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Research Paper

BICYCLE OPERATED PUMP FILTER

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In this paper, design and construction of bicycle operated pump filter is explained which is used in irrigation and filtration at small scale. The pedal operated pump can be constructed using local material and skill. The water system comprises of a centrifugal pump operated by pedal power. The pump stand is made up of a housing in which a foot pedal and a drive shaft rotates. It works on the principle of compression and sudden release of a tube by creating negative pressure in the tube and this vacuum created draws water from the sump. Thus, providing irrigation and drinking water where electricity is not available. The setup can be built using locally available materials and can be easily adapted to suit the needs of local people. It frees the user from rising energy costs, can be used anywhere, produces no pollution and provide healthy exercise.

Keywords: Pedal, Centrifugal Pump, Shaft, Impeller

INTRODUCTION

Mechanism

The mechanism comprises of single centrifugal pump which is fixed with the rear wheel bicycle and runs by rotating the pedal of a cycle at a particular rpm. Paddling for just a minute or two is enough to pump 5-10 litres of water to a height of 10-15 feet. The complete system includes a bicycle rim, impeller, an inlet and delivery pipes. The final supporting shaft is connected with an impeller. The wheel rotates the impellers of the centrifugal pump by sliding action between wheel and friction roller. In this process liquids and their movement from place to place, plays an important role. Liquid can only flow under its own power from a higher elevation to a lower elevation or, from a high pressure system to a lower pressure system. The flow of liquid is also affected by friction, pipe size, liquid viscosity and the bends and fittings in the piping. This project could be highly useful for rural areas which are facing load shedding problem. It can be used mainly for irrigation, filtration and water drawing water from wells and other water bodies (M Serazul Islam *et al*., 2007). Using this process of paddling water can be lifted from the pipe into the form for cultivation. It is useful for pumping water from river, ponds,

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wells and similar water sources enabling poor farmers for pumping water for irrigation and cultivation. To overcome flow problems and to move liquids from place to place, against a higher pressure or to a higher elevation, energy must be added to the liquid. To add the required energy to liquids a pump is used. A pump thus is defined as A machine used to add energy to a liquid. Pumps come in many types and sizes. The type depends on the function the pump is to perform and the size (and speed) depends on the amount (volume) of liquid to be moved in a given time (R K Bansal, 2005).

WORKING MECHANISM OF A ROTARY PUMP

In any process plant, a centrifugal pump is used to first convert energy of an electric motor or turbine into velocity or kinetic energy and then into pressure energy of a fluid that is being pumped. The energy change occurs due to the impeller and the diffuser of the pump. The impeller is the rotating part that converts driver energy into the kinetic energy. The diffuser is the stationary part that converts the kinetic energy into pressure energy. All of the forms of energy involved in a liquid flow system are expressed in terms of feet of liquid that is the head (R K Bansal, 2005).

Conversion of Kinetic Energy to Pressure Energy

The key idea is that the energy created by the centrifugal force is kinetic energy. The amount of energy given to the liquid is proportional to the velocity at the edge or vane tip of the impeller. The faster the impeller revolves or the bigger the impeller is, then the higher will be the velocity of the liquid at the vane tip and the greater the energy imparted to the liquid. This kinetic energy of a liquid coming out of an impeller is harnessed by creating a resistance to the flow. The first resistance is created by the pump volute (casing) that catches the liquid and slows it down. In the discharge nozzle, the liquid further decelerates and its velocity is converted to pressure according to Bernoulli's principle. Therefore, the head (pressure in terms of height of liquid) developed is approximately equal to the velocity energy at the periphery of the impeller expressed by the following well-known formula:

$$H = vxv/2g \quad ...(1)$$

where, H = total head developed in feet

v = velocity at periphery of

Impeller in ft/sec

g = acceleration due to gravity-32.2 feet/sec2.

SPECIFICATIONS

Hand-rotary pump used for transferring oil, water, alcohol, diesel fuel, gasoline and solvents from tank. High volume delivery at low pressure makes pumping.

- Body, cover and lever: cast iron
- Hand drum pump
- Fits 50-220kgs drums

Refer to Table 1

Table 1: Pump Specification

Pump Power	0.5 HP
Flow Rate	35-40 lit/min
Head	15-20 m
Pump Size	25*25 mm

RESULTS AND DISCUSSION

Axle Grip Deflection Analysis

The deflection of the free end of the axle grips is given by the following formula:

$$\delta_{axlegrip} = \frac{ML^2}{2EI} + \frac{WL^3}{3EI}$$

$$= \frac{64.68 * (80 * 10^{*3})^2}{2 * 207 * 10^9 * 2.292 * 10^{*-9}}$$

$$+ \frac{1068 * (80 * 10^{*3})^3}{3 * 207 * 10^9 * 2.292 * 10^{*-9}}$$

=.08 mm

Conclusion

The deflection of the axle grips is just less than 1mm.

Bearing Fatigue Analysis

The reactions at the bearings are calculated using static force and moment balances:

$\Sigma F: \Sigma Fr = R_A + R_B$

ΣM_B (CW) : R_A (30 + 30) - Fr * 30 = 0

F_r=100N → R_A=50N, R_B=50N

Conclusion

The reactions are 50 N each.

Results

Pump was able to pump at maximum of 10 feet. At desired height of 8 feet pump pumped at rate of 5 litres/min.

TESTING THE PROTOTYPE

Deflection Testing

The bicycle was locked into the supporting frame using the axle grips, but without the pump assembly in place, as failure of the axle grip lighteners would cause the weight of the bicycle and peddler to suddenly drop onto the pump. As the peddler gradually mounted the bicycle, the deflection at the axle grips was observed Figure 1. The observed deflection was negligible, which agrees with the predicted value of just less than 1mm. The supporting frame was also found to be structurally sound.

Figure 1: Deflection Testing

Mobility Testing

The process detailed above was executed first in reverse to go from pumping mode to transportation mode, then back to pumping mode. It was found to take around one minute to switch form one mode to the other. The

Figure 2: Mobility Testing

mudguard presented a slight problem, but could easily be tucked under the pump assembly. The bicycle was ridden around whilst in transportation mode with little change to the normal handling of the bicycle Figure 2.

General Operational Testing

During pumping, the Bicycle Operated Pump Filter was found to be slightly wobbly but stable due the supporting stand's wide base. The tilting of the frame due to the lifting of rear wheel did not hinder mounting and dismounting of the bicycle or make the peddling position uncomfortable Figure 3.

Figure 3: General Operational Testing

FUTURE PROSPECTS

In the future we can improve and work on this project to make it much more effective and efficient. Some of the future aspects of our project are:

- It can be used to generate electricity.
- It can be used to filter with higher accuracy.
- It can be used for large scale irrigation purpose.
- It can be used to filter stagnant water in disaster affected areas.
- It can be used to transport stagnant water in mountainous regions.
- It can be used to distribute water for domestic purposes in rural areas.

It can be integrated with cooling tower to provide cooling water for domestic use.

CONCLUSION

With reference to the objectives of the project, a concept and prototype for a bicycle powered water pump was designed, built and evaluated. Its main advantage over existing technology is its mobility which means that it is suitable for a variety of applications such as irrigation, agricultural, light industrial and domestic water transportation. The achievable pumping head and flow rate are directly related to the input power. Therefore the performance of pump will vary on who is peddling and how much effort they are putting in. Bicycle has dual functions of transporting equipment and driving membrane filtration system. UF membrane (0.5 micron) removes suspended particulates, colloidal material and certain bacteria. Cleaning of membrane is easily done by switching positions of flexible tubing direction and pedalling so that clean water flows in reverse direction, flushing out the particulates stuck on membrane surface.

REFFERENCES

Journal

1. M Serazul Islam, M Zakaria Hossain and M Abdul Khair (2007), "Design and Development of Pedal Pump for Low-Lift Irrigation" Publisher JARD

WEBSITE

2. www.mayapedal.org

BOOKS

3. R K Bansal (2005), "A Text Book of Fluid Mechanics and Hydraulic Machines".