

“Design, Fabrication and Experimental study of Human Paddle Powered Mechanical Device for Electricity Generation, Irrigation and Winnowing”

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Abstract—In this research work authors, design, fabricate and experimentally studied a human paddle powered mechanical device for electricity generation for battery charging, to run centrifugal pump for irrigation and winnowing system for cleaning seed. It has unique features of using human power as prime mover for electric generator. Muscle energy in the form of high-torque low-speed can be converted into low-torque high-speed through speed increaser to energize the electric generator. The car alternator of 12V and 40 AH is used for electricity generation. The electricity generated is stored in the batteries of different capacity and used when required. The centrifugal pump of 0.5 hp is used for irrigation which discharged 15 liters of water in 40 seconds, when the suction head is 4 meter. Also the winnowing system work very efficiently. This equipment is emission free, low cost and has long life. Also this equipment needs less maintenance and any person can run either skilled or unskilled.

Keywords: Human paddle energy, speed increaser, electric generation, dc battery Ansys.

1. INTRODUCTION

Over 1.5 billion people rely on kerosene for light and fossil fuel for irrigation and winnowing. Lack of suitable home lighting is directly linked to illiteracy, poverty and health problems. The current widespread burning of kerosene also results in environmental pollution. It is very difficult and very costly to available grid power everywhere specially at remote isolated communities in developing countries. Although from beginning of mankind human have been doing for domestic works, but the electricity generation by muscle power is a novel technology.

Human power is a work or energy that is produced from the human body. It can also refer to the power (rate of work per time) of a human. Power comes primarily from muscles, but body heat is also used to do work like warming shelters, food, or other humans. A trained cyclist can produce about 400 watts of mechanical power for an hour or more, but adults of good average fitness average between 50 and 150 watts for an hour of vigorous exercise. A healthy well-fed laborer over

the course of an 8-hour work shift can sustain an average output of about 75 watts. The yield of electric power is decreased by the efficiency of the human-powered generator [1-9]

2. FABRICATION DETAILS

(i) Human Power: The authors' main object is to use the Human muscle power for generating electricity for domestic use. The two person of 55 kg and 73kg of age 22 year were worked alternate as an energy source.

(ii) Chain Drive: In this research work we used the Chain Drive system of Hero Cycle. A single strand chain number 8B is used in mechanical drive. The power rating is 0.64 KW at 100 rpm. The pitch dimension (p) of the chain is 12.70 mm. The driving sprocket has 54 teeth and rotates at 100 rpm. The driven sprocket has 17 teeth and rotates at 300 rpm.

(iii) Gears: Spur Gears are very useful in numerous applications. Not only can they transfer velocity and torque from one shaft to another, but, by using different size gears, they can alter the ratio between velocity and torque as they transfer them; a gear with many teeth driving a gear with fewer teeth will have less torque, but greater velocity and vice versa. One set of spur gears transmit the power among parallel shafts. The spur gears are made of ductile cast iron. The spur gears have 68 teeth while the spur pinions has 18 teeth. The pressure angle is 20.

(iv) Speed increaser: Speed increaser has one set of chain drive and one set of spur gears housed in a frame of mild steel angles. It is having single number of stages with gear ratio of 1: 3.8. Input and output shaft of the speed increaser having 50 mm diameter and 600 mm length of mild steel material is in horizontal. One pulley of 18 inch is mounted on the side of the out-put shaft of gear system. The horizontal shafts are supported with roller bearings at the both ends.



Fig. 2.1: Human paddle powered Speed increaser.

(v) Belt and Pulley transmission unit: According to Indian Standard Code (IS: 2494-1974), the A type of belts are selected which has power ranges 0.7kW –3.5 KW.[29, 30] There are one set of pulley and belt system. One pulley of 18 inch is mounted on the output shaft of the gear system and counter pulley of 3 inch is mounted on shaft of centrifugal pump/ alternator/ winnowing fan thereby stepping up the speed in the ratio 1: 6 when connected with belt.

(vi) Generator: In this experimental study authors select the car alternator to generate electricity. Lucas-TVS car alternator of 12V and 40 AH is used. Car alternator needs high rpm to work efficiently.

(vii) Storage system: In this experiment a typical 12V, 40AH Lead-acid automotive battery is used. An automotive battery is a type of rechargeable battery that supplies electric energy to an automobile. Charging time depends on the capacity of that battery and the resting voltage of that battery when you begin to charge it.

(viii) Hand Winnowing Fan: Hand Winnowing Fan is a set with three blades which is fitted on the upper part of frame to maintain height. The winnowing shafts have a 3 inch pulley are supported with the roller bearings.

(ix) Water Pump system: The 0.5 hp/0.37 kwatt centrifugal water pump of RC Energy metering (P) Ltd is used for experiment. The specification of water pump is shown in table:

Drive	0.5HP/0.37KWatt
Voltage (V)	220 ±5%
Frequency (Hz)	50
Suction head (meter)	8 MTRS
Discharge head (meter)	27 MTRS
Discharge (L/min)	33 LPM

3. FABRICATION AND PROCEDURE

The fabrication of speed increaser is done very carefully because there are three shafts which are supported on bearings. The bearing covers are fitted with the help of nut and bolt on the mild steel frame. Gears are fitted by means of nuts by drilling two holes on the shafts and on gear hubs. There is

one step chain drive system, one step gear transmission system and one step pulley and belt transmission system. The two identical cycle paddles are fitted on the first sprocket axle and second sprockets are mounted on second shaft. And the first gear of 68 teeth is mounted on second shaft which mesh with the second gear having 18 teeth mounted on third shaft. The first pulley of 18 inch is mounted on one end of third shaft which drives another pulley of 3 inch mounted on water pump / alternator which are fabricated on the frame.

[A] CENTRIFUGAL WATER PUMP

Author selects the 0.5 hp centrifugal pump for water pumping. If human paddle the driving sprocket having 54 teeth with average 100 rpm then the driven sprocket having 18 teeth rotates with $100 * 3$ rpm. Since gear of 68 teeth is fabricated in same shaft hence it also rotates at $100 * 3$ rpm which rotates the second gear having 18 teeth with rpm of $100 * 3 * 3.78$. The first pulley of 18 inch is mounted on same shaft; it has the same speed of $1000 * 3 * 3.78$ rpm. The counter pulley of 3 inch mounted on pump thereby stepping up the speed in the ratio 1:6; hence the pump rotates at $100 * 3 * 3.78 * 6$ rpm [10, 11].

$$100 * 3 * 3.78 * 6 = 6800 \text{ rpm [max]}$$

The system is tested by means of human paddle power for many times. Before starting the experiment the centrifugal pump is connected with the pipe of 30 mm diameter having football at the end. Two mechanical link paddles is fitted with the first shaft by means of nut-bolt at one end and another end is free to applied force. When human applied force through paddle the driving sprocket starts rotate and drives the second sprocket as well as gear one. The first gear starts rotate and drive the meshing gear as well as pulley one. The pulley one transmits power to counter pulley. At the starting the rpm is very low hence the centrifugal pump was not responding but as well as speed is increasing the centrifugal pump start to discharge water. Human were need to applied force to maintain average speed.



Fig. 5.2 Human Paddle powered irrigation system.

[B] ALTERNATOR

Author selects the car alternator for generating electricity. Car alternator starts to work about 1000 rpm. The system is tested by means of human power for many times. Before starting the experiment the alternator is connected with battery and ampere meter is jointed in series. When human applied force through paddle the driving sprocket starts rotate and drives the second sprocket as well as pulley one. The pulley one transmits power to counter pulley. At the starting the rpm is very low hence the alternator was not responding but as well as speed is increasing the alternator start to generating power. Human were need to applied force to maintain average speed. The rpm and generated volt & current were taken after every minute.



Fig. 5.2: Human Paddle powered electricityl system.

[C] WINNOWING FAN

If human paddle the driving sprocket having 54 teeth with average 100 rpm then the driven sprocket having 18 teeth rotates with 100×3 rpm. Since gear of 68 teeth is fabricated in same shaft hence it also rotates at 100×3 rpm which rotates the second gear having 18 teeth with rpm of $100 \times 3 \times 3.78$. The first pulley of 18 inch is mounted on same shaft; it has the same speed of $100 \times 3 \times 3.78$ rpm. The counter pulley of 3 inch mounted on the shaft having winnowing fan which mounted on the upper frame thereby stepping up the speed in the ratio 1:6; hence the fan rotates at $100 \times 3 \times 3.78 \times 6$ rpm.

$$100 \times 3 \times 3.78 \times 6 = 6804 \text{ rpm.}$$

4. RESULT AND DISCUSSION

4.1 WATER IRRIGATION SYSTEM

The humans' effort and speed depend on the load subjected. The suction head is 4 meter. The experiment had done 15 times. Experimental result shows that human take very little time to get working speed. The readings are taken after discharging 15 litters. Figure No of Experiments Vs. RPM of Centrifugal Pump shows that rpm is almost constant in every experiments. The force applied by human paddle power is varying so that the discharge from centrifugal pump is varying during experiment. The average rpm of human muscle powered water system is 2700 rpm. Figure between No of

Experiments Vs Time for 15 LTR (in seconds) shows that the time taken to discharge 15 liter water is almost constant and the average time to discharge 15 liters is 40 seconds for 4 meter suction head of 0.5 hp centrifugal water pump.

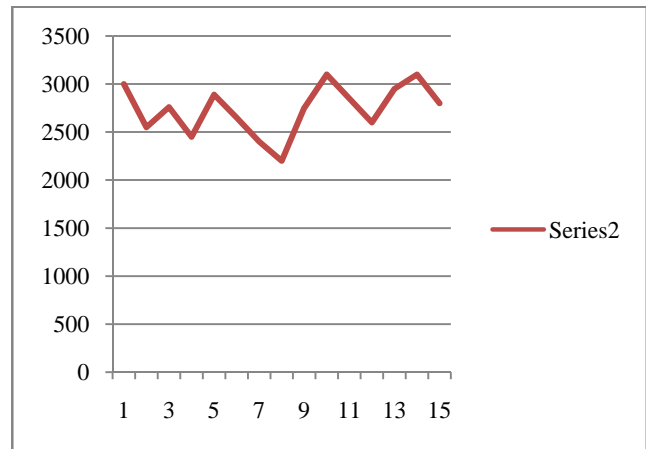


Fig. 4.1: No of Experiments Vs. RPM of Pump.

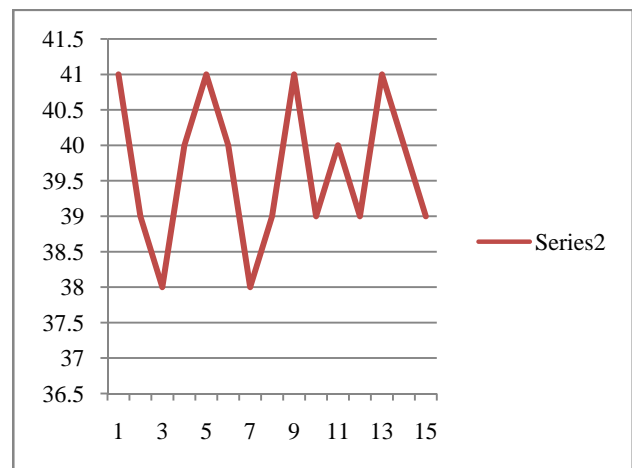


Fig. 4.2: No of Experiments Vs Time for 15 LTR (sec)

4.2 Electric generation system

The humans' effort and speed depend on the load subjected. Experimental result shows that human take very little time to get working speed of 1000 rpm. Alternator generates constant voltage of 12V as specified after reaching ideal speed. The readings are taken after every minute. Speed vs. Current shows that at low rpm at starting motion it is not generating current by alternator, but as well as rpm is increasing and reaches to ideal working rang alternators producing high value of currents. The force applied by human muscle is varying so that the alternator rpm is also changing time to time and generated current also changing time to time.

The average rpm of human muscle power system is 2100 rpm and average generated current is 12AH. The experiment had done 9 times.

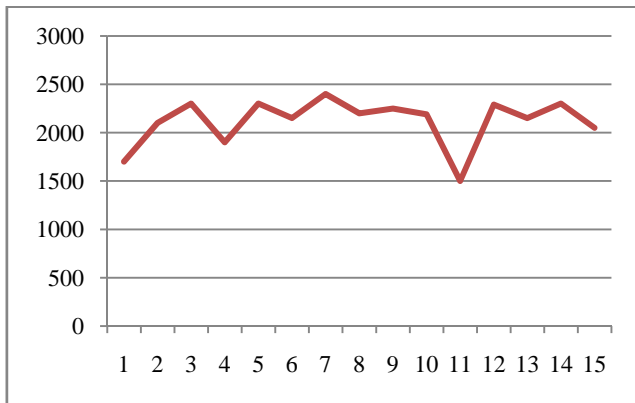


Fig. 4.3: Time (in minutes) vs. RPM of alternator.

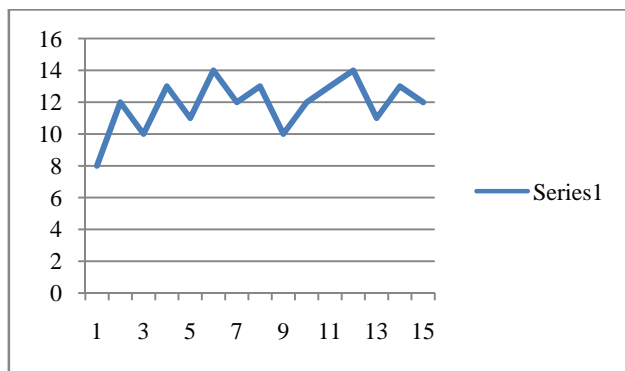


Fig. 4.4: Time (in minutes) vs. Current in AH.

4.1.3 RESULT OF WINNOWING FAN SYSTEM

The humans’ effort and speed depend on the load subjected. The power required to drive the winnowing fan is very low. The experiment had done many times. Experimental results show that human take very little time to get working speed. The readings are taken time to time. Figure No of Experiments Vs. RPM of winnowing fan shows that rpm is almost constant in every experiments. The average rpm of human paddle powered water system is 900 - 1000 rpm. Experiment also shows that light dust particle can easily remove but heavy particle need high speed of wind.

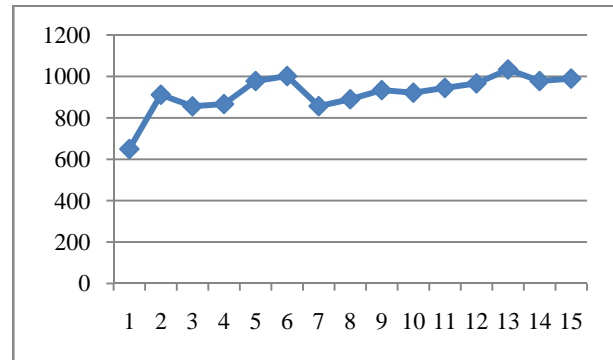


Fig. 4.5: No of Experiments Vs. RPM of winnowing fan.

5. CONCLUSIONS

The present work provides a mechanical device for to run centrifugal water pump for irrigation, to run alternator for generating electricity and to run winnowing fan using power of the human paddle power. The project goal was to design, fabricate and experimentally studied of mechanical device to run centrifugal pump irrigation system for billion people who rely on natural water for irrigation and to run alternator for electricity for people who rely on kerosene and also to run winnowing fan for cleaning seed. This goal had to be met within the constraints of a low production cost and high safety. The project has to offer a durable product with relatively good efficiency. This is also concluded that fabricated mechanical device is itself a very small scale industry at rural and isolated areas.

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