DESIGN AND EXPERIMENTAL ANALYSIS OF SOLAR BICYCLE

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***Abstract*— A solar bicycle is an electric vehicle powered completely or significantly by direct solar energy. Usually, photovoltaic (PV) cells contained in solar panels convert the sun's energy directly into electric energy. The term solar bicycle usually implies that solar energy is used to power for vehicle's propulsion. The solar bicycle is a possible future scope when petrol and diesel is not available, so overcome the fuel and emission problems of the vehicle and develop a solar bicycle that gives better comfort for the normal person without human paddling and the without the use of fuel cost. In this paper make a experimental setup of solar bicycle and result obtained in the form of power produced by solar panel and load versus speed of solar bicycle.*)**

***Index Terms*— Solar, PV Cell, Bicycle, Power.**

I. INTRODUCTION

Solar-powered vehicles (SPVs) use photovoltaic (PV) cells to convert sunlight into electricity. The electricity goes either directly to an electric motor powering the vehicle, or to a special storage battery. PV cells produce electricity only when the sun is shining. Without sunlight, a solar powered car depends on electricity stored in its batteries.

Solar energy, radiant light and heat from the sun, has been harnessed by humans since ancient times using a range of ever-evolving technologies. Solar energy technologies include solar heating, solar photovoltaic cell, solar thermal electricity, solar architecture and artificial photosynthesis, which can make considerable contribution to solving some of the most urgent energy problems the world now face.

Since the 1970s, inventors, government, and industry have helped to develop solar-powered cars, boats, bicycles, and even airplanes. In 1974, two brothers, Robert and Roland Boucher, flew an extremely lightweight, remote-controlled, pilotless aircraft to a height of 300 feet. It was powered by a PV array on the wings. (The U.S. Air Force funded the development of these aircraft with the hope of using them as spy planes.) The first totally solar-powered car was built in 1977. It was small, lightweight, and cost relatively little. Experimental SPV's, equipped with advanced technology, have been built with the backing of major auto manufacturers, including General Motors, Ford, and Honda..

II. OBJECTIVE

To overcome the problem and the weakness, this project need to do some research and studying to develop better technology. To make it success there are several thing that we need to know such as what will be the prime mover, how to stored it and the advantages of this new vehicle. In that case, these are the list of the objective to be conduct before continue to proceed on this project.

1. To develop a vehicle that use renewable energy, environmentally friendly and cheap.
2. To develop a solar bicycle that can charge the battery when it is not in used.
3. To develop medium speed bicycle, but for a longer distance.

III. DESIGN AND DESCRIPTION

For making of solar based bicycle it required different parts. Without this component the solar based bicycle are not developed

a. Design of Shaft

An electric power shaft transmits to 250 watt power at 300 rpm to find out design of shaft with assuming Suitable material. For find out shaft diameter require pre-data such as Power=0.25 KW and N=300RPM.

Step 1- Design of shaft for finding diameter:

Assuming material for shaft –

SAE=1030

Sut = 527, Syt = 296

Step 2- T=torque

$T = \frac{\Pi}{16T \times d3}$

$P = \frac{2\Pi NT}{60}$

$0.25 = \frac{2\pi \times 300 \times T}{60000}$

T=7.96×KL Where KL is a load factor: KL=1.75

T=5.96×1.75
T= 13.93N-M
T=13.93×103N-mm

Step-3 for solid shaft:-

Tmax×<0.3syt OR Tmax×<0.18
=0.3×296 =0.18×527
=88.8Mpa =94.86 Mpa

Consider minimum value of

Tmax = 88.8 N/mm2 (Without keyway)
Tmax = 88.8 × 0.75 (With keyway)
Tmax = 66.6N/mm2

Torque = $\frac{\Pi}{16T \times d3}$
13.93×1000= $\frac{\Pi}{16 \times 66.6 \times d3}$
d=10.21mm

Considering bending stress develop on a shaft therefore diameter of shaft will be increased by 50%

d=10.21±1.5
d=15.32mm
d=16mm
d=16mm

Therefore diameter of shaft is **16mm**

b. Design of solar beam radiation

A Solar bicycle which is placed in navsari made of angle beam radiation On May 1 at 9.00am (local apparent time) the solar panel is located in college (28° 35´N 77 12E) It is tilt an angle of 36°with horizontal and is pointing done in south For this h=0° Where h=the surface incident angle on May 1, n=121.

ɖ=23.45 sin [360/360 × (284+121)]
ɖ=16.50° at 9.00am (local apparent time)
W=45° Substituting in equation of inclination surface facing due south h=0°
Cos Q =sinɖ(sinQ-B) + cosɖ(Q-B)
CosQ=sin14.90°sin(28.58°-36°)+ (Cos14.90°cos45°cos(28.58°-36°)
CosQ=0.6444
Q=48.90°

c. Design of brake power:

The torque is measured by the tachometer device is 7.65N/mm
$BP = 2\pi NT/60$
$BP = (2\pi \times 300 \times 7.65)/60$
$\boldsymbol{BP = 240\ W}$

Brake power of scooty 800 w in normal condition in two wheeler but when two side wheels are attach then due to load these BP is also reduce. Our BP is for single sitter person which is 240 w and observed that is sufficient.

IV. EXPRIMENTAL SETUP

Detailed discussion of this parts are described below.

A. **Solar Panel**

A photovoltaic module or photovoltaic panel is a packaged interconnected assembly of photovoltaic cells, also known as solar cells. The photovoltaic module, known more commonly as the solar panel, is then used as a component in a larger photovoltaic system to offer electricity for commercial and residential applications.

Figure 1: Solar Panel

B. **Battery**

Given the current market, lead-acid is the only viable battery technology for electric vehicle conversion. Batteries are available in both 6V and 12V units. Most standard, wet-cell, golf cart batteries are 6V units. Most sealed batteries are 12V unit.

C. **Motor**

The main characteristic of Brushless DC Machines is that they may be controlled to give wide constant power speed ranges because the Motor Voltage may be held constant at Maximum Bus Voltage over the Constant Power Range. In this condition the machine exhibits a leading power factor and with suitable control leads to low switching losses in the Inverter when in the High Speed Region-The Machine has the lowest size and weight of any of the main contenders.

D. **Speed Control**

In this bicycle push type on and off switch used generally in doorbell type are used and fitted with rear tyre brake for that a complete mechanism with brake is done. When it push the brake power supply start that runs the bicycle and when it release the brake the power supply is cut-off.

E. **Dynamo**

It is used for this solar bicycle are directly taken from kinetic Luna bike.

Figure 2: Motor

Figure 3: Dynamo

F. **Rectifier**

Rectifier that is used in solar bicycle are used for converts the dynamos A.C power into D.C power.

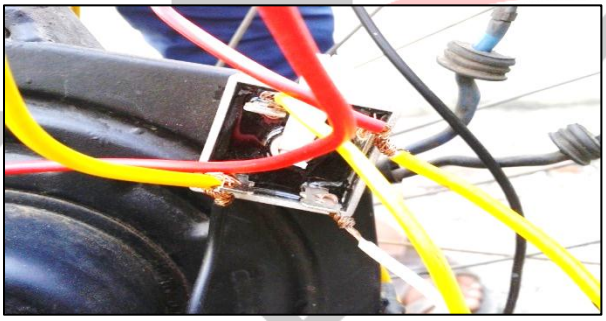

Figure 4: Rectifier

G. **Specification of Parts**

1) Motor: 180W brushless hub motor
2) Battery: 36V 8AH Li-ion
3) Speed: 20km/h
4) Max range: 45km or pedalling-electric model 50-65km
5) Recharge times: ≥800min.
6) Charging period: 4-7H (by power supply)
7) Frame: Lightweight 6061 aluminium frame
8) Wheels: Alloy rims and lightweight alloy
9) Type size: 18"
10) Lamp: 36V LED lamp
11) Brake (F/R): V-Brake/V-Brake
12) Handle bar & stem: Aluminum
13) Battery case: Aluminum
14) Speed sensor With 1:1 intelligent pedal assistant system (PAS)

V. WORKING SETUP

Solar panels transfer energy to 12 volt deep cell batteries located on the bike's frame just below the chair, from there, a small brushless dc motor between the front wheel hubs powers the bike. The whole system is on a continuous feedback loop, enabling the bike to partially recharge while in use thus extending the bike's range. A dc motor located in front wheel is controlled by the speed controller and throttle. The rider can switch from pedal power to solar power easily, and when not in use, the solar panels continue to recharge the batteries. The motor's maximum is 250 w.

Figure 5: Working mechanism

Figure 6: Speed control mechanism

Figure 7: Solar Bi-cycle

VI. RESULTS AND DISCUSSION

From above experimental setup we can conclude that Design parameter of following setup as below:

Diameter of the back wheel = 0.66 m

Diameter of the front wheel = 0.33 m

RPM of brushless dc motor = 375 RPM

From the experimental setup taking reading at different interval of time that gives voltage and amp. From that getting information regarding power

$$P = V\,I$$

The average output of solar power generation= 144 watt-hours. Electric motor runs at 3000 rpm which is reduce by reduction gear =1: 8. So, speed of wheel rotation= 3000*1/8= 375 RPM.

Solar Average power output: P=144 Watt

$$P = \frac{2\Pi N\,T}{6000}$$

$$\therefore 0.144 = \frac{2\times 3.14\times 375\times T}{60000}$$

$\therefore$ T= 6.420 N-m (including multiplication of load factor)

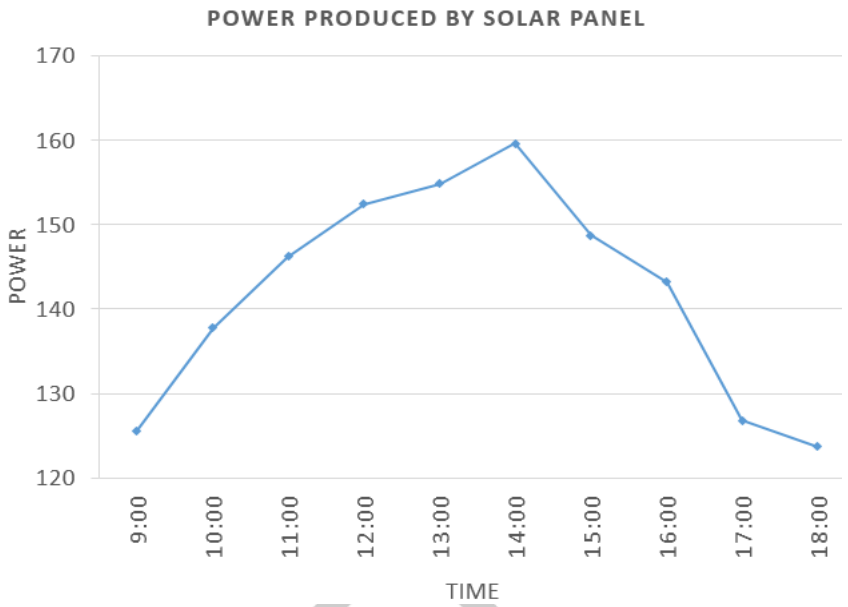

Figure 8: Power Produced By Solar Panel

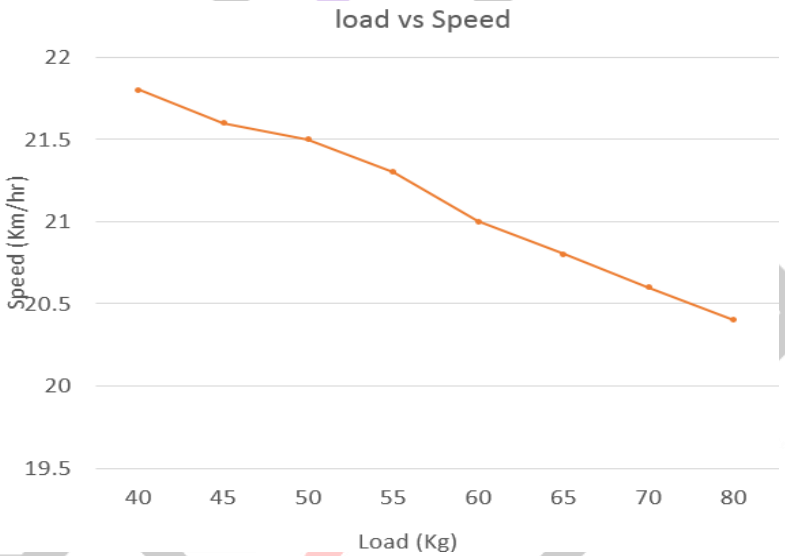

Figure 9: Relation between Load and Speed

Brake power of scooty 600 w in normal condition in two seater.Our BP of solar bicycle for single seater person which is 252 w and observed that is sufficient.

II. CONCLUSION

After performing the experimental setup of solar powered bicycle, we get the time Vs solar power value is efficient to travel. By our useful project we get the speed of solar bicycle= 20 Km/hr and run the bicycle up to 45-50 km by the power generated from the solar and dynamo. We overcome the limitation of solar powered bicycle by adding feature of dynamo and gearbox attachments.

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