. The Pelton turbine generates tangential flow, which requires less water. The Pelton wheel has numerous buckets evenly distributed all the way around a circular disc. Each bucket has one symmetrical section and an elliptical cup shape, as shown in fig.1 [3].

- Large hydropower: These are facilities that have an output capacity greater than 30 MW.
- Medium hydropower plants are those with a capacity of between 1MW and 30MW.
- Small hydroelectric facilities: These can also be broken down into the following categories:
    1. Miniature hydroelectric power plants (100 to 1,000KW).
    2. Micro-hydropower infrastructure (5 to 100 kW)
    3. Facilities for Pico hydropower (below 5 kW)

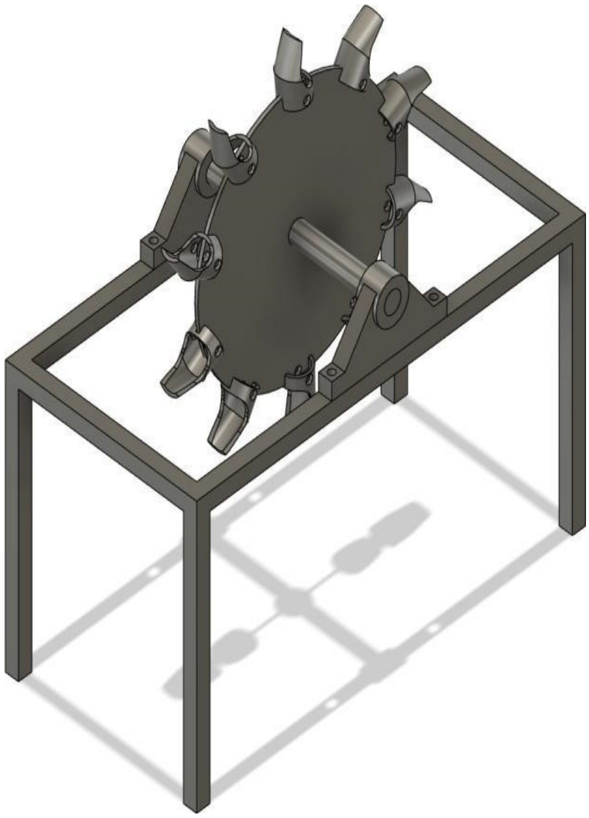

FIGURE 1. Pelton Wheel Turbine

PELTON WHEEL TURBINE COMPONENTS DESIGN SPECIFICATIONS

A head (H) of water drops at a flow rate (Q). To transfer torque (T) to the electric generator and generate power, the Pelton wheel must rotate at a specific speed (Ns) (P). The expected output of the system is Power = 100W. Between the bottom of the collecting tank and the jet nozzle, there is believed to be a head of 3.2 meters. Performance is impacted by pressure and flow in the hydraulic system [4].

CALCULATIONS

Calculation of Diameter of Pelton Runner

The performance in terms of Power can be expressed as follows in SI units:

P_{ti}= density x gravitational acceleration x Cv^2 x H x Q

Q= P_{ti} / density x gravitational acceleration x C_v^2 x H

Q = 100 / 1000 x 10 x 3.2 x 0.98

= 0.0032 m^3 /s

Where,

Q = flow rate

Density of water = 1000 kg / m^3

gravitational acceleration = 9.82 m/s^2

Head = 3.2 m
C_V = Nozzle (jet) discharge coefficient (0.98) Specific
Speed, N_s of the turbine

N_s= (85.49 x √n)/(H^0.234)

=65.119 rpm

While; n_j= number of turbine nozzle = 1

N= Speed of the turbine

= N_s x $H^{5/4}$ / √Pti

= 65.119 x $3.2^{5/4}$ / $\sqrt{100}$

= 30.06 rpm

3.2 Calculation of water jet velocity through the nozzle

Calculate the velocity (V1) in (m.s -1) of the water jet exits from the nozzle by using this formula.

V_j = C_v x g x H

= 43.5 m/s

D_r= diameter of pelton runner = 300mm

D_j =diameter of jet = 20mm

3.3 Calculation the bucket dimensions

Calculations for the bucket's axial width include,

B_w= 40 mm

Calculations for the bucket's radial length include

B_l = 65 mm

3.4 Calculation of bucket depth

B_d =35 mm

3.5 Calculation the number of buckets

N_b = 10

The number of buckets in pelton wheel turbine is 10.

DESIGN PARAMETERS IN SUMMARY

Table 1. Below shows a summary of the calculated design parameters.

Sr. No	Parameters	Calculations
1.	Flow rate , Q	0.0032m^3 /s
2.	Calculation of water jet velocity through nozzle , V_j	43.5 m/s
3.	Diameter of pelton wheel , D_r	300 mm
3.	Diameter of jet , D_j	20mm
4.	Bucket width , B_w	40mm
5.	Bucket length , B_l	65mm
6.	Bucket depth , B_d	35mm
7.	Number of buckets , N_b	10

SELECTION OF MATERIALS

Special attention is paid to the low expense of the raw materials used to make the Pelton wheel. Plastic/metal sheet and PVC pipes in a range of sizes are less expensive and more readily available materials for case construction locally. For this reasonably priced Pico Pelton wheel, aluminum alloy was chosen as the material because it is lightweight, less corrosive, and easier to cast. Using Fusion 360, a model was produced. FIG. 2 and 3 simulates the structural displacement of the material under an applied force during analysis. [5].

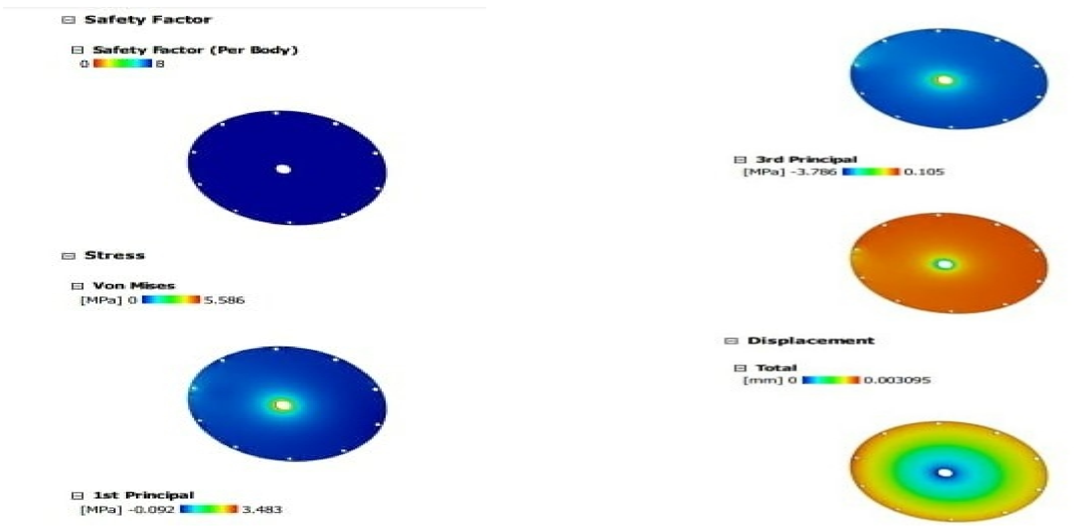

FIGURE 2:- Runner Total Displacement

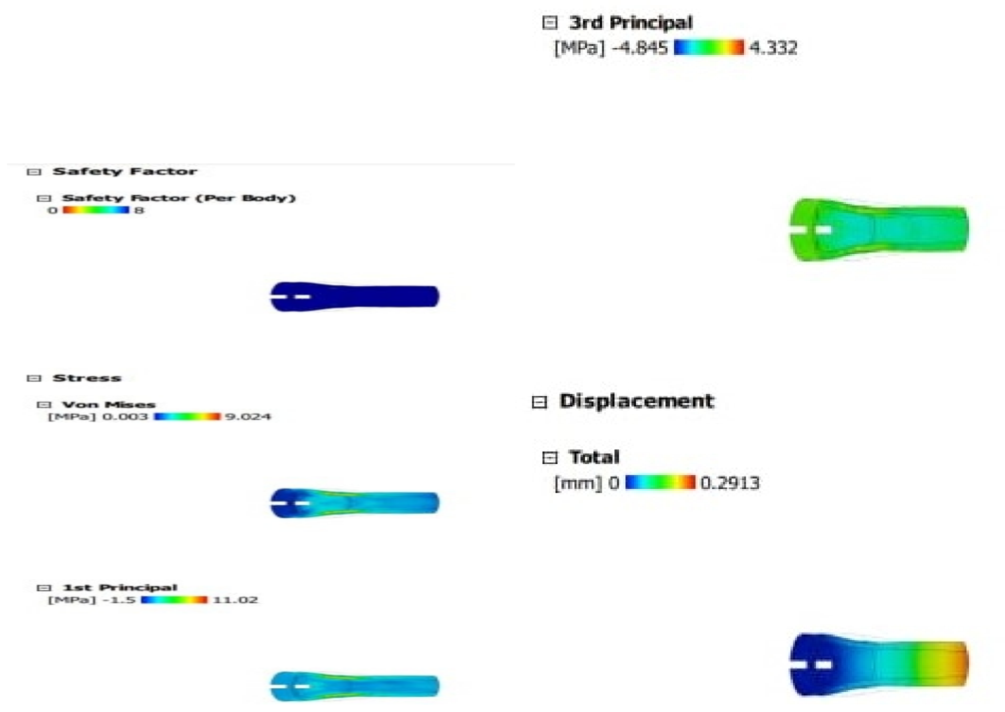

FIGURE 3:- Bucket Total Displacement

6. FINAL DISPLACEMENT OF RUNNER AND BUCKET

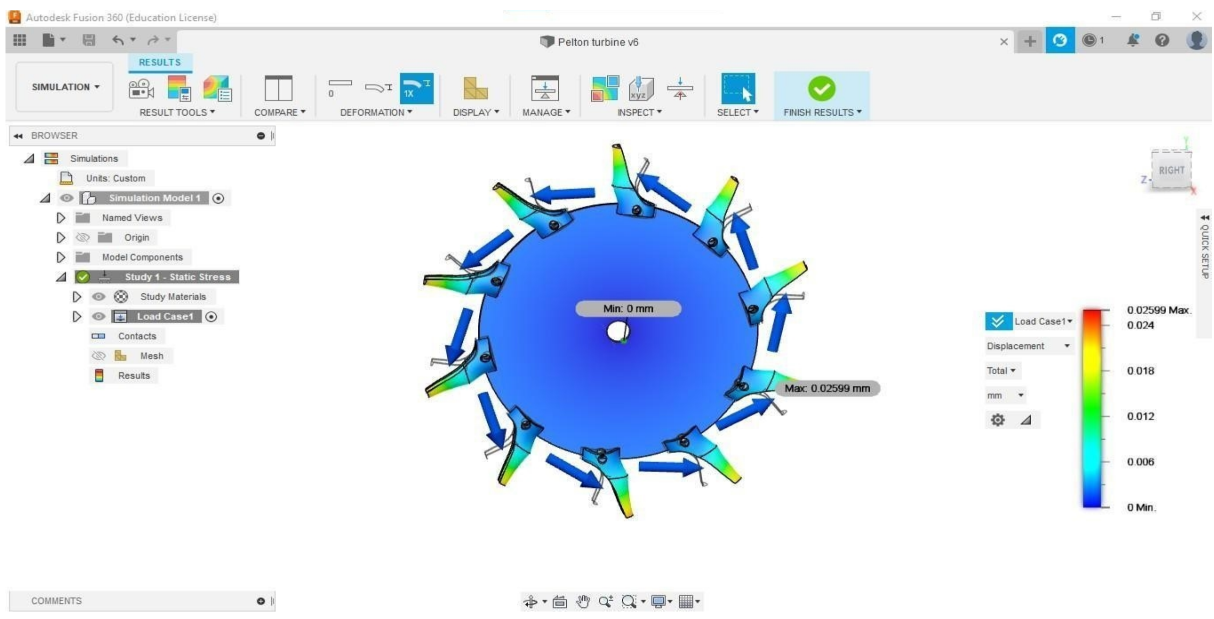

FIGURE 2. Pelton wheel displaying the displacement caused by the forces at work

CONCLUSION

Certain tasks that require relatively little power but are absolutely necessary include charging mobile devices and low-energy lights. These needs can be met by producing, storing, and using Pico-scale power instead of using fossil fuel able to generate facilities, which raise greenhouse gas emissions. This study designed and examined a Pelton wheel turbine model for a small hydropower system. [6].

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