

Experimental Setup of Pedal Operated Centrifugal Pump for Low-lift Applications

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Abstract: Objective of this paper based on renewable energy, If we boost the research on pedal powered technology - trying to make up for seven decades of lost opportunities - and steer it in the right direction, pedals and cranks could make an important contribution to running a post-carbon society that maintains many of the comforts of a modern life. The possibilities of pedal power largely exceed the use of the bicycle. As the concept of [pedal renewable energy](#) is emerging again with the revolutionary approach to clean the environment so many inventions are before us. So we had made an attempt to design and construct pedal operated water pump which is used in small irrigation like gardening is illustrated in this paper. 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 can be built using locally available materials and can be easily adapted to suit the needs of local people. This free the user from rising energy costs and can be used anywhere, produce pollution less environment and provide healthy exercise.

Keywords: centrifugal pump, gear, impeller, pedal, renewable energy.

I. Introduction

Pedal power vehicles are becoming popular day by day. Pollution in the environment is causing serious health issue and doctors are emphasizing the use of bicycle as an exercise to be healthy. On this line Chinese are replacing their vehicles with pedal power vehicles. Indians and Bangladeshi bicycle rickshaws are the examples of such vehicles.

Pedal power energy concept is not newer just renewed in the modern times because once again there is need to shift towards is to protect the environment. It does not mean that the advancement in technology will not proceed. It provides a secure environment to do positive work. It will increase the efficiency level of man power.

1.1 What is Pedal Power?

Human are using their powers for different purposes from ancient time. Today this power is giving ways for generating power. Pedal power means transfer of human energy from one body part that is leg to power generating system. After pedaling the bicycle, energy is transferred from human body to equipments that work with electric power.

1.2 What pedal power does?

Pedal power uses bicycle power generator to lighten bulbs or supply power to many other appliances. Production of power under this method completely depends on human capabilities. As more and more appliances are attached with power generator, it becomes tough for the person to maintain the supply. Pedal power generating system is combination of different technologies including man power and bicycle as most important. Other technologies used with this system include voltage and current meters, capacitors, display board and transmitters etc. Pedal power is very easy and simple to use so a non-technical person or even a kid can also try using it.

1.3 Mention the operating principles of pedal power?

Pedal power works under three main principles, power levels, pedaling rate and gear ratios. Power levels depend on capacity of human to pedal. Power level depends on how strong the peddler is and how long he can pedal. It is considered that a healthy non-athlete can easily generate up to 75 watts of mechanical power while an athletic person can give twice to this value. A smaller and weaker person can probably produce 50 watts in same time period. This analysis shows that power level varies with health of peddler.

Pedaling rate is another principle that influences pedal power. It counts the number of pedals a person made with pedaling speed. But some persons can produce more power at slow but consistent count of pedal. Therefore we can say that this rate varies from person to person because of physical conditions. A research shows that if a person pedal at range of 50 to 70 revolutions per minute then he can give most efficient results.

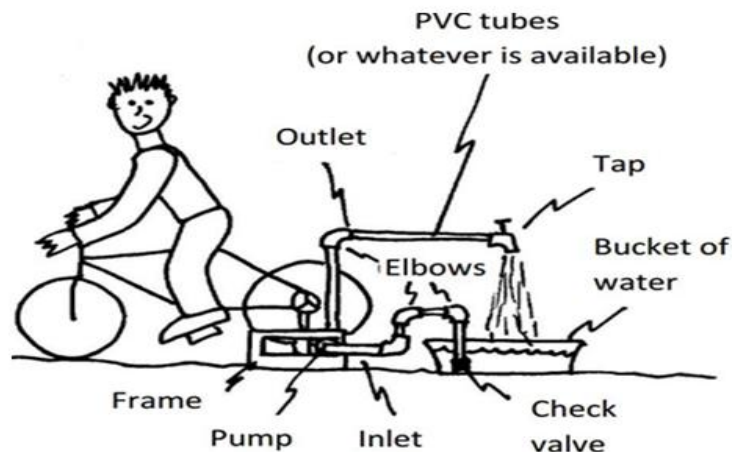
Gear ratio is relationship between rotating speed and pedaling rate. Balance between these two figure let us get beneficial results.

1.4 How pedal power is helping us in real world?

Pedal power is a reliable source of energy. It is helping humans in their survival. Worldwide more than 3.5 million people die due to water related diseases every year. To help everyone a Japanese company is developing a bicycle that purifies the water. Bicycle rider can take water from a river or lake with a hose attached with it and starts pedaling. Pedaling power pump that water through multi-unit filtration system and produces about 1.3 gallon of clean water per minute. Pedal motion is helping this world in generating electricity to run heavy machines and help home uses. But new advancement in this technology is conversion of mechanical motion. With this repetitive motion different businesses are enjoying benefits.

Pedaling does not help at business or global level but it is also helping us in maintain our physic. When you pedal at home you lose some inches from your body and generate some electric power to run your appliances at same time. You can store your produced energy into batteries as well to use it later. Human powered nebulizer technology has been developed to help patients suffering from respiratory disease. This attached with the machine, it turns liquid medicines into mist and flow it to parents lungs through a mouth piece attached with it.

II. Design And Experimental Setup Of Pedal Operated Water Pump



2.1 Design of Equipment

A bicycle pumping system that can be used to pump water for irrigation and small sector area like gardening, floor cleaning works etc...It is a very small mechanism on which our project is based on. The mechanism consists of single centrifugal pump which is fixed with the rear wheel bicycle. Paddling for just a minute or two is enough to pump water. 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. 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 gear 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

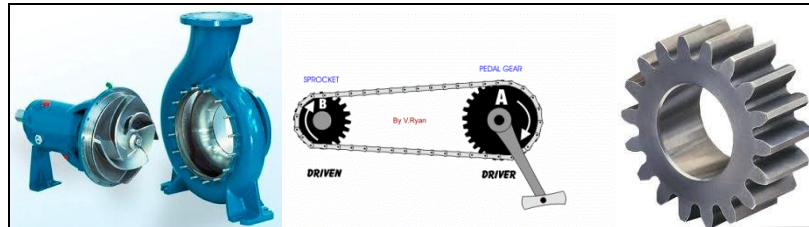
2.2 Working Mechanism

The rare wheel of the bicycle is rotated with the help of driver and driven gear of the bicycle. The chain drive of the centrifugal pump is connected to the rare wheel hub of the bicycle, it also rotates when the rare wheel of the bicycle is rotated with the help of the rotation system. The shaft of the centrifugal pump rotates up to 3700rpm. With the rotation of the great speed the vacuum is created in the centrifugal pump and this vacuum in this centrifugal pump suck the water from the water tank and it discharge the water through outlet with some amount of pressure

2.3 Main components of pedal powered water pump

The pedal powered water pump consists of the following components they are:

1. Centrifugal pump
2. Gear
3. Bicycle
4. Power transmitting unit (Chain drive from rear wheel hub to pump shaft)
5. Inlet and outlet tubes of the centrifugal pump
6. Bucket of water



III. Definition Of Pump

Pumps convert mechanical energy into fluid energy which can be explained as a pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action.

Or

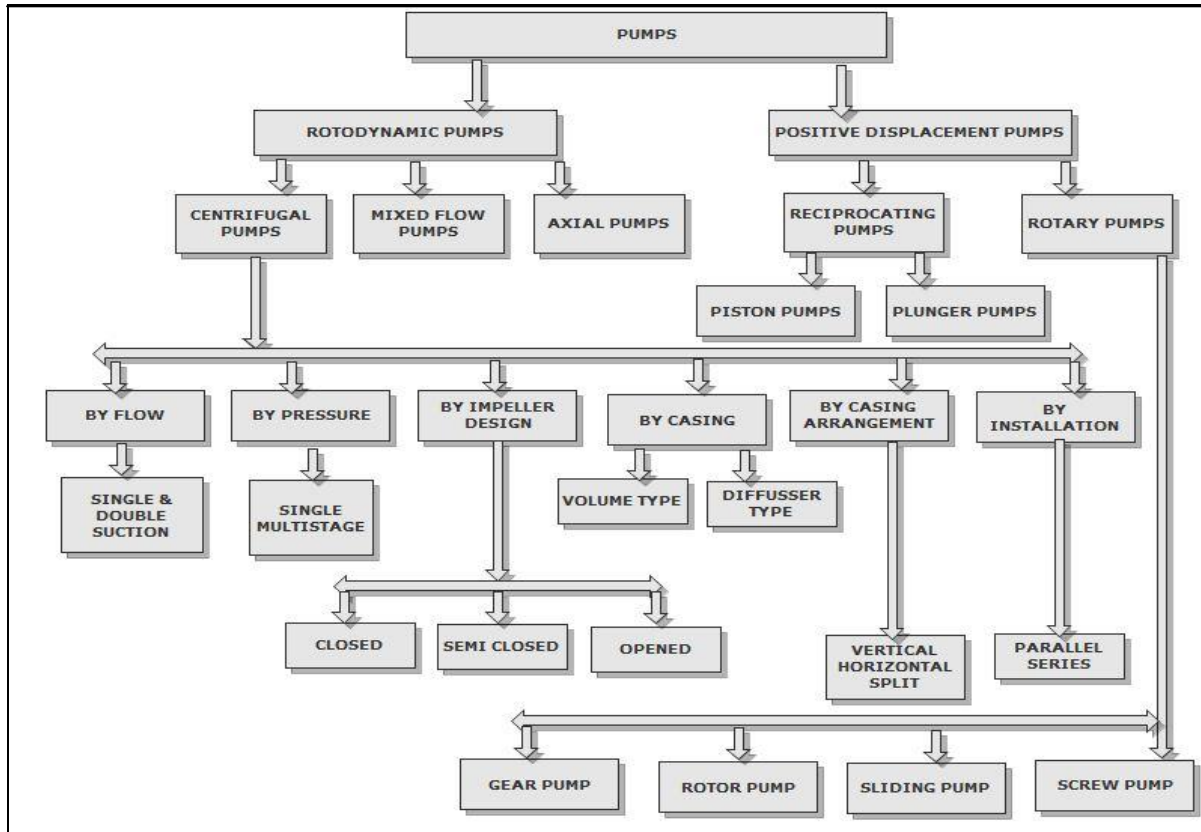
A pump is a device used to raise, compress, or transfer fluids from one place to another. When a fluid, be it hot or cold, has to be "moved" in a system, pumps are used. In other words, in a more technically appropriate manner, the pump is a machine which has the function of increasing the total (mechanical) energy of a liquid; this means that the pump transfers energy to the fluid that it receives from the driving motor.



3.1. Classification of Pump

Pumps can be classified into two major groups according to the method by which mechanical energy is transferred to the fluid.

1. Roto dynamic typed pumps
2. Positive displacement pumps,



Block diagram representation of classification of Pump

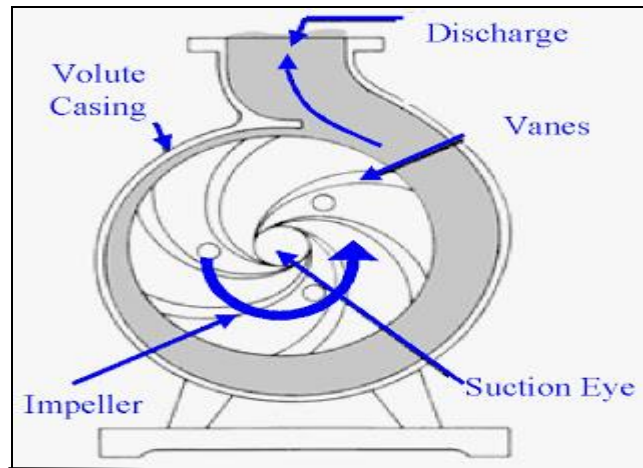
3.2. Centrifugal Pump

A centrifugal pump is a rot dynamic pump that uses a rotating impeller to increase the pressure and flow rate of a fluid. Centrifugal pumps are the most common type of pump used to move liquids through a piping system. The fluid enters the pump impeller along or near to the rotating axis and is accelerated by the impeller, flowing radially outward or axially into a diffuser or volute chamber, from where it exits into the downstream piping system. Centrifugal pumps are typically used for large discharge through smaller heads. Centrifugal pumps are most often associated with the radial-flow type. However, the term "centrifugal pump" can be used to describe all impeller type rot dynamic pumps including the radial, axial and mixed-flow variations.



3.3. Main Parts

A centrifugal pump is of a very simple design. The two main parts of the pump are the impeller and the diffuser. Impeller, which is the only moving part, is attached to a shaft and driven by a motor. Impellers are generally made of bronze, polycarbonate, cast iron, stainless steel as well as other materials. The diffuser (also called as volute) houses the impeller and captures and directs the water off the impeller.



3.4. Different Types of Impellers:



IV. Calculation



Bicycle chain drive specifications

- Diameter of the driver $d_1=16\text{cm}$
- Diameter of the driven $d_2 =7.2\text{cm}$
- Maximum speed of the driver $N_1=80\text{ rpm}$
- Maximum speed of the driven $N_2=450\text{rpm}$
- Teeth of the driver $T_1=40\text{ numbers}$
- Teeth of the driven $T_2=18\text{ numbers}$
- The centre length between driver and driven $x=45\text{cm}$

Motor and Pump chain drive specification:

- Diameter of the motor shaft $d=1.3\text{cm}$
- Length of the motor shaft $l=22\text{cm}$
- Pump type: single stage type
- Type of pump: centrifugal type
- Power of the pump: 1.5HP

- Suction diameter of the pump=3cm
- Discharge diameter of the pump=2cm
- Diameter of the driver $d_1=20$ cm
- Diameter of the driven $d_2=5.5$ cm
- Maximum speed of the driver $N_1=2100$ rpm
- Maximum speed of the driven $N_2=3700$ rpm
- Teeth of the driver $Td_1=50$ numbers
- Teeth of the driven $Td_2=12$ numbers
- The center length between driver and driven $x=47.5$ cm

4.1 MODEL CALCULATION:

$$L_1 = \pi(r_1 + r_2) + 2x + (r_1 - r_2)^2/x_1 \text{ (for cycle)}$$

Where,

R_1 = radius of the driver= 8cm

R_2 =radius of the driven=3.6cm

X_1 =the centre length between driver and driven=45cm

$$L_1 = \pi(8+3.6) + 2*45 + (8+3.6)^2/45$$

$$L_1 = 126.42 \text{ cm}$$

Where

$$L_2 = \pi(r_1 + r_2) + 2x + (r_1 - r_2)^2/x_2 \text{ (for pump)}$$

R_1 = radius of the driver=10cm

R_2 =radius of the driven=2.75cm

X_2 =the centre length between driver and driven=47.5cm

$$L_2 = \pi(10 + 2.75) + 2*47.5 + (10-2.75)^2/47.5$$

$$L_2 = 138.9 \text{ cm}$$

Speed ratio :- (for cycle chain drive)

Speed of the driver/speed of the driven= number of teeth on the driven/no. of teeth on driver=

$$N_2/N_1 = d_1/d_2 = t_1/t_2$$

$$= 450/80 = 16/7.2 = 40/18$$

Speed ratio= 56.25: 2.2: 2.2

Where

N_1 =Speed of the driven =450rpm

N_2 =Speed of the driver=80rpm

D_1 =diameter of the driver=16cm

D_2 =diameter of the driven=7.2cm

T_1 =teeth of the driver=40numbers

T_2 =teeth of the driven=18numbers

Speed ratio (for pump chain drive):

Seed of the driver/speed of driven=number of teeth on driven/number of teeth on driver=

$$N_2:N_1 = d_1:d_2 = t_1:t_2$$

$$3700/2100 = 20/5.5 = 50/12$$

Speed ratio= 1.3: 3.6: 4.1

- Power (p) = $2\pi NT/60$ KW

Where

N =speed of the motor shaft=3700 rpm

T =total torque produce in the motor shaft

4.2 Assembly of Pedal Powered Water Pump

The pedal powered water pump includes the pump chain drive with driver and driven. The driver of the pump chain drive consists of 50 numbers of teeth and it is placed on the centre hub of the rear wheel of the bicycle and the driven gear is consisting of 18 number of Teeth's. It is connected to the shaft of the centrifugal pump the single stage pump of 1.5 hp. The shaft diameter of 1.3 cm and length of the shaft 22 cm without electric winding is placed on the carriage of the bicycle. The carriage of the bicycle is placed on the rear wheel of the bicycle.



Advantages of pedal powered water pump

1. It is renewable as well as sustainable. As it is needed till the human existence on this planet and the ultimate source is the human himself.
2. Pedal renewable is cost-effective so everyone can access to its advantages. There is only need to set pedal with crank system attached to the drive.
3. It is pure energy zero percent carbon emission so clean and healthy surroundings.
4. It keeps the body system well and increases the efficiency level if used to a certain extent. Excess use of anything is bad for health.
5. It does not harm the socio-political benefits as it is the personal property of every individual.
6. The conventional centrifugal pump needs either electricity or diesel engine, but the present innovation works on pedaling.

This is a non-polluting and environment friendly device. Since it is made of commonly available materials and costs less. It is affordable to common people. It requires less maintenance Minimum input energy is required to get the maximum output of water. This device can be transported easily from one place to another.

V. Results And Discussions

The below Figure gives the variation of discharge with rotor shaft rpm of Pedal power centrifugal pump. It is observed that the discharge increases uniformly with the rpm. Experimental result shows that discharge of about 0.0025m³/sec can be obtained for around 140rpm. The variation in the obtained plot is due to errors in observation and due to power transmission losses.

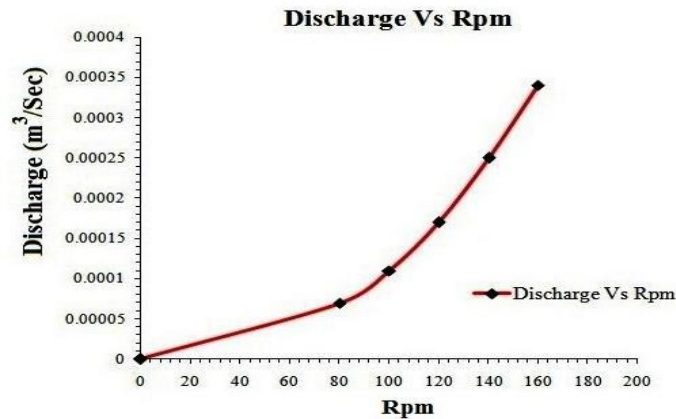


Figure: Variation of Discharge with Rpm

Figure .shows the variation of head with discharge of PPCP. It is observed that the head decreases uniformly with discharge. Experimental result shows that head of 8m can be obtained with discharge of about 0.00007m³/sec. The variation in the obtained plot is due to errors in observation and due to power transmission losses.

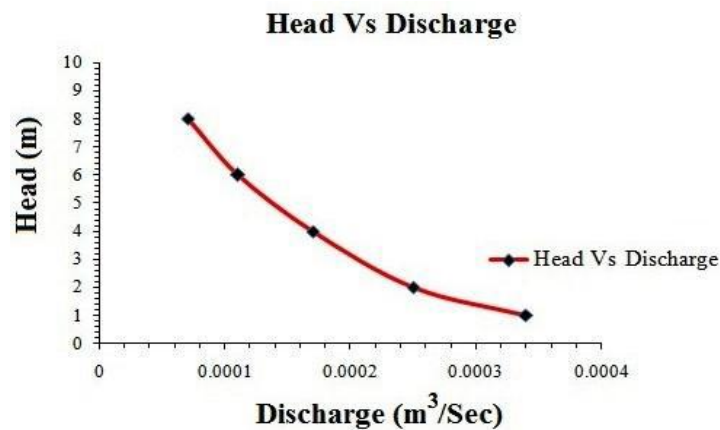


Figure: Variation of Head with Discharge

VI. Applications

➤ Pedal Power Applications The following, mostly agricultural related, mechanical application have used pedal power technology: chain trencher, weeding/harvester rider, frontend loader, thresher, weedier (paddy), rot tiller, grain reaper, oil seed press, forklift, huller/Sheller, soy grinder, reel mower, bulldozer, dumptrike, grain drill, rice separator, tri- and quadric-cycle (with interchangeable units: cargo, flatbed, tanker, stake bed, dumper, pickup, animal, garden tools), sickle bar mower, crawler tractor, wildflower seed harvester, rice polisher, grain winnower and seeder.

➤ Various applications of standard bicycle with Pedal power attachments are shown



Operating a Circular



Rice Threshin



Winnowing



Corn Shelling



Water Pumping from a Shallow Well

VII. Conclusion

At a time when there is energy crisis casting its shadow all over the world, one has to look into alternate renewable energy resources. One such alternate way to generate power is presented in this paper. The Kinetic energy of the gear in terms of velocity ratio is generated by pedaling, which can be used to operate small powered devices. The various applications where this power could be used are also discussed in this paper. Villagers who use bicycles are going to be benefited the most.

We had successfully proven the calibration and working of centrifugal pump with pedal power of bicycle type for gardening purpose and it is also suitable for small scale work.

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