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Design and Experimental Setup of Pedal Operated Water Pump

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1. Abstract

In this paper, design and construct pedal operated water pump which used in small irrigation and garden irrigation. The pedal operated pump can be construct using local material and skill. A water system includes a Centrifugal pump operated by pedal power. The pump stand includes a housing in which a foot pedal and a drive shaft rotate. 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. This bicycle pedal operated pumps water at 2-3 gallons per minute from wells and boreholes up to 23 in feet depth. Provides irrigation and drinking water where electricity is not available. They can be built using locally available materials and can be easily adapted to suit the needs of local people. They free the user from rising energy costs, can be used anywhere, produce no pollution and provide healthy exercise. Energy is the primary and most universal measure of all kind of work by human Being and nature. Everything what happen in the world in the expression of flow of energy is one of its form. Most people use the world energy for input to their bodies or to the machines and thus about fuels and power. Energy is an important input in all sectors of counters economy.

Keywords:- Pedal, Centrifugal Pump, Pulley, Shaft, Impeller etc.

2. Introduction of Mechanism

The mechanism consists of single centrifugal pump which is fixed with the rear wheel bicycle. Paddling for just a minute for just a minute or two is enough to pump 30-40 liters of water to a height of 100 feet. Our project could prove helpful for rural areas. Which are facing load shedding problem? It can be used mainly for irrigation and water drawing water from wells and other water bodies.[1]

This is a centrifugal water pump which is run by rotating the pedal of a cycle. The system comprises a bicycle, rim, impeller, pulley and inlet and delivery pipes. A wheel is connected to another pulley with a smaller diameter the final supporting shaft is connected with an impeller through this process of paddling is used to lift water from a pipe into the form for cultivation. This innovation is useful for pumping water from river, ponds, wells and similar water sources thus enabling poor formers for pumping water for irrigation and cultivation.

We drive a bicycle by using a paddling the wheel of the bicycle rotates a particular rpm. And this wheel rotates the impellers of the centrifugal pump by sliding action between wheel and pulley but the rpm of the wheel is very low so we can't get require head and power effort on the paddling is low so we can use the pulley which is mounted on the shaft of the pump and create the high rpm by using less power. [2]

In process operations, liquids and their movement and transfer from place to place, plays a large part in the process. Liquid can only flow under its own power from one 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.[3]

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, we use ' PUMPS '. A pump therefore 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.[4]

3. Working mechanism of a Rotary Pump

A centrifugal pump is one of the simplest pieces of equipment in any process plant. Its purpose is to convert energy of a prime mover (a electric motor or turbine) first into velocity or kinetic energy and then into pressure energy of a fluid that is being pumped. The energy changes occur by virtue of two main parts of the pump, the impeller and the volute or diffuser. The impeller is the rotating part that converts driver energy into the kinetic energy. The volute or diffuser is the stationary part that converts the kinetic energy into pressure energy.

Note: All of the forms of energy involved in a liquid flow system are expressed in terms of feet of liquid i.e. head.[4]

3.1 Generation of Rotational Force

The process liquid enters the suction nozzle and then into eye (centre) of a revolving device known as an impeller. When the impeller rotates, it spins the liquid sitting in the cavities between the vanes outward and provides centrifugal acceleration.

As liquid leaves the eye of the impeller a low-pressure area is created causing more liquid to flow toward the inlet. Because the impeller blades are curved, the fluid is pushed in a tangential and radial direction by the centrifugal force. This force acting inside the pump is the same one that keeps water inside a bucket that is rotating at the end of a string. Figure A.01 below depicts a side cross-section of a centrifugal pump indicating the movement of the liquid.

Figure No. 1: cut section of rotary pump

3.2 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:**

$$H = v \times v / 2g$$

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

A HANDY formula for peripheral velocity is:

$$v = N \times D / 229$$

Where,
v = velocity at periphery of impeller in ft / sec
N = the impeller rpm (revolution per minute)
D = impeller diameter in inches

This head can also be calculated from the readings on the pressure gauges attached to the suction and discharge lines.

Pump curves relate flow rate and pressure (head) developed by the pump at different impeller sizes and rotational speeds. The centrifugal pump operation should conform to the pump curves supplied by the manufacturer. In order to read and understand the pump curves, it is very important to develop a clear understanding of the terms used in the curves. This topic will be covered later[5][8]

4. Specification

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

Figure No. 2 Lobe Type Rotary pump

Place of Origin: Zhejiang China (Mainland)	Brand Name: RSF	Model Number: RSF-MP-100
Theory: Axial Flow Pump	Structure: Multistage Pump	Usage: liquid
Power: Hand-operated	Standard or Nonstandard: Standard	Fuel: Gasoline
Pressure: Low Pressure	Application: Metering	Theory: Hand-rotary
Feature: Light and easy to store	Application: 50-220kgs drum	Flow rate: 20lpm/55rpm

5. RESULTS AND CALCULATION

5.1 Rotary pumps calculation formulas:

Flow

$$Q = n \cdot V_{stroke} \cdot \eta_{vol}$$

Where,

$$Q = \text{Flow in cubic meter per second} \quad \left[\frac{m^3}{s}\right]$$

$$n = \text{revolution per second} \quad \left[\frac{rev}{s}\right]$$

$$V_{stroke} = \text{Swept volume in cubic meters} \quad [m^3]$$

$$\eta_{vol} = \text{Volumetric efficiency} \quad [.]$$

Power

P = n * Vstroke * Δp / ηmech,hydr
P = Power in Watt (Nm/s)
n = revs per second.
Vstroke = swept volume in m^3
Δp = pressure difference over pump in N/m^2
ηmech,hydr = mechanical/hydraulic efficiency[7]

5.2 Power and Efficiency

Brake Horsepower (BHP) is the actual horsepower delivered to the pump shaft, defined as follows:

$$BHP = \frac{Q \times Hr \times Sp.\ Gr.}{3960 \times Eff.}$$

Q = Capacity in gallons per minute
Hr = Total Differential Head in absolute feet
Sp. Gr. = Specific Gravity of the liquid.
Eff. = Pump efficiency as a percentage

5.3 Water Horsepower (WHP) is the hydraulic horsepower delivered by the pump, defined as Follows:

$$WHP = \frac{Q \times Hr \times Sp/Gr.}{3960}$$

Q = Capacity in gallons per minute
Hr = Total Differential Head in absolute feet
Sp. Gr. = Specific Gravity of the liquid

The constant (3960) is the number of foot-pounds in one horsepower (33,000) divided by the weight of one gallon of water (8.33 pounds).

Brake horsepower is always greater than hydraulic horsepower due to the friction in the pump. Pump efficiency is the ratio of these two values.

Pump Efficiency = WHP/ BHP

5.4 CALCULATION:-

Minimum rpm required for impeller shaft = **1000 to 1200 rpm**
Rpm available in rear wheel = **200 to 300 rpm**
Diameter of cycle rim= **0.6m**
Circumference of cycle rim= **3.14X0.6** = **1.88m**
Diameter of pump pulley = **0.06 m**
Circumference of pump pulley=**3.14x0.06** = **0.188**
Therefore,
Ratio between rim & pump pulley=1/10[9]

5.5 RESULTS

Pump was able to pump at maximum of 23 feet.
At desired height of 18 feet pump pumped at rate of 2.5 gallons/min.

Fig. No. – 3
(Experimental Setup of Pedal Operated Water Pump)

Fig. No. – 4
(Experimental Setup of Pedal Operated Water Pump)

6. CONCLUSIONS

The whole study over the topic that the wheel deal bicycle powered water pump is a very advantageous especially for rural areas

The problem of energy crises is very big in India and many rural powered water pump by use of this project we save electricity and get a particular water head and we supply the water in irrigation. We will operate a water pump by using bicycle mechanism in the project and we can fill the water tank of housing power and get construction work. when we drive a bicycle the wheel of bicycle are rotate so we can provide a pulley over the wheel the pulley is mounted on the shaft impeller of impeller of the pump the impeller is rotate due to rotating of wheel with rotation of pulley. So we operate the pump and deliver the water at a particular head this project is installed any of the place where water. Create a simple and efficient way of pumping water utilizing a human powered bicycle for communities where electricity is unavailable or impractical. Isolated community with or without electricity in need of efficient water pumping. Pumps can be adapted to fit individual community needs.

It can also be placed in garden, both gardening & cycling can do simultaneously. Operate pump near best efficiency point. Replace old pumps by energy efficient pumps. Reduce system resistance by pressure drop assessment and pipe size optimization. Provide booster pump for few areas of higher head.[10]

8. REFERENCES

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