DESIGN AND FABRICATION OF PUMPING SYSTEM USING TWO WHEELER

Mr.D. Karunakaran,
Associate Professor,
Department of Mechanical Engineering,
Sri Manakula Vinayagar Engineering College,
Puducherry- 605107
karunakaran@smvec.ac.in

Mr.A.Jeyachandran
Associate Professor,
Department of Mechanical Engineering,
Sri Manakula Vinayagar Engineering College,
Puducherry-605107

ABSTRACT
This work aims at fabrication of pumping arrangement using two wheeler. This arrangement is useful in emergency situation to lift water from sump or well. Two wheelers can be used as input power source and special pumping arrangement is attached using the chain drive mechanism. Testing of this arrangement produced 5 meter suction head in a pipe of diameter 1.5 inch to delivery head of 10 meters. Mechanical input power got from chain drive of a two wheeler is coupled directly with input shaft of centrifugal pump. It is easy to attach this arrangement within few minutes. This pumping arrangement is especially very useful during natural calamities such as flood, earthquake etc., during which the main EB power source is unavailable. This is also helpful during disasters.

Keywords: Pumps, chain drives, two wheeler pumps, water pumping, water management during disasters.

1. INTRODUCTION:

Pumps play predominant role in industrial and residential applications. Pumping equipments are of different types and varieties of categories, varying in type, size, and materials of construction. They are used to transfer liquids from low-pressure to high pressure A pump refers to a machine that uses several energy transformations to increase the pressure of a liquid. Pumping system are used widely in irrigation, water supply plants, stream power plants, sewage transfer, oil refineries, hydraulic power service, food processing industry and mines. Also, they are also used extensively in the chemical industry because of their suitability.

PRESSURE MEASUREMENT

***Static Head*:** Static head is the difference in height between the source and destination of the pumped liquid. It consists of:

Static Suction Head (h_S): The resulting from lifting the liquid relative to the pump center line. The h_S is positive if the liquid level is above pump centerline, and negative if the liquid level is below pump centerline (also called “suction lift)

Static Discharge Head (h_d): The vertical distance between the pump centerline and the surface of the liquid in the destination tank. The static head at a certain pressure depends on the weight of the liquid and can be calculated with this equation:

$$\text{Head (in feet)} = \frac{\text{Pressure (psi) X 2.31}}{\text{Specific gravity}}$$

The shaft is analyzed for stresses and deflection and same results are verified using graphical integration method. In the second test for dynamic analysis, result obtained by static analysis is used to calculate dynamic forces acting in the pump shaft. Again, shaft is analyzed in dynamic input condition and results are verified by using graphical integration method. Maximum deflection and stress are generated to minimum flow condition. Maximum dynamic deflection is obtained 11% less than allowable deflection and Maximum stresses for dynamic is obtained 18% less than allowable tensile strength.

2. DESIGN AND FABRICATION

COMPONENTS USED

- Four stroke bike
- Centrifugal pump
- Chain sprocket mechanism set up

SPECIFICATIONS

BIKE

Bike model	: Hero Passion Plus
Engine displacement	: 97
Engine type	: Ohc-4stroke
No of cylinder	: One
Cooling system	: Air Cooling
Power	: 5.74kW at 7500rpm
Natural torque	: 8.04N-m at 500 rpm

CENTRIFUGAL PUMP

Maximum Power	:	0.5 HP
Maximum current	:	3.5A
Power Input	:	0.75kW
Total head	:	19m
Rotation speed	:	2800rpm
Discharge	:	900lph
Highest range	:	14/24m
Specific Time	:	100sec at 3m

SELECTION OF MATERIALS

Sl. No	Part Name	Material Selected
1.	Shaft	Mild Steel
2.	Sprocket	Cast Iron
3.	Impeller	Cast Iron
4.	Casing	Cast Iron

DESCRIPTION OF COMPONENTS

SPROCKET

The sprocket which chosen is to support the shaft because positioning is important to transmit power.

Fig.1. Sprocket

CHAIN DRIVE

Chain drive mechanism transmits mechanical power from driver to driven shaft. It is often used to convey power to the wheels, particularly in bicycles and automotive and also industrial machineries. The chains are mostly used to transmit motion and power from one shaft to another, when the centre distance between their shafts is short such as in bicycles, motor cycles, agricultural machinery, conveyors, rolling mills, road rollers etc. The chains may also be used for long centre distance of up to 8 meters.

DESIGN OF CHAIN DRIVE

Design Specifications

Rated power(R.P) = 0.75 kW

Speed of two wheel (N_1) = 7500 rpm

Speed of centrifugal pump (N_2) = 2800 rpm

Torque of two wheeler = 8.04 N-m

To calculate Velocity Ratio,

$$V.R = \frac{N1}{N2} = 7500/2800 = 2.67$$

Velocity Ratio = 3

By choosing the velocity ratio the no of teeth on small sprocket on pinion in velocity ratio of 3 is 25.

Therefore no of teeth on larger sprocket

$(T_2) = T_1 * (N_1/N_2)$

$= 25* (7500/2800)$

$T_2 = 66.78 = 70$ (approx.)

To calculate Design Power

Design Power =Rated power* service factor

Service Factor (k_s) is calculated with calculation of Load factor [k_1] , Lubrication factor[k_2], Rating factor[k_3].

Assuming the following values

Load Factor (k_1) = 1.5

Lubrication Factor (k_2) = 1

Rating Factor (k_3) = 1.25

Solving,

Service factor = $k_1 * k_2 * k_3$

= 1.25*1*1.5

k_s = 1.875

Design Power = R.P *Service factor

= 0.75*1.875

= 1.5 kW

The Pump running at 0.75 kW input power coupled with 5.74 kW produces 1.5kW power.

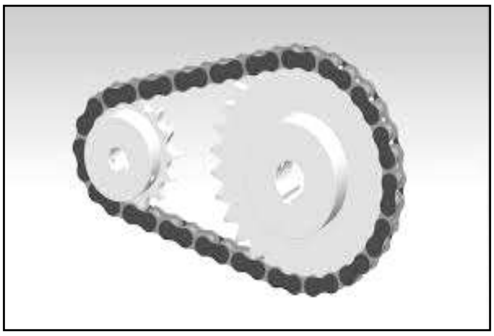


Fig.2. Chain drive set up

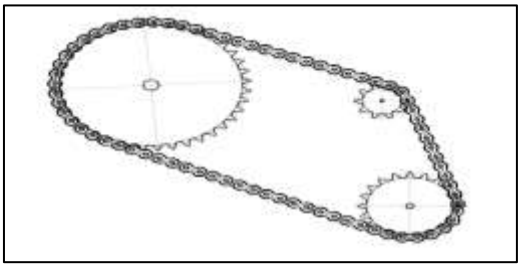


Fig.3. chain drive with additional power output sprocket

SHAFT

A shaft is a mechanical component for transmitting torque and rotation. It usually used to connect other components of a drive train that cannot be connected directly because of distance. If the need is there to allow relative movement between components there also we need to use shafts. Power or Drive shaft is the one which carries torque; they are subject to torsion and shear stress, according to the input torque and the load.

2

Fig.4. EN8 Steel Shaft

FABRICATION OF SETUP:

The special pumping arrangement is to pump water to certain height with the help of two wheelers. For that, we designed a setup with a little modification in the existing centrifugal pump. After disassembling, the impeller of the centrifugal pump is alone kept for use and all the other parts are removed. The below figure (Fig.5) shows the arrangement. The shaft which is connected from impeller is known as impeller shaft. The impeller shaft is connected with the chain drive. A sprocket is welded along the end of the shaft. The sprocket is welded in such a way that it rotates along the chain drive mechanism of two wheeler. The chain cover and barrier guard at the rear wheel side is removed and set up is fitted using bolt and nut. The entire arrangement is as shown below.

Fig.5. Setup

Fig.6. Pumping Arrangement Setup

3. EXPERIMENTATION

TESTING PROCEDURE

The two wheeler is kept in the resting position, stands vertically using double side stand. Then, the setup is fixed to it. Inlet water connection is made with the sump using plumbing arrangements such as pipe; hose etc., now, the set-up is ready for testing.

Engine is started and the gear shifted to First gear. In the resting position, the rear wheel rotates with chain drive mechanism. As the set-up is connected with chain drive, the sprocket of the set up engages with the chain and the impeller shaft starts to rotate.

Priming is done, if needed; to remove air lock in the pump. Due to rotation, the water is pumped from the sump to the outlet pipe. The discharge of water is taken and readings are noted. The amount of water discharged for certain time is calculated and specific fuel consumption of the two wheeler is calculated. The experiment is repeated for different gears and amount of water discharged is noted. The experiment is carried out for specific fuel consumption and amount of fuel required.

DIMENSIONS OF THE SETUP

The experiment was conducted for the calculation of time taken per liter discharge of water through outlet pipe at different gears and the specific fuel consumption was found. The details of the setup for calculation are given below:

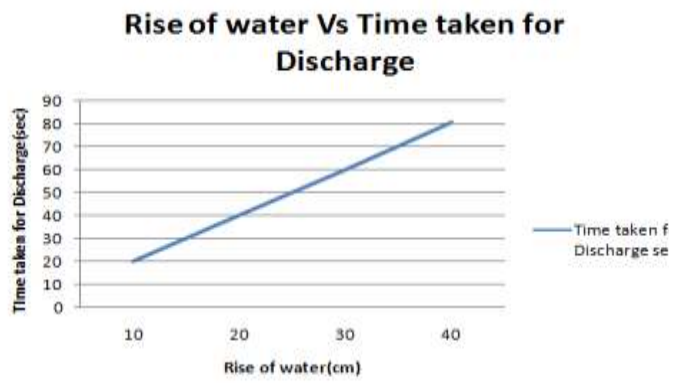
Diameter of the shaft = 12mm
Diameter of the inlet pipe = 25mm
Diameter of the outlet pipe = 27mm
Length of the shaft = 70mm

4. RESULTS AND DISCUSSION

RISE OF WATER Vs TIME TAKEN FOR DISCHARGE

The readings are tabulated as per the experiment conducted.

Sl.NO.	RISE OF WATER (mm)	TIME TAKEN FOR DISCHARGE (sec)
1.	100	20.06
2.	200	40.24
3.	300	60.22
4.	400	80.47



Graph 1. Rise of water Vs Time plot Curve

COMPARISON AND ANALYSIS OF RESULTS FUEL CONSUMPTION

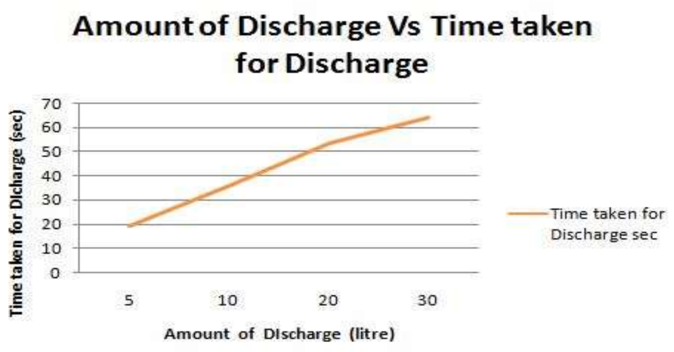
BEFORE CONNECTING SET UP

Fuel consumed(ml)	Time taken (sec)
100	25

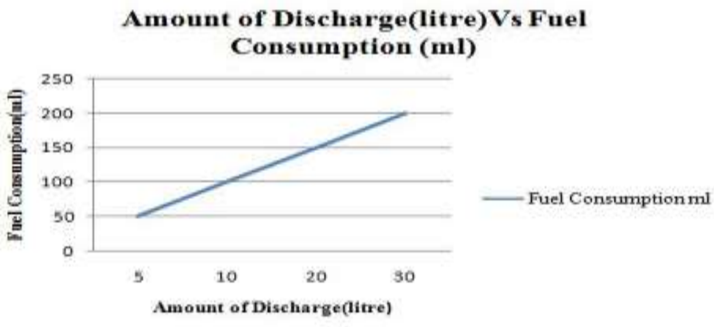
Speed is 20 Km/Hr.

AFTER CONNECTING SET UP

Sl.NO	**AMOUNT OF DISCHARGE** (liter)	**TIME TAKEN FOR DISCHARGE** (sec)	**FUEL CONSUMP-TION** (ml)
1.	5	19.06	50
2.	10	35.51	100
3.	15	53.22	150
4.	20	64.05	200



Graph 2. Amount of Discharge Vs Time taken for Discharge



Graph 3. Amount of Discharge Vs Fuel Consumption

DISCUSSION

Using petrol as the fuel, it is found that fuel consumption of 500 ml is there for a discharge of 25 liters of water at a height of 10 feet.

5. CONCLUSION

This pumping system is very useful to lift water during power failure. This innovative idea provides many opportunities to explore creativity in solving social problems and use of engineering knowledge for the benefit of society. Many trial and errors are made to achieve the maximum efficiency of the system. The experience during this work is very valuable and it enables many new avenue of creative thinking for solving day to day problem.

REFERENCES

1. Akhras M. El Hajem R. Morel J.Y. Champagne. "The Internal Flow Investigation of a Centrifugal Pump" Journal of Visualization volume 4, pages 91–98(2001)

2. Amit Suhane, "Experimental Study on Centrifugal Pump to Determine the Effect of Radial Clearance on Pressure Pulsations, Vibrations and Noise" International Journal of Engineering Research and Applications (IJERA) Vol. 2, Issue4, July-August 2012.

3. Austin. H. Church. 1972. Centrifugal Pump and Blowers. New York: John Wiley and Sons, Inc. [9] William. L. Amminger., and Howard. M. Bernbaum.. "Centrifugal Pump Performance Prediction". 1973.

4. Daugherty,L. "Centrifugal Pumps". A book published by McGraw-Hill Book Company Inc., 1915.

5. Jonathan X. Weinert & Ogden, Joan M. & Sperling, Dan & Burke, Andy, 2008. "The future of electric two-wheelers and electric vehicles in China," Institute of Transportation Studies, Working Paper Series qt0d05f8v9, Institute of Transportation Studies, UC Davis, 2008.

6. Khin Cho Thin, Mya Mya Khaing, and Khin Maung Aye " Design and Performance Analysis of Centrifugal Pump", World Academy of Science, Engineering and Technology 2008.

7. Stepanoff, A.J, "Centrifugal and Axial Flow Pumps". Krieger Publishing Company; 2 edition (1993).

8. Takemura T and Goto A, "Experimental and Numerical Study of Three-Dimensional Flows in a Mixed-Flow Pump Stage, "*Journal of Turbomachinery"* Volume 118, Issue 3 July 1996.

9. Tuzson, J. "Centrifugal Pump Design" USA: A book published by John Wiley and Sons. Inc.2000.

10. William. L. Amminger and Howard. M. Bernbaum.. "Centrifugal pump performance prediction using computer aid" Computers & Fluids,Volume 2, Issue 2, August 1974, Pages 163-172,.1973.
