Experimental Study of Renewable Sources for Lighting and Irrigation for a Forest village

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Abstract: - *In this project the renewable sources solar energy, animal energy and human energy is experimentally studied for home lighting and Irrigation for a village Mohgaon at dist. Rajnandgaon in Chhattisgarh, India where grid power is not available and population rely on kerosene for light. Although animals and Human have been using for domestic works at rural and remote areas, but the electricity generation and water pumping by animal and human power is a novel technology. The solar system is used as main energy source while the animal and human system is used as secondary or back-up energy source. This invention provides animal powered and human powered mechanical device for prime mover to electric generator and centrifugal pump. Human and animal energy in form of high-torque low-speed can be converted into low-torque high-speed through speed increaser to energize the electric generator. A simple and cost effective charge control with dc–dc converters is used for maximum power point tracking and hence maximum power extracting from the solar systems. The results show that even when the sun is not available; the system is reliable and available and it can supply high-quality power to the home lighting and irrigation by the animal powered or human power system. 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: Renewable source, solar power, animal power, human power, speed increaser.

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 muscle power have been doing for domestic works, but the electricity generation by muscle power is a novel technology.

Muscle 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/animal. 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. Similarly an animal bullock can work for 6 hrs and can work 540watt per hr. 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. FABFRICATION DETAILS

2.1 PADDLE POWER SYSTEM

(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. The first pulleys of 18 inch is mounted on third shaft 50 mm above the fourth gear and drive the second pulley of 3 inch which is mounted on the alternator/pump and winnowing fan.

(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) 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

2.2 HANDLE POWER SYSTEM

(i) Mechanical link: Two identical Mechanical link of mild steel plate having 25 mm wide, 5 mm thick and 400 mm length, capable of transmitting power in form of high torque low speed are attached to speed increaser first shaft at the both ends.

(ii) Speed increaser: Speed increaser is a two set of spur gears housed in a frame of mild steel angles. It is having 2 numbers of stages with gear ratio of 1: 3.8. Input shaft of the speed increaser having 50 mm diameter and 800 mm length of mild steel material is in horizontal position whereas output shaft having 50 mm diameter and 600 mm length of mild steel material of the same is also in horizontal position. 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 - 2.2: Human Handle powered speed increaser

2.3 ANIMAL POWER SYSTEM

(i) ANIMAL POWER: The main aim is to use the animal energy for generate electricity for rural use. Bullocks are mostly use in Indian agriculture for different uses. For that experiment study we use the pair of bullocks.

(ii) SPEED INCREASER: Speed increaser is a three set of spur gears housed in a frame of mild steel angles having 690 mm × 690 mm at the top and 780 mm × 780 mm at bottom. It is having 3 numbers of stages with gear ratio of 1:3.78. Input shaft of the speed increaser having 50 mm diameter and 600 mm length of mild steel material is in vertical position whereas output shaft having 50 mm diameter and 450 mm length of mild steel material of the same is also in vertical position in fourth stage there is one set of bevel gears having teeth 64 and 8. The car Alternator of 12V, 40AH / The Centrifugal pump of 0.5 hp is coupled with the other end of small bevel gear with mechanical couple. The shaft is fixed with roller bearings at top and bottom.

Fig - 2.3: Speed increaser with centrifugal pump

2.4 SOLAR POWER SYSTEM

(i) Solar Energy: The solar energy of size 1000 W which have two solar panels of 500 W in series was used in experiment which has been using by author for last two

years. Solar panel is manufactured by Sova Power Ltd. It have efficiency of greater than 85%.

Module	SS 500P
Rated peak power (Pmax)	500 Watt
Rated voltage (Vmp)	34.85 Volt
Rated current (Imp)	7.19 Amp
Open circuit voltage (Voc)	42.91Volt
Short circuit current (Isc)	7.85 Amp

Fig - 2.4 : Solar power system

3. FABRICATION AND PROCEDURE

3.1 PADDLE POWER SYSTEM

The fabrication of speed increaser was done very carefully because there are three shafts which are supported by bearings. The bearing covers were 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 framed 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 end of third shaft which drives another pulley of 3 inch mounted on alternator and alternator is fabricated on the frame.

Author selects the car alternator for generating electricity. Car alternator starts to work about 1000 rpm. 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 100 * 3 * 3.78 rpm. The counter pulley of 3

inch mounted on car alternator thereby stepping up the speed in the ratio 1:6; hence the car alternator rotates at 100 * 3 * 3.78 * 6 rpm.

100*3*3.78*6 = 6000 rpm [max]

(i) CENTRIFUGAL PUMP

The system is tested by means of human paddle power for many times. Before staring 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 The system is tested by means of human paddle power for many times. 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 - 3.1: Centrifugal pump

(ii) 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 staring 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 - 3.2: Human Paddle powered mechanical system.

3.2 HANDLE POWER SYSTEM

The fabrication of human handle powered mechanical device called speed increaser is done on the upper frame of paddle powered mechanical system. There are two step gear transmission system and one step pulley and belt transmission system. 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. The first two identical gears of 68 teeth are mounted on first shaft which mesh with the second two identical gears having 18 teeth mounted on second shaft. The third gear having 68 teeth is mounted on mid of the second shaft and meshes with the fourth gear having 18 teeth which is mounted on mid of third. The first pulley of 18 inch is mounted on end of third shaft which drives another pulley of 3 inch mounted on alternator/ pump and alternator/ pump is fabricated on the frame.

If human rotates the starting gear having 68 teeth with average 30 rpm then the meshing gear having 18 teeth rotates with 30*3.78 rpm. Since gear of 68 teeth is fabricated in same shaft hence it also rotates at 30*3.78 rpm which rotates the fourth gear having 18 teeth with rpm of 30*3.78*3.78. The first pulley of 18 inch is mounted on same shaft; it has the same speed of 30*3.78*3.78 rpm. The counter pulley of 3 inch mounted on car alternator thereby stepping up the speed in the ratio 1:6; hence the car alternator/ pump rotate at 30*3.78*3.78*6 rpm.

30*3.78*3.78*6 = 2571 rpm

(i) WATER PUMP

Before staring the experiment the centrifugal pump is connected with the pipe of 30 mm diameter having football at the end. Two mechanical link handles 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 forces through handle the first gear starts rotate and drive the meshing gear as well as pulley one. The pulley one transmits power to counter pulley.

Fig - 3.3: Human handle powered increaser

(ii) ELECTRIC GENERATOR

The system is tested by means of human handle power for many times. Before staring the experiment the alternator is connected with battery and ampere meter is jointed in series. Two mechanical links called handle are fitted with the first gear of first shaft by means of nut-bolt at one end and another end is free to applied force. When human applied force through arm at handle the first gear start 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 alternator was not responding but as well as speed is increasing the alternator start to generating power. Human are need to applied force to maintain average speed. The rpm and generated volt & current were taken after every minute.

Fig - 3.4: Complete system of electricity generation.

3.3 ANIMAL POWER SYSTEM

The fabrication is done very care-fully since there are many vertical shafts which are supported by taper bearings. The bearing cap is fixed with nut and bolt on steel ties, which are fixed on the frame at top and bottom. Gear is fixed screw fasteners on the shafts. It have 4 gear system. The one gear having 68 teeth is fixed on shaft at 25 mm above color it drives gear have 18 teeth fixeded on second shaft at 20 mm above from the collar. The third having 68 teeth is mounted on second shaft 50 mm above the second gear and meshes with the fourth gear having 18 teeth which is mounted on

third shaft at the same height. The fifth gear having 68 teeth is mounted on third shaft 50 mm above the fourth gear and meshes with the sixth gear having 18 teeth which is mounted on the fourth shaft at the same height. The seventh gear is a bevel gear having 64 teeth is mounted on fourth shaft 50 mm above the sixth gear and meshes with the eighth gear having 8 teeth which is mounted on fifth shaft fixed horizontally on extended frame. The Centrifugal pump of 0.5 hp / Car alternator of 12V 40AH is coupled alternate with the other end of horizontal shaft with mechanical couple. The shaft is fixed with taper roller bearings at top and bottom.

The selected centrifugal pump of 0.5 hp for irrigation and Car alternator of 12V 40AH for generating electricity which are work efficiently on and above speed of 600 rpm. And animal have very low speed (v = 1m/s) [6-11]. If bullock rotates at radial distance (r) of 2.5 m from the main shaft (first gear) then the distance at one revolution is 15.7 m (2× π × 2.5). And the distance cover in one minute by bullock is 1×60=60 m. Hence the initial rpm is 3.82(60/15.7). Three stage of spur gear system and single stage of bevel gear are used. So that the rpm of output gear according to S S Ratan.

$$\frac{N_8}{N_1} = \frac{Z_1}{Z_2} \times \frac{Z_3}{Z_4} \times \frac{Z_5}{Z_6} \times \frac{Z_7}{Z_8}$$

$(N_f)_g = 3.82*3.78*3.78*3.78*8 \approx 1771$ rpm.

Fig - 3.5: Animal powered mechanical device with centrifugal pump.

4. RESULT AND DISCUSSION

4.1 PADDLE POWER SYSTEM

(i) 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.
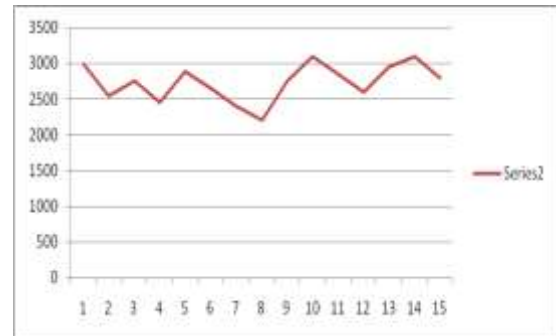

Chart- 4.1: No of Experiments Vs. RPM of Centrifugal Pump.
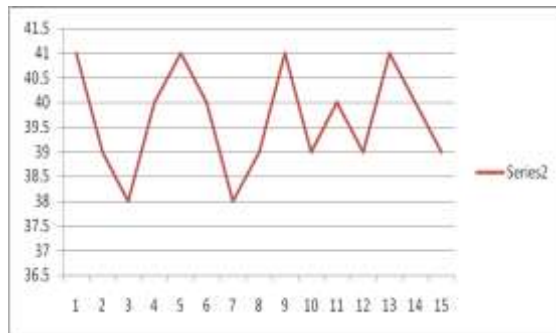

Chart - 4.2: No of Experiments Vs Time for 15 LTR (in sec).

(ii) 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.
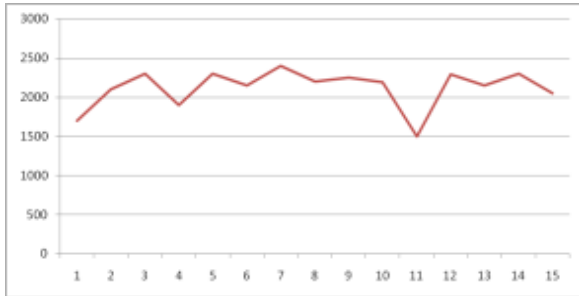
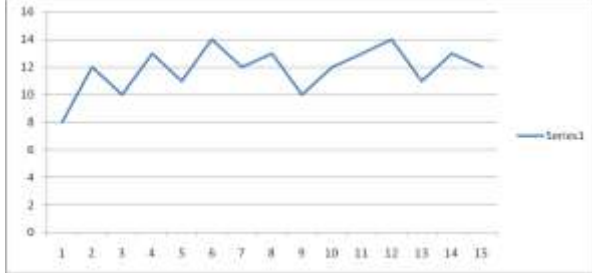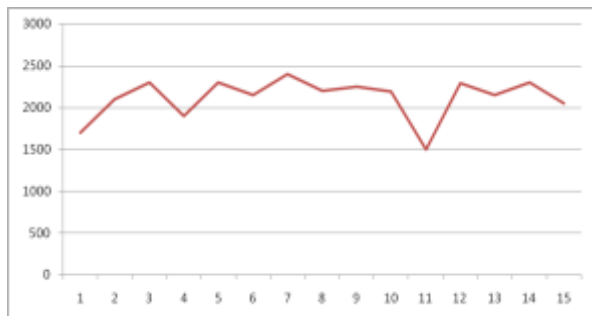**Chart - 4.3:** Time (in minutes) vs. RPM of alternator.

Chart - 4.4: Time (in minutes) vs. Current in AH.

4.2 HANDLE POWER SYSTEM

(i) ELECTRISITY GENERATION

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 2200 rpm and average generated current is 12AH. The experiment had done 9 times.

Chart - 4.5: Time (in minutes) vs. RPM of alternator.
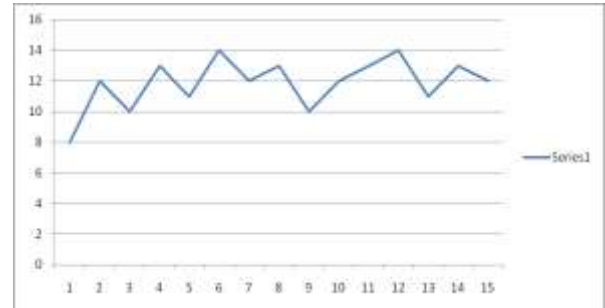
Chart - 4.6: Time (in minutes) vs. Current in AH.

(ii) 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 39 seconds for 4 meter suction head of 0.5 hp centrifugal water pump.
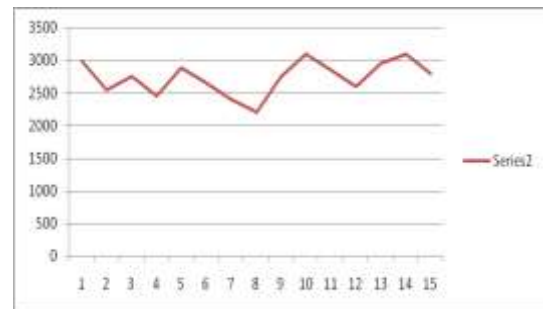

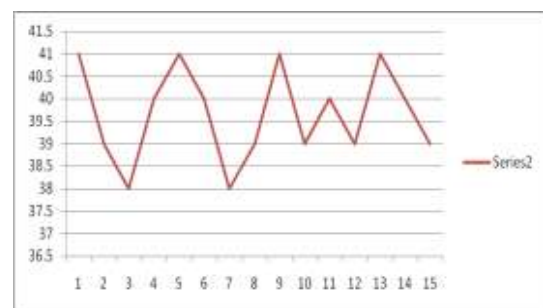**Chart - 4.7:** No of Experiments Vs. RPM of Pump.

Chart - 4.8: No of Experiments Vs Time for 15 LTR (in sec).

4.3 ANIMAL POWER SYSTEM

(i) ELECTRICITY

The Animals' effort and speed depend on the load subjected. Experimental result shows that animal take very little time to get working speed of 600 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 animal 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 animal muscle power system is 900 rpm and average generated current is 9AH. The experiment has done 15 times.
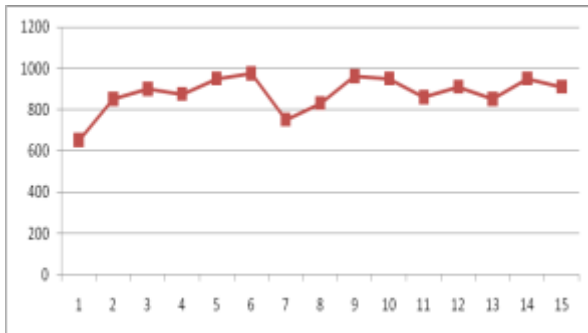

Chart - 4.9: Time (in minutes) vs. RPM of alternator.
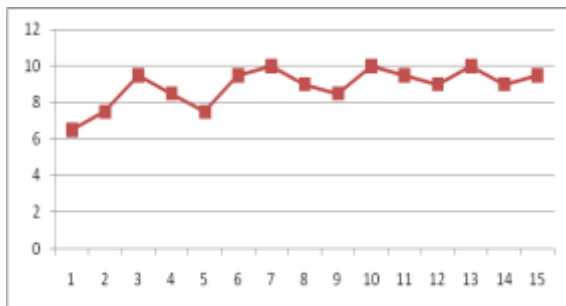

Chart - 4.10: Time (in minutes) vs. Current in AH.

(ii) CENTRIFUGAL PUMP

The animals' effort and speed depend on the load subjected. The experiment had done 15 times. Experimental result shows that animal take very little time to get working speed. The readings are taken after discharging 15 liters. Figure No of Experiments Vs. RPM of Centrifugal Pump shows that rpm is almost constant in every experiments. The force applied by animal power is varying so that the discharge from centrifugal pump is varying during experiment. The average rpm of animal muscle powered irrigation system is 800-900

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 38 seconds for 0.5 hp centrifugal water pump.
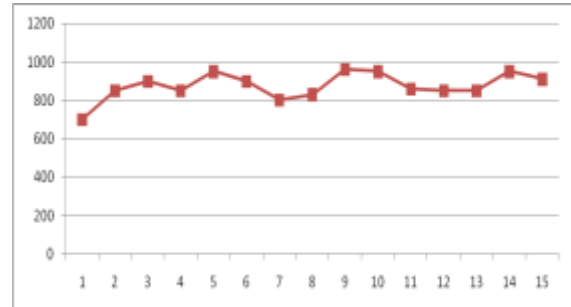

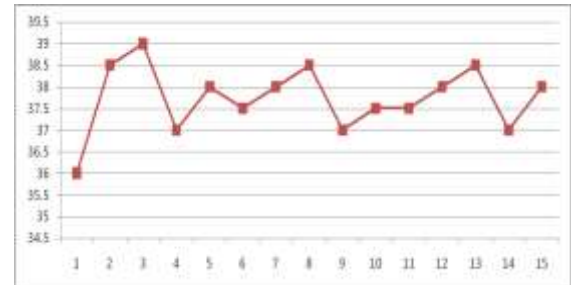**Chart - 4.11:** No of Experiments Vs. RPM of Pump.

Chart - 4.12: No of Experiments Vs Time for 15 Ltr. (in sec).

## 4.4 ANIMAL POWER/ HUMAN POWER COMBINNING WITH SOLAR POWER

The humans' and animals' effort and speed depend on the load subjected. Animal and human speeds are change very quickly and abruptly. It is very difficult to taking speed reading continuously because animals get puzzled. The readings are taken after every four minutes within one hour. Speed vs. Current shows that at low rpm at starting of animal motion it is not generating current by both alternator, but as well as rpm is increasing and reaches to ideal working rang alternators producing high value of currents. Experimental result shows that animals take very little time to get their average speed of 1 m/s. Alternator generates constant voltage of 12V as specified after reaching ideal speed. Fully charged battery shows 12.6V.

Solar battery is parallel connected with the alternator run by animal or human muscle powered. The time taken by solar system to charge the battery is depending on atmosphere temperature. Since MPPT technology is used to charge controlled battery get the constant voltage. Normally 12V 180Amps tubular battery is charged in 10–12 hours because temperature is vary from morning to evening. But when tubular battery was charged using animal powered alternator of TVS-Lucas 12V 40AH which generate 12 AH (average) With solar system it took 7hrs to fully charge and it take 9-10 hrs when connected with human powered.
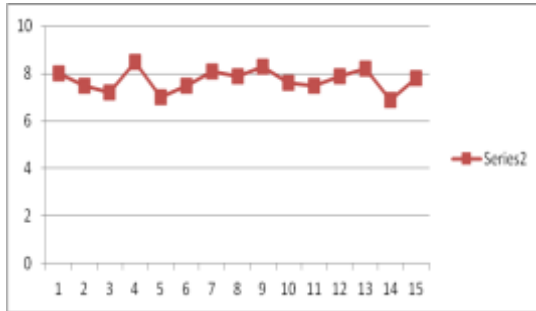
Chart - 4.13: No of Experiment vs. Time to charge solar battery (in hr).

When the centrifugal pump connected with solar tubular battery charging with solar system and muscle power (animal/human) the discharge rate is constant as well as it take the little time to discharge water as compare individual discharge by animal/human power. The time taken to discharge 15 lit water from the well when suction head is 4 meter is 31 second using 0.5 hp centrifugal pump.
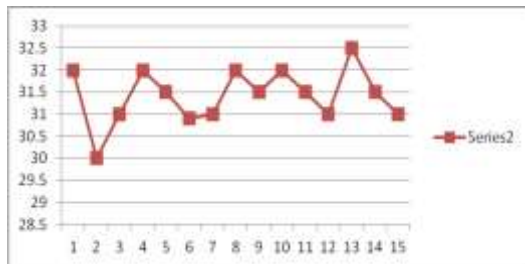
Chart - 4.14: No of Experiments Vs Time for 15 Ltr. (in sec)

Fig - 4.1: The water pump powered by hybrid system.

5. CONCLUSION

The present work provides a automaton for to run centrifugal pump for irrigation, to run generator for generating electricity power of the human handle and paddle power or animal power with combining with solar system. The project aim was to style, fabricate and by experimentation studied of automaton for run pump irrigation system for billion those that suppose natural water for irrigation and to run generator for electricity for those that suppose lamp oil. This aim is meet inside constraint of coffee cost and also highly safe. This project must supply a very good product with high potential. This can be conjointly ended fictitious automaton is itself a really tiny scale business at rural and isolated areas

ACKNOWLEDGMENT

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