International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2015): 6.391

Fabrication of Hydropump

Pramod Mahajan[1], Kiran Harnale[2], Akshay Jadhav[3], S.T Dhande [4]

[1, 2, 3]People's Education Society's College of Engineering, Nagsenvana, Aurangabad-431002 (M.S.), India

[4]Professor, People's Education Society's College of Engineering, Nagsenvana, Aurangabad-431002 (M.S.), India

Abstract: *As we know that river water current has some velocity in the range 0.5-5m/s it poses an amount of kinetic energy & also the obvious need for agriculture is water, which is required to be pumped from river. So it is seems a good idea to pump that water by using the hydropower from the same river without any special construction. So we decided to put that idea in actual practice. The moving water rotates the wheel or turbine, which spins a shaft. The motion of the shaft can be used for mechanical processes, such as pumping water, or it can be used to power an alternator or generator to generate electricity. The use of hydrokinetic energy to pump the water for agriculture fields is very economical*

Keywords: Waterwheel, Hydropower, Pump, Head, Agriculture

1. Introduction

It is a typical type of pump which is used to pump the water without electricity. The main purpose of our project is use of Hydropump in Agricultural field.

Another major application of impoundment hydropower is pumped storage. In contrast to conventional hydropower plants which release water after it generates power, pumped storage plants reuse water after it initially produces electricity. Typically, the water flows from the turbines into a second, lower reservoir located below the dam. During off-peak hours (i.e., periods of low energy demand), some of the water is pumped back to the upper reservoir and released to generate electricity during periods of peak energy demand.

2. Literature Survey

1. Water Power: the Undershot Waterwheel and Pelton Wheel Collections Department Museum of Science & Industry

Waterwheels first appeared in Egypt in around 200 BC. These early waterwheels were aligned horizontally and could be powered by oxen. They were used to raise water to irrigate the land and to power millstones for grinding grain into flour. Their use quickly spread throughout the Mediterranean. The Romans brought waterwheel technology to Britain. By 1086 when the Domesday Book was produced, there were more than 5,000 waterwheels in England. These would have been vertical waterwheels, featuring a right-angled gear system, which were much more efficient than the horizontal waterwheel.

Before the development of the steam engine in the eighteenth century, many industries relied on the water power to drive their machines. Using cast iron instead of wood enabled the manufacture of more powerful and durable waterwheels. However, waterwheels were an unreliable source of power, because of the possibility of drought or flood, and were soon surpassed by the steam engine. The undershot waterwheel is the simplest type of waterwheel. It consists of a paddle wheel that is placed so that it is about a quarter submerged in the river. The wheel is turned by the force of the water current against the submerged paddles.

During the dry season, the level of the waterfalls and the river flows more slowly, supplying less power to the waterwheel. Undershot waterwheels are wholly reliant on the energy of flowing water. The other types of waterwheel, the overshot waterwheel and breast shot waterwheel are more efficient because they harness the force of gravity as well as the water energy. The overshot waterwheel is positioned so that water flows onto the top of the wheel.

2. Design and Performance Analysis of Centrifugal Pump, Khin Cho Thin, Mya Mya Khaing, and Khin Maung Aye.

This paper deals with the design and performance analysis of centrifugal pump. In this paper, centrifugal pump is analyzed by using a single-stage end suction centrifugal pump. Two main components of a centrifugal pump are the impeller and the casing. The impeller is a rotating component and the casing is a stationary component. In centrifugal pump, water enters axially through the impeller eyes and water exits radially. The pump casing is to guide the liquid to the impeller, converts into pressure the high velocity kinetic energy of the flow from the impeller discharge and leads liquid away of the energy having imparted to the liquid comes from the volute casing.

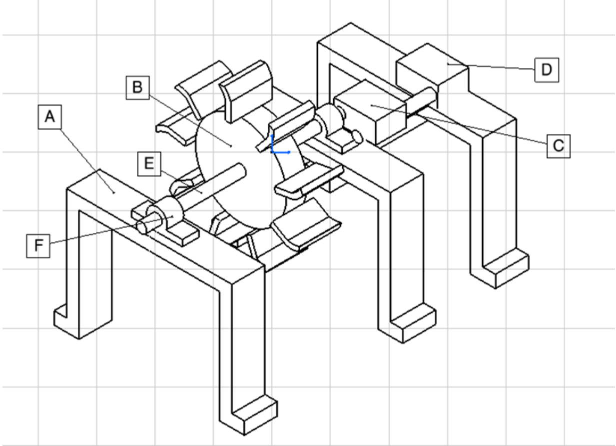
A design of centrifugal pump is carried out and analyzed to get the best performance point. The design and performance analysis of centrifugal pump are chosen because it is the most useful mechanical rot dynamic machine in fluid works which widely used in domestic, irrigation, industry, large plants and river water pumping system. Moreover, centrifugal pumps are produced by manufacturing processes in Myanmar.

In this paper, the pump is driven by one horse power electric motor and the design is based on Berman Method. The head and flow rate of this pump are 10 m and 0.179m3/s and the motor speed is 2900 rpm. The low specific speed is chosen because the value of specific speed is 100. The number of impeller blade is 9 blades. The performance analysis of centrifugal pump is carried out after designing the dimensions of centrifugal pump. So, shock losses, impeller friction losses, volute friction losses, disk friction losses and recirculation losses of centrifugal pump are also considered in performance analysis of centrifugal pump.

3. Methods/Approach

3.1 Concept

The basic concept is, run a water wheel by means of flow of river water current & use that power for pumping the water.



A- Foundation
B- Water wheel
C- Gear box
D- Impeller
E- Main shaft
F- Pedestal housing for bearing
We design this particular assembly to run the impeller of **0.5hp** (373watt) pump.

3.2 Design of water wheel

Design of water wheel contains design of blades, its angle, depth & no of blades.

3.2.1 Angle of deflection

For maximum o/p, the water should strike the blades at an angle of 90˚. From geometry of water fall at site, we found the angle of deflection is to be 165˚.

3.2.2. No. of blades

For water wheels, No. of blades are found from geometry of water fall. By considering the fact that, only one blade should have contact with the flow stream. So the angle between two blades is 40˚.

Then no of blades= $\frac{360}{40}$
= 9 nos.

Water wheel

3.3 Design of main shaft-

Assuming the power o/p of 1 kw to be transmitted with 40 rpm.

Then torque to be transmitted is given by,

$$T = \frac{60\times10^6\times(Kw)}{2\pi n}$$

$$T = \frac{60\times10^6\times1}{2\pi\times40}$$

T= 238.73 N-m

Value of τ for M.S. material is taken as 100 N/mm^2.
Diameter of shaft is calculated from equation,

$$\tau = \frac{16T}{\pi d^3}$$

d = 22.65 mm
≈ 25 mm

3.4 Design of gear box

From trials we have the rpm of main shaft as 65 rpm, with the power o/p as 1169watt. So by considering, various losses we decided to run the impeller by 1440rpm.

Consider a loss of 10rpm when wheel is loaded
Then i/p rpm= 55 rpm
Output rpm required= 1440 rpm.

$$V.R. = \frac{1440}{55} = 25.35$$

We design the gears to achieve this rpm in two stages to reduce the size of gears.

∴ V.R. in each stage = $\sqrt{25.35}$
= 5.08
We can select a gear pair of 25&127. Which has a V.R.=5.08.
So, rpm of impeller shaft= 1456.35rpm

3.5 Design of Intermediate Shaft

Torque transmitted by intermediate shaft= $\frac{238.73}{5.08}$
= 47.73 N-m

Value of τ for M.S. material is taken as 100 N/mm^2.
Diameter of shaft is calculated from equation,

$$\tau = \frac{16T}{\pi d^3}$$

d = 13.37 mm
≈ 15 mm

3.6 Bearing Selection

3.6.1 Selection of bearing for main shaft

Shaft diameter, d= 25mm
For mounting, we used adapter sleeve of i.d. 25mm & o.d. 30mm

$\therefore$ Bearing i.d. = 30mm

Radial load on bearing, F_r=723.43 N

L_{10}=8446.64 million rev.

$\therefore$ dynamic load carrying capacity, C= $F_r \times (L_{10})^{\frac{1}{3}}$

=723.43$\times (8446.64)^{\frac{1}{3}}$
=14733.53 N

So we can select bearing having designation **1206**, which has dynamic load carrying capacity, C=19500 N

3.6.2. Selection of bearing for intermediate shaft:

Shaft diameter, d= 15mm

$\therefore$ Bearing i.d. = 15mm

Radial load on bearing, F_r=135.01 N

L_{10}=146.4million rev.

$\therefore$ Dynamic load carrying capacity, C= $F_r \times (L_{10})^{\frac{1}{3}}$

=135.01$\times (146.4)^{\frac{1}{3}}$
=5590.2 N

So we can select bearing having designation **6202**, which has dynamic load carrying capacity, C= 7800 N

4. Result / Discussion

4.1 Results

For finding out the rpm of main shaft & the power output from it, we took no of trials. The results are discussed as follows.

4.1.1 Results of first trial

Rpm of wheel shaft= 52 rpm
Work done= 296.47 watt

4.1.2 Results of second trial

Rpm of wheel shaft= 65 rpm
Work done= 1169.06 watt

4.1.3 Results of final trial

Rpm of wheel shaft= 65 rpm
Rpm of intermediate shaft= 65 rpm
Head available= 9m
Discharge= 0.165 lit/sec

4.2 Discussion on results

After first trial, we had a power output at water wheel shaft 296.47watt. Which is not sufficient to run the pump of 0.5hp (i.e. 373watt). So we modify water wheel & took a second trial. At that time we had a power approximately 1169watt, which was more than sufficient to run the pump of 0.5hp, by considering all the losses & efficiencies.
After the final trial we got results as discussed above.

4.3Estimation of payback period

Table 1: Estimation of payback period

Sr. No.	Cost category	Conventional electric pump	Hydropump
1	Initial cost in Rs. ‘I’	2,800	13,550
2	Running cost in Rs./month ‘R’	900	0
3	Maintenance cost/year ‘M’	5% of initial cost =140	10% of initial cost= 1355
4	Cost after 1 year= I+(R*12)+M	13740	14905
5	Cost for further 4 months =13740+(R*4)+(0.5*M)	17410	15582.5

From above analysis it is clear that, the payback period of **Hydropump** is around **16 months.**
*The above analysis was done by assuming the fact that; the pump is running for 24 hours each day.

5. Conclusion

From above results & analysis, it is seen that, the use of hydrokinetic energy to pump the water for agriculture fields is very economical. Though the initial & implementation cost of this project is more than conventional pump, but it recovers by the zero running cost. The payback or recovery period for 24 hour running 0.5 hp pumps is found to be 16 months i.e. after 16 months, the use of Hydropump is totally cost free. Only small maintenance cost is required. In spite of above advantages, it also possible to run the pump of more power, by increasing the diameter of water wheel or mounting the no. of water wheels on the main shaft.

The site selection becomes the key factor in designing this types of projects. It’s because the site should have the required flow characteristics with the feasibility of installation & maintainability. If the site is feasible for installing, then use of **Hydropump** gives an uninterrupted & economical output.

6. Acknowledgement

We are extremely thankful and express our sincere gratitude to our guide **Prof. S.T. Dhande,** Whose enthusiastic and ever helping attitude helped us a lot to make this endeavor a success.

We also take this opportunity to thank **Dr. M.M. Dhobe,** H.O.D. Mechanical Engg. and all lecturers for inspiring & helping us in very possible way.

We are also thankful to **Mr. Ravi Shirolkar** & **Mr. Shivaji Kadam** for their kind & whole hearted co-operation without which this project would have been only a dream.

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[2] DOE has identified approximately 5,677 sites with the potential to generate about 30 GW of power using small-scale hydroelectric technologies. U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy ,Hydropower Resource Potential, DOE 2006, http://www1.eere.energy.gov/windandhydro/hydro_potential.html.
[3] Low-head hydropower usually refers to sites with a head (i.e., elevation difference) of less than five meters (about 16 feet). Sites with less than three meters (about 10 feet) of head are generally referred to as "ultra-low head."
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Author Profile

Pramod Mahajan - received the Diploma in Mechanical Engineering from T.B.G. Polytechnic, Ambajogai (M.S.) in 2013, and pursuing B.E. in Mechanical Engineering.

Kiran Harnale- pursuing B.E. in Mechanical Engineering from P.E.S. College of Engineering, Aurangabad.

Akshay Jadhav - pursuing B.E. in Mechanical Engineering from P.E.S. College of Engineering, Aurangabad.

Prof. S.T Dhande- assistant professor in P.E.S Engineering College, Aurangabad.