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Design & Manufacturing of Micro Pelton Turbine for Electricity Generation

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Abstract

Electricity is becoming one of the basic needs of human being. Electricity consumption in developed and developing countries is high, especially in residential and commercial building sectors. Electricity generation can be produced clean entirely with renewable methods, such as wind, water, and sunlight. So taking into consideration the importance of electricity generation by renewable method, we propose to design and manufacture a system that will generate electricity with the help of micro pelton turbine. The potential energy of water stored in overhead tank of multi-storied building is used to generate electricity using micro pelton wheel turbine at lower level of building.

Keywords— Micro Pelton turbine, multi storied building, Alternator

I. INTRODUCTION

Due to increasing population, energy requirement is also increased. So to overcome energy deficiency, use of conventional power, resources like coal, crude oil are depleting and there is large impact on environment due to adverse effect of using these resources. on conventional energy is an exact solution for all this problems. Solar, wind, water are abundant and priceless. Also they nearly don't have impact on our environment. Hydropower is non conventional power resource which converts energy of water into electrical energy. India is focusing greatly on renewable energy. It was estimated that India can produce up to 84000 MW capacity of electricity at load factor of 60% from hydroelectric power plant. Government plans to increase the generation of hydro electricity by additional 50000 MW by year 2026.

Many high rise/ tall buildings are constructed in India. More than 2200 buildings are situated in Mumbai Metropolitan Region, more than 1800 buildings in Delhi Region, more than 600 in both Chennai and Kolkata region and more than 500 in Pune Region.

The water stored in tall buildings is a potential source for electricity generation. The freely falling water from tall buildings (i.e. Building with height more than 22m from surface) holds promising results. Water from tank having potential energy due to height is converted into mechanical energy and thus electrical energy using hydro turbine, alternator, etc. In high rise building there is enormous amount of water is consumed on daily on daily basis. These water using micro Pelton wheel turbines in high rise building can generate pure, pollution free and free of cost electricity after breakeven point is passed for long period of time.

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II. LITERATURE REVIEW

P. Sarkar et al. stresses on use of grey water in tall buildings for electricity production using micro Pelton turbine. The increasing population have increased electricity consumption and with given condition there is power shortage. It is proposed to use useless grey water from tall buildings to generate electricity. A storage tank for grey water is constructed such that it uses half of buildings height. Grey water is stored in tank from above floors. These water is passed to micro Pelton turbine situated at bottom floors of building. Turbine rotates and thus conversion of potential energy into mechanical energy and ultimately into electricity. Any building whose height is more than 22 m above the surface can be referred as high rise/ tall buildings. After breakeven point is crossed, electricity obtained is pure, pollution free and free of cost.

Audrious Zidonis et al. explains the use of CFD for development of impulse turbine. CFD can be used to simulate the turbulent flow with good accuracy and in the reasonable timescale. The accurate numerical modelling of Pelton wheel turbine can be achieved by using ANSYS, CFX, and ANSYS fluent commercial codes. By vast amount of CFD based studies on Pelton turbine the design can be optimized. The lagrangian approach and Euler's method are used for simulation purpose. It was observed that simulation of Pelton wheel are getting closer to experimental result and there is scope using same methodology for detailed analysis of floe in turgo runner.

N. J. Kumbhar et al. focused on to generate the electricity from low head water source. In urban areas, vast amount of water is used on daily basis and there is presence of potential head of water which is left unused. By using the available water head from overhead tank, potential energy of water is converted into electrical energy using micro hydro turbine and alternator situated at bottom floor of the building. The generated electricity is stored in battery which can be used for the building purpose. The hydro power is the renewable, reliable source of energy. This technology will play important role in upcoming days.

III. AIM AND METHODOLOGY

In this paper we have proposed a commercially feasible system to harness the energy from the water flowing through main pipe line of high raised buildings. In such high raised buildings, massive amount of water is consumed on daily basis. A micro Pelton turbine can be used in high rise buildings to generate electricity from water stored in overhead tank containing potential energy. The setup consist of micro pelton turbine, nozzle, alternator, and coupling. The micro pelton turbine is installed in casing. The micro pelton turbine shaft is coupled to shaft of alternator. The micro pelton turbine is setup at bottom floor of high rise building.

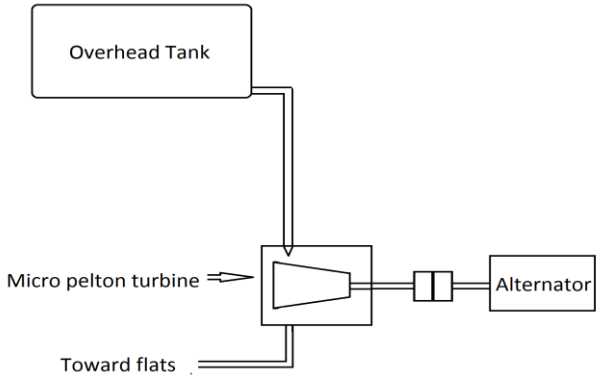

Fig. 1 Schematic Diagram of Proposed System

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The water in overhead tank contains potential energy when the water starts to flow through pipe from overhead tank to respective floors of building its energy gets converted into kinetic energy. When the water impinges on buckets of turbine from nozzle it starts rotating and energy is converted into mechanical energy, further it is converted into electrical energy using alternator and thus electricity is obtained.

IV. COMPONENTS

1. Nozzle

Nozzle is installed at the top of casing. Nozzle helps to decrease the pressure of water and allows high velocity jet to strike on the bucket of pelton wheel turbine. Nozzle used in setup is made up of brass material.

2. Pelton turbine

A pelton turbine is an impulse type water turbine, the energy available at inlet is kinetic energy and the pressure at inlet and outlet is atmospheric. As the turbine is tangential type, the water strikes the bucket along the tangent of the runner. It consist of rotor having buckets on its periphery. The buckets are of cup shaped having two halves with a jet strikes at the centre such that after striking in centre, water gets deflected by sideways. The size of bucket should be such that it accommodates the incoming and outgoing jet properly and deflect the jet to a desired angle. The number of buckets should be few as possible so that there should be a little loss due to friction and jet should be fully utilized so that the volumetric losses are minimum. The buckets used in turbine is made up of polyurethane using plastic molding. The buckets are held together by stainless steel hub.

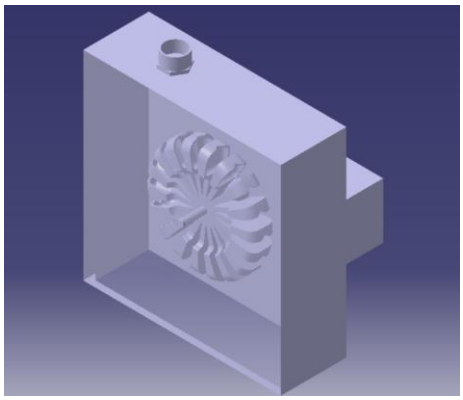

Fig. 2 Pelton wheel turbine setup

3. Alternator

An alternator is an electrical generator which converts the mechanical energy to electrical energy. It works on the principle of rotating magnetic field with a stationary armature. The rotating magnetic field induces an AC voltage in the stator winding and then current varies. MITSUMI RM16 is used as alternator in setup.

V. CALCULATIONS

Calculation of the net head (H):-

Gross head = Hg = 31.82m

Total head loss due to friction (hf) = 1.9m (6% of Hg)

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H = Hg – hf
H = 31.82 – 1.9
H = 29.92 m

Velocity of jet: - The velocity of jet at inlet is given by
$V = Cv\sqrt{2 \times g \times h}$
$V = 0.99\sqrt{2 \times 9.81 \times 29.92}$ Cv = Coeff of velocity = 0.98 to 0.99
V = 23.98 m/s

Initial velocity
$U = \Psi\sqrt{2 \times g \times h}$
$U = 0.45\sqrt{2 \times 9.81 \times 29.92}$ Ψ = Speed Ratio = 0.43 to 0.48
U = 10.90 m/s

Mean diameter of runner (D) :-

$U = \frac{\pi DN}{60}$
$10.90 = \frac{\pi \times D \times 1350}{60}$
D = 0.154 m

Area of Jet :-

$A = \frac{\pi}{4} X (d)^2$
$= \frac{\pi}{4} X (0.015)^2$
$A = 1.76 X 10^{-4}\ m^2$

Discharge :-
Q = A X V
$= 1.76 X 10^{-4} X 23.98$
$Q = 4.22 X 10^{-3}\ m^3/s$

Number of Bucket (Z) :-

$Z = 15 + \frac{D}{2d}$
$= 15 + \frac{0.154}{2(0.015)}$
Z = 20

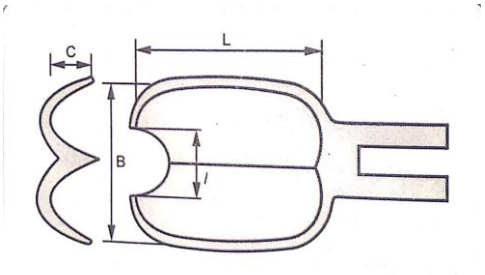

Fig. 3 Geometrical proportions of Pelton wheel

Geometrical features of Pelton wheel bucket :-
L = Length of bucket = (2.3 to 2.8)d
L = 2.5 X 0.015
L = 0.0375 m
B = Breadth of bucket = (2.8 to 3.2)d
B = 3 X 0.015
B = 0.045 m

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C = Depth of bucket = (0.6 to 0.9)d
C = 0.7 X 0.015
C = 0.0105 m
l = width of notch = (0.002 to 0.006 m) + d
l = 0.004 + 0.015
l = 0.019 m

Power :-
V_1 = 23.98 m/s
U_1 = 10.90 m/s
H = 29.92 m/s
Ø = 180 -165 = 15°
$U_1 = U_2$ = 10.90 m/s
$Vr_1 = V_1 – U$ = 13.08 m/s
$Vr_1 = Vr_2$ = 13.08 m/s
$V_1 = Vw_1$ =23.98 m/s
$Vw_2 = Vr_2 (Cos Ø – U)$
= 13.08 × [Cos(15)] – 10.90
Vw_2 = 1.75 m/s

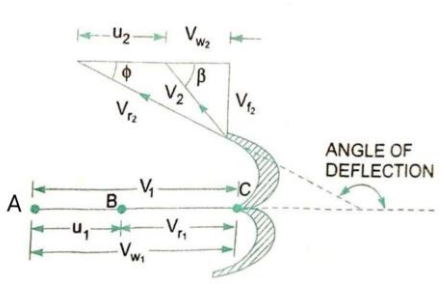

Fig.4 Velocity triangle for Pelton wheel turbine

$$Po = \frac{\rho \times A \times V1 \times [Vw1 + Vw2] \times u}{1000}$$
$$= \frac{1000 \times 1.76 \times 10^{-4} \times 23.98 \times [23.98 + 1.73] \times 10.90}{1000}$$
Po = 1182.73 Watts
$$Pi = \rho \times g \times Q \times H$$
$$= 1000 \times 9.81 \times 4.22 \times 10^{-3} \times 29.92$$
Pi = 1239.63 Watts

VI. CONCLUSIONS

If proper use of resources are been made the generation of electricity is easily possible. The available head readily available in high rise building can be utilized using this concept. The micro pelton turbine can be used to light the street lamp and bulb present in society. The electricity produced is pollution free, reliable and renewable. It is cost effective setup and electricity produced will be free, after it crosses break even point.

REFERENCES

[1] P.Sarkar, B.Sharma and U. Malik, *Energy generation from grey water in high raised buildings:the case of India* , Renewable Energy, vol.69, 2014, p. 284-289.
[2] L.S.Tieswosh, J.Jirasek and M.Sivek, *Electricity Generation in India: Present State,Future Outlook and Policy Implications*, Energies, 2019, 12,1361.
[3] A.Zidonis, D.S.Benxon and G.A.Aggidis, *Development of hydro impulse turbines and new opportunities*, Renewable and Suistainable Energy Reviews, vol.51, 2015, p.1624-1635.
[4] N.J. Kumbhar, P. Patil, A. Zunjar, R. Salokhe, and S. Patil, *Design and implementation of hydro turbine for power generation and its application*, IRJET, 2016, p. 1653-1656.

ISSN: 2233-7857 IJFGCN

[5] N. Manjunatha, K. Kumar and Dr, T. Gowda, *Design of apeton wheel turbine for a micro hydro power plant*, ICSTM-16, 2016, p. 447-454.
[6] T, Ghosh, A. Das and P. Das, *Small scale power for tall building through waste management*, IOSR-JMCE, vo.12, 2015, p.p. 20-22.
[7] C.Ye, J. Yang, X. Liamg and W. Xu, *Design and Research of a High-Speed and High Frequency Pulsed Alternator*, IEEE Transactions on Plasma Science, 2017.
[8] S. Sabu, N. Jacob, Tom Alphonse Antony and A. Alex, *Design and Modeling of a Pelton Wheel Bucket*, IJERT, vol. 3, 2014, p. 2271-2273.
[9] T. Nigussie, A. Engeda, and E. Dribssa, *Design Modeling CFD Analysis of a Micro Hydro Pelton Turbine Runner*: For the Case of Selected Site in Ethiopia, International Journal of Rotating Machinery vol. 17, 2017, pages.17.
[10] Dr. R. K. Bansal, *Hydraulic Machies*, Laxmi Publication.

ISSN: 2233-7857 IJFGCN