International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 11 | Nov 2022 www.irjet.net p-ISSN: 2395-0072

A Study on the performance of a proposed working model of Pedal Operated Centrifugal Water Pump

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Abstract - *The objective of this work is to design, fabricate and experimentally investigate the performance of Pedal pedaled water pumping machine which is used to lift water in the range of 10–15-meter height. Pedal operated centrifugal water pumping machine is used to lift water from sump to that place where irrigation is required. It provides irrigation in remote areas where electricity is not available. Pedal water pumping machine is free from pollution. It is designed as a portable one which can be used for irrigation in various places. The Pedal operated centrifugal water pumping machine requires only manual power thereby reducing the utility bill considerably.*

Key Words: Pedal Operated Water Pump (POWP), centrifugal pump, impeller, Sprocket, Angular Velocity.

INTRODUCTION

Pedal Operated Water Pump (POWP) is an ecofriendly water pump system. The POWP works on mechanical energy without electricity. POWP provides drinking water and irrigation in remote areas where electricity is not available. POWP is not only free from pollution but also provide healthy exercise. POWP reduces the rising energy costs. POWP consists of a centrifugal pump operated by pedal power, along with small and large sprockets with 18 and 90 teeth respectively. The centrifugal pump is positioned on its stand and the driven shaft of the centrifugal pump is connected to the sprocket and then bicycle pedal with the help of belt. By pedaling, the connected small sprocket that is connected with shaft with rotate and along with it the larger sprocket will also rotate, thereby rotating the centrifugal pump which in turns discharges water from the pump with the help of impeller present inside the pump.

1.1 Working Principle

In pedal operated water pump when pedal is operated by human being then human energy is transfer into mechanical energy and this energy is transferred to the second sprocket and it is connected to the third sprocket with a rotating shaft which generates more rpm (Fig.1).The 3rd sprocket is connected with the 4th sprocket by chain and the 4th sprocket is connected with the 5th sprocket by rotating shaft .Also the 5th sprocket is connected a chain with the 6th sprocket which is connected with the impeller shaft. After all the energy transferred to the impeller shaft which creates vacuum inside the pump casing which caused water is sucked by suction pipe through impeller eye. It strikes the impeller blade and velocity energy is imparted to the liquid by means of centrifugal force produced by rotation of the impeller and the water is radially pushed out towards the impeller periphery. The velocity energy of water is converted to pressure energy by directing it to an expanding volute design casing in a volute type centrifugal pump. Then the water is discharged through the delivery pipes (Fig.2).

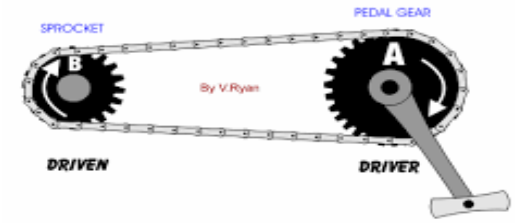

Fig.1: Driver to driven Sprocket power transmission.

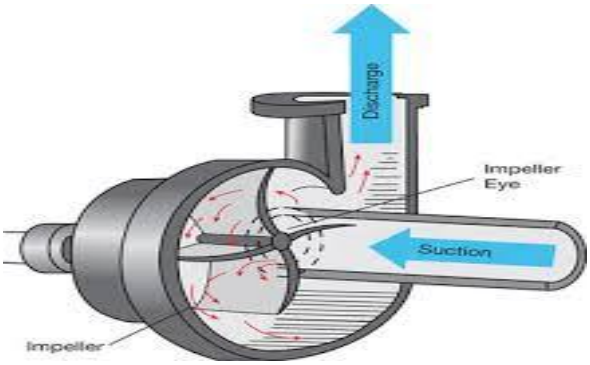

Fig.2: Suction and discharge through pump.

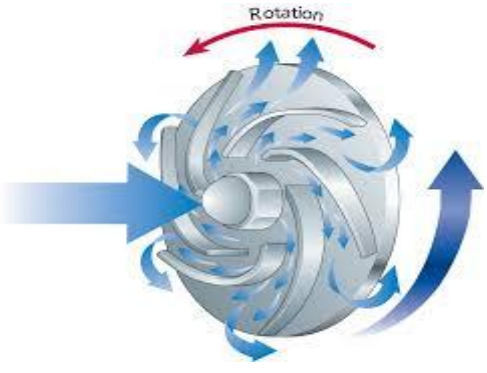

Fig.3: Impeller

2 NUMERICAL APPROACHES

Sprocket:

Relative velocity, $V_R = \frac{Angular\ velocity\ of\ follower}{Angular\ velocity\ of\ driver}$

$= \frac{\omega_2}{\omega_1}$ $[\omega = 2\pi N]$

$= \frac{N_2}{N_1}$ $[\pi d_1 N_1 = \pi d_2 N_2]$

$= \frac{d_1}{d_2} = \frac{T_1}{T_2}$

Where $\omega = Angular\ velocity$

N=R.P.M(Revolution per minute)

T=teeth of sprocket.

From the above equation we can write, $\frac{T_1}{T_2} = \frac{N_2}{N_1}$

Circumference of the sprocket:

Circumference = pitch× teeth.

Diameter of the sprocket:

Diameter=$2(\frac{c}{2\pi})$

Where c=circumference

Formula for chain speed calculation:

- Take chain pitch and multiply ×2.
- Multiply above number by number of teeth on main sprocket.
- Multiply that number by sprocket RPM. The number we get will be chain speed in inches per minute to convert to feet divide by 12. To convert to feet per second divide by 720.

Centre to Centre distance in inches:

$$C = \frac{p}{8}[2L - (N+n) + \sqrt{2L - (N+n)^2 - \frac{8}{\pi^2}(N+n)^2}]$$

Chain length in pitches:

$L = \frac{2c}{p} + \frac{N+n}{2} + \frac{p(\frac{N-n}{2\pi})^2}{c}$

C=Centre to Centre distance.

L=Chain length in pitches.
P=Pitch of chain.
N=Number of teeth on large sprocket
n=Number of teeth on small sprocket.

Pump:

Discharge of pump, Q=AV

Where A=area of cross section

V=velocity of fluid

Horse power of pump:

Horse power =torque ×RPM

Where torque=Distance×Force

RPM=Revolution of per minute

Static Head:

$H_{static} = h_s + h_d$

Where $h_s = Suction\ head$

$h_d = Delivery\ head$

3. CALCULATION:

In case of pump:

From the pump we can take,

Q=45 $\frac{m^3}{h}$

H=14.5 m , RPM=2600

Now, we can calculate torque=$\frac{1}{520}$

In case of sprocket:

We can assume we have six sprocket $T_1, T_2, T_3, T_4, T_5, T_6$ and also we can assume the teeth of the sprocket and the RPM of first sprocket is 50 rpm,

Let=T_1=90 $T_2 = 18$

T_3=70 $T_4 = 18$

T_5=50 $T_6 = 18$

We know, $\frac{T_1}{T_2} = \frac{N_2}{N_1} = 5N_2 = 5 \times 50$=250rpm

$\frac{T_3}{T_4} = \frac{N_4}{N_3} = 3.9N_4 = 3.9 \times 250 = 975$ rpm

$\frac{T_5}{T_6} = \frac{N_6}{N_5} = 2.78N_6 = 2.78 \times 975 = 2710.5$rpm

Now, we can measure the radius of the sprockets,

We know,

Pitch ×teeth =circumference

$r_1 = \frac{1.5\times90}{2\times3.14} = 21.497$ cm

$r_2 = \frac{1.5\times70}{2\times3.14}$ =16.719 cm

$r_3 = \frac{1.5\times50}{2\times3.14}$=11.943cm

3. CONCLUSION

The whole study over the topic concludes over the fact that the Pedal operated power pump is very advantageous especially for rural areas. The problem of energy crisis is very big in India and by the help of this pedal powered water pump we can save electricity and also supply the water in irrigation. We can operate a water pump by using pedal mechanism of the project and we can fill the water tank of housing, produce power and get help in the construction work. Pumps can be adapted to fit individual community needs. It can also be placed in garden, both gardening and cycling can be done simultaneously. We will try to operate pump near best efficiency point.

REFERENCES

[1] A. S. Akinwonmi et al. "An Experiment on Pedal powered Centrifugal water pump" ISDE (Vol.3, No. 11),2012.

[2] M. S. Islam et al. "Design and Development of Simple Pedal Operated water pump" JARD,5 (1&2)116-126, 2007.

[3] B. Lee. "Pedal powered centrifugal pump for pure water supply device", International Journal of Technology, 2007

[4] N. K. Pedalare "An Experiment Setup and Design of Pedal Powered Water Pump" International Journal of Engineering Research and Technology (Vol.2, Issue.1),2013

[5] S. K. M. Sunny et al. "Experimental Investigation of Pedal Powered Centrifugal Pump," International Journal of Engineering and Science, p. 5, 2014

[6] A.P. Ganorkar et al."Development of Pedal Operated Water Pump", vol. 7, no. 2, 2016.

[7] A. T. Wadgure et al. "Bi-cycle operated centrifugal pump mechanism for water lifting," vol. 02, no. 03, 2015

[8] J. Gidwani et al. "Pedal Powered Water Pumping and Purification," vol. 2, no. 5, 2016.