FABRICATION OF BICYCLE DRIVEN WATER PUMPING AND POWER GENERATION SYSTEM

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Abstract
Bicycle is the most cheap and easiest mode of transport especially in countries like India on which humans apply their effort to propel the bicycle, over centuries from now. Human effort is transferred to the wheels through pedals, crank and chain mechanism. But the same pedal power can be used for other purposes such as to generate electricity, to operate hand tools or agricultural tools. Therefore, an idea of using pedal power is presented in this paper. In this paper, a system is fabricated for generating electricity by pedaling a bicycle and at the same time water pumping also. The fabricated mechanism is tested to determine its performance and results are presented.
Index Terms: Bicycle, Electricity, Pedal Power, Water Pumping.

I. INTRODUCTION

The idea of pumping water has been in existence since the evolution of man. Pumping plays a very pivotal role in the day to day existence of mankind and as a result, different methods have evolved over the years to pump or displace water. Water supply has been a very critical issue, mostly affecting the rural areas. Different methods and techniques have been used over the years ranging from man-powered operated ones down to the more efficient, but costly electrically and internal combustion engine powered pumps. The mechanism consists of single centrifugal pump which is fixed with the rear wheel bicycle. The pulley arrangement converts the efforts which are applied by human being into the rotating motion which is used to generate electricity and this electricity will be used as a preliminary requirement of electricity.

Fig. 1. Pedal powered machines

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 50 feet. Our project could prove helpful for rural areas. It can be used mainly for irrigation and water drawing water from wells and other water bodies. 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. We are wasting resources that can produce energy as if they are limitless. If we can renew and reuse the energy we waste, it would help in some way to the problem of scarcity of energy, which is the major threat of present world. Humans are able to generate approximately 150W of power while riding bicycle. However, this power goes waste without any use. If we can make use of this energy, we would be able to power many electronic devices. A dynamo or an alternator can be used for harvesting the energy generated by a cycle rider while riding. We can charge mobile phones or a small lighting device with this power.

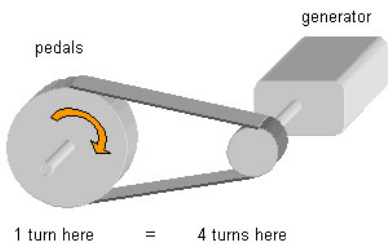


Fig. 2. Pedal Power

II. LITERATURE REVIEW

Atul. P. Ganorkar et al. [1] conducted an experiment on “Development of pedal operated water pump”. Their machine consists of three subsystems namely (1) Energy Unit : Comprising of a suitable peddling mechanism, speed rise gear pair and Flywheel conceptualized as Human Powered Flywheel Motor (HPFM) (2) Suitable torsionally flexible clutch and torque amplification gear pair and (3) a water pump unit. Vishal Garg et al. [2] conducted an experiment on “Pedal powered water pump”. They founded an pedal operated pump can be construct using local material and skill. 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. Ademola Samuel Akinwonmi et al. [3] conducted an experiment on “Pedal powered centrifugal pump for pure water supply device”. This analyzes the design of a pedal powered purified water supply device to be used by local dwellers. 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 into the pump while rollers push the water through to the filter where adsorption takes place to purify the water. Bryan Lee[4] has prepared a conceptually “Simple water pump” that will be easy to maintain and repair using basic tools while providing enough water flow to irrigate a small plot of farmland. The report outlines the design process that has been followed and a description of the agreed model that is to be constructed, cost analysis and timeline. M.Serazul Islam et al. [5] conducted an experiment on “Design and development of pedal pump for low lift irrigation”. A study was undertaken to design and construct a low-lift pedal pump for use in small irrigation project areas. For this purpose, different types of piston valves and check valves were constructed and tested at different suction heads in the laboratory to evaluate their performances. During pedal pump operation, less input power was needed and it can be operated by one adult man for a long time (more than 2 hours) continuously without being tired. Efficiency of the pump was 46.53 percent against a head of 1.65 m.

In the July-2011 issue of IEEE Spectrum, a detailed study and analysis of pedal power energy generation, its usage, feasibility, and economics is presented. The power is produced from the exercise bikes used in gyms by means of a small generator. This article presents a case where in it looks at the overall feasibility of including the pedal power technology in the mainstream. Besides all these studies available in the literature, many other applications can be developed using pedal power such as generators, washing machines, farm and factory applications, blenders and many other applications. One such attempt is made in this work to use pedal power as a source for generating electricity and also for water pumping. Performance analysis of fabricated unit is carried out.

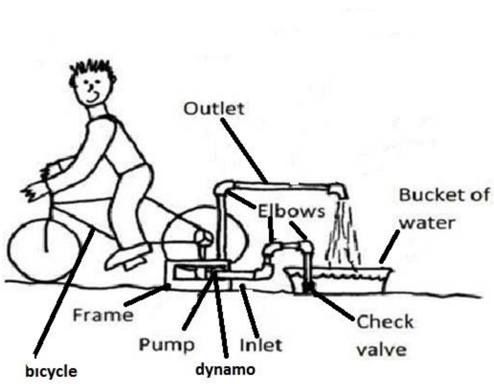
III. FABRICATION OF MECHANISM

This fabricated unit consists of mainly four parts, the first one is centrifugal pump, the second is the bicycle, and the third one is the stand, the fourth one is dynamo. This consists of a centrifugal pump operated by pedal power. The centrifugal pump is positioned on its stand in such a way that driven shaft of the centrifugal pump is butted to the bicycle wheel. By pedaling the bicycle, the bicycle wheel rotates, thereby rotating the centrifugal pump which in turn discharges water from the sump and also generates electricity from dynamo which is connected in parallel and opposite to shaft of pump.

The suction and delivery pipes are then connected to the suction and delivery ports respectively Manual priming of the centrifugal pump is done next. By pedaling the Rpm of the rotor shaft is measured using tachometer. The flow rate of water is measured by using measuring tank and stop watch. Such that the water lifted is measured in terms of liters per minute.

The multi meter is connected to the dynamo output. The electricity is generated and is varied due to variation in speed of pedaling. This electricity generated is measured in terms of amperes.

Fig. 3. Principle of Operation



A frame is set to support the bicycle on which a carriage can be moved. On this carriage pump and dynamo are fitted which can be driven by a screw arrangement to adjust the friction between rear wheel and shaft of the pump.

GI square pipes are made into sufficient pieces and are welded together to get the frame. The total frame comprised of this square pipe of one inch. In this frame the joints are arc welded to give stiffness and strength.

Fig. 4. Frame

Fig. 5. Fabricated Unit

Fig. 6. Fabricated Unit with Pump and Dynamo

Fabricated model specifications:

Length of frame = 3 feet

Width of frame = 1.5 feet

Height of frame = 1.5 feet

Inclined support length of frame = 1.6 feet

Diameter of pump shaft at contact with rear wheel of bicycle= 5.66 cm

Diameter of dynamo rotor = 2 cm

Diameter of shaft in contact with dynamo =3.3 cm

Experimental calculations:

Diameter of rear wheel of a bicycle = 0.7 m

Speed available on rear wheel =50-250rpm

Diameter of the pump shaft =0.0566m

The expected speed available at pump shaft =900-2915 rpm

Diameter of inlet of the pump (D_1) = 0.025m

Diameter of outlet of the pump (D_2) = 0.0125m

Speed of the impeller shaft (N) = 990rpm

Speed of rear wheel = 80 rpm

Power of pump = 0.37kW

Impeller diameter =0.06m

$$Q_a = C_d \times Q_t$$

Where, Q_a = Actual discharge

Q_t = Theoretical discharge

C_d = Coefficient of discharge =0.62,

In general, coefficient of discharge is taken as 0.62

$$N_1 \times D_1 = N_2 \times D_2$$

Where,

N_1 =Speed of rear wheel of bicycle in rpm

N_2 =Speed of impeller shaft in rpm

D_2 = Diameter of bicycle rear wheel

D_2 =Diameter of impeller shaft

Velocity of flow (V) = $\frac{\pi DN}{60} m/s$

Where,

D= Diameter of impeller

N= Speed of impeller

IV. RESULTS AND DISCUSSIONS

Various tests are performed on the fabricated unit to analyze the performance.

The performance of the pump is tested based on its discharge i.e actual and theoretical discharge for various speeds of the wheel indicated in Table 1. , and the graph is plotted as shown in Fig 7.

The pump output is also calculated at different weights of the person's by varying the speed of the bicycle. The performance of the pump is tested using a person weight of 52kg's as indicated in the Table 2, and the graph is plotted as shown in Fig 8.The performance of the pump is tested using a person weight of 60kg's as indicated in the Table 3, and the graph is plotted as shown in Fig 9.The performance of the pump is tested using a person weight of 68kg's as indicated in the Table 4, and the graph is plotted as shown in Fig 10.

The Dynamo output is also calculated at different weights of the person's by varying the speed of the bicycle. The performance of the Dynamo is tested using a person weight of 52kg's as indicated in the Table 5, and the graph is plotted as shown in Fig 11.The performance of the Dynamo is tested using a person weight of 60kg's as indicated in the Table 6, and the graph is plotted as shown in Fig 12.

Table .1 Performance of the pump

Speed of the wheel(rpm)	Speed of impeller shaft(rpm)	**Actual discharge(m^3/s)**	Theoretical discharge(m^3/s)	Velocity at outlet(m/s)
78	964	**0.192**	0.32	3.02
102	1261	**0.222**	0.37	3.96
117	1446	**0.374**	0.62	4.54
141	1743	**0.590**	0.983	5.47
155	1916	**0.645**	1.075	6.01
201	2485	**0.740**	1.233	7.80
216	2671	**0.941**	1.569	8.39

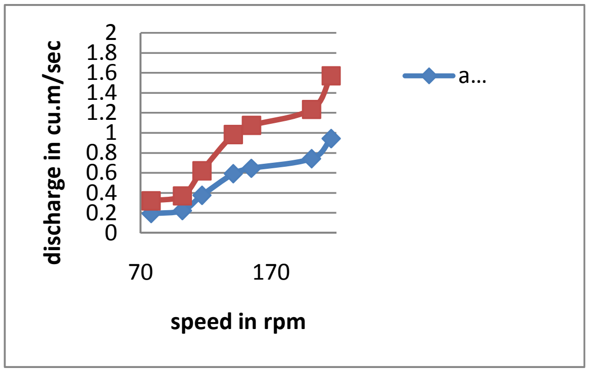


Fig .7 Actual Discharges *vs*. Theoretical Discharge

Table .2 **Pump output at 52 kg's of human weight**

Bicycle speed (rpm)	**Pump shaft Speed (rpm)**	**Discharge lpm**
78	928	7811.4
98	1212	9813.2
117	1446	11721.9
201	2485	20142.0

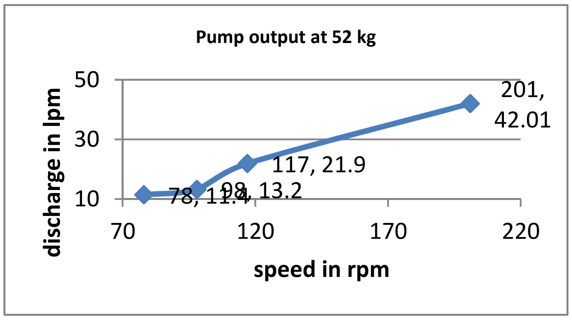


Fig .8 Pump output at 52 kg's

Table .3 **Pump output at 60 kg's of human weight**

Bicycle speed (rpm)	Pump shaft Speed (rpm)	Discharge lpm
83	1026	8311.8
119	1471	11921.8
141	1743	14133.2
216	2671	21654.8

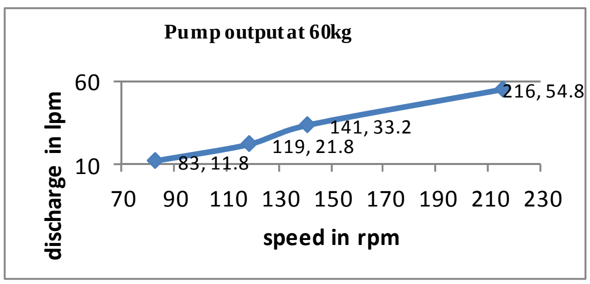


Fig .9 Pump output at 60 kg's

Table .4 **Pump output at 68 kg's of human weight**

Bicycle speed (rpm)	Pump shaft Speed (rpm)	Discharge lpm
77	952	11.48
106	1310	14.10
115	1422	21.3
155	1916	36.8

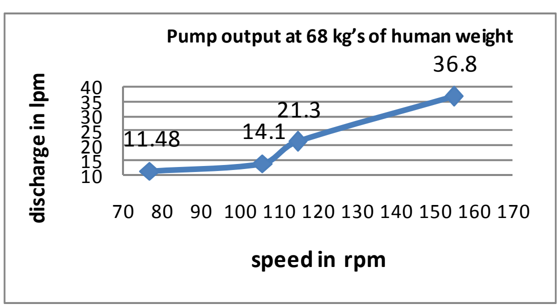


Fig .10 Pump output at 68 kg's

Table .5 **Dynamo output at 52kg's of human weight**

Bicycle speed (rpm)	Output volt(V)	Output current (A)
75	**10**	**0.126**
146	**10**	**0.369**
201	**11**	**0.560**

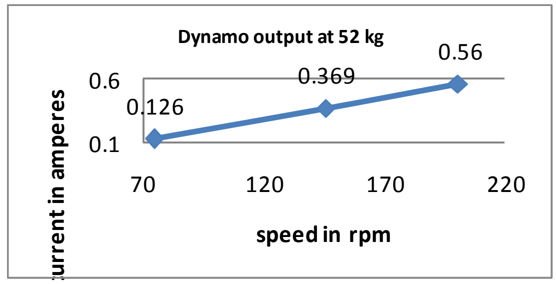


Fig .11 Dynamo output at 52 kg's

Table .6 **Dynamo output at 60 kg's of human weight**

Bicycle speed (rpm)	Output volt(V)	Output current (A)
104	**10**	**0.236**
141	**10**	**0.369**
216	**11**	**0.615**

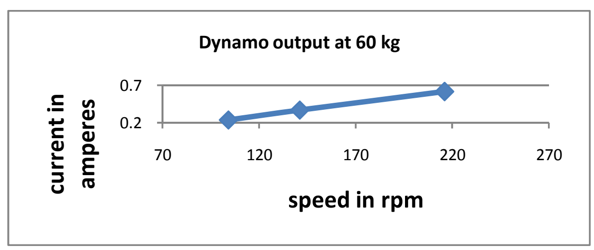


Fig .12 Dynamo output at 60 kg's

V CONCLUSIONS

As per the observations from the graph, the difference between the actual discharge and the theoretical discharge is calibrated. When the weight of the person is varied the output is also varied. If the weight of the person is increased then the output is increased.

Thus a low cost and simple design pedal operated water pumping and power generation system is fabricated. This unit reduces the human effort. This simple design can enhance day today household needs and daily day to day purposes and it can be also used in for industrial applications during power shut down scenarios.

By using this method we can do both as per our requirement without the use of electricity hence we can save the electrical power.

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