ISSN: 0974-2115
www.jchps.com Journal of Chemical and Pharmaceutical Sciences

Design and Development of Solar Assisted Hybrid Tricycle

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ABSTRACT

Solar Energy plays a very important role in our day to day life. It was intended to devise a solar tricycle especially for the handicapped persons. The Solar hybrid vehicle uses solar energy for driving the vehicle, which reduce the manual effort. The tricycle includes Solar panel, Brushless DC motor, Battery, Charge controller and the braking and steering system. The design of vehicle involves selection of solar panel, power calculation for drives and battery charging and the required rated power of solar panel,i.e number of modules. The vehicle is cosnstructed using Mild steelframe having provision for installing solar panel, battery, charging pack, drive and braking system. Since this vehicle is driven by solar power, it is free from any harmful emission as in conventional vehicle. This vehicle also fulfils the need of Handicapped people by eliminating hand efforts through solar drive. It is comparatively economical than a vehicle driven by standard power pack.

KEY WORDS: photovoltaic, commutator , tricycle, green-friendly

1. INTRODUCTION

This paper details about the utilization of solar energy in to usefull driving power fortricycle, which helps in reducing the efforts of the handicapped person.In case of unforeseen situation, the same vehicle can also be driven by hand. The vehicle has the provisions for solar panel at top which also acts as a roof, battery power pack platform underneath the driver seat and braking and steering system. The required PV panels are provided, which converts the solar power in to electrical energy. This energy further is being stored in battery, which is used to run the tricycle using an electrical prime mover through chain transmission drive. The discussion covers the design, assembly and assay the performace of the tricycle.

This solar tricycle has the advantage of lower weight and can use the rider's hand power to supplement the power generated by the solar PV cell roof. By this, anequivalently comprehensive and low-cost tricycle can be propelled without using of any fossil fuels. The solar electric tricycle is easily accessible, safe and practical with limited maintenance requirements due to a minimum of mechanical parts used. It is optimal for the experienced cyclists and further for those non-athletes, the elderly and individuals with health problems.

Components:

Solar Panel: A photovoltaic array (PV) or photovoltaic panel is a combination of mutual assembly of photovoltaic cells, also known as solar photovoltaic cells. This finds application in the form larger photovoltaic system to supply electricity for trading and house hold applications. A desired number of interconnected solar cellsis mounted as a single integrated structure or frame known as photovoltaic module. The deisgened Solar Modules will be able to supply electricity at a desired voltage, generally a 12 volt set up.

The desired number of cells depends on the solar area andsize.The wiring of solar cells are done in series connection and are divided into several zones. For illutration, if a 750 solar cells, we need to wire 3 sets of each 250 cells, each zone generating nearly 125 volts. If case of any emergency failure of one zone ,the two other zones will generate power. On using power trackers, solar array voltage would match the system voltage of the motor which convert the solar array voltage to the system voltage.

The rating of module is done by its DC output power devisedby standard test conditions (STC), and it ranges from 110 to 320 watts. The effectivness of a module s depends on the the area of a module atthe given same rated output.A module of 230 watts having 8% efficient will have twice the area of a 16% efficient 230 watt module.. A single solar module can produce only finite amount of powerHence, multiple modules are used .A photovoltaic system cosists of an array of solar modules, an inverter, battery with or without solar tracker and wiring for interconneciton.

Figure.1. Solar Panel

Battery: Battery is a storage device for storing electicenegy produced from solar power. Batteries aremore econcomical and technically feasible component. It is important that the storage system should be optimumin lieu of

available energy and nativedemand design.It is essential that a batteryshould posses the amalgamaitonsof following factors:

- Low cost
- Longer life
- High consistency
- High overall efficiency
- Low discharge
- Least maintenance
  - ❖ Ampere-hour efficiency
  - ❖ Watt-hour efficiency

The Lead-acid battery as shown in figure 2 is used for storing the electrical energy from the solar panel.The lead-acid cell type battery is commonly used ,where high load current are inevitable. The electrolyte is a dilute solution of sulfuric acid (H_2SO_4).Batteries of 6-V, 12-V, 24-V are available and their desired combination could give different total voltage as required depending on applications.

By making discharge and charge cycle inrepetition for several times in restoring the output voltage, and further this happens when the cell is in bettersolid condition. However, heat caused due to disproportionate charge and discharge currents restricts the useful life from 3 to 5years. Unlike another types of secondary cells, the lead-acid type has the maximum output voltage, which results in fewer cells for a specified battery voltage.

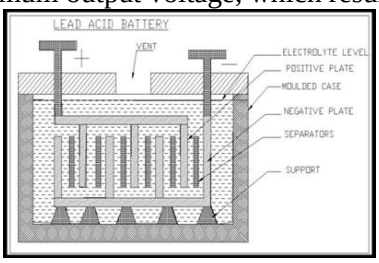

Figure.2. Lead Acid Battery

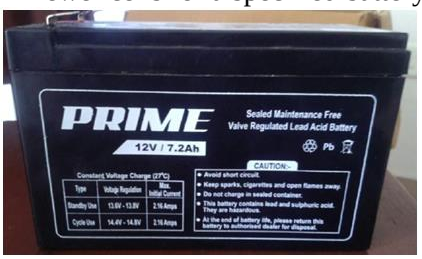

Figure.3.12V Battery

DC Motor: An electric motor is a appliance which converts electrical energy to mechanical power. When a current-carrying conductor is located in a magnetic field, it experiences a magnetic force. The direction depends on Fleming's Left hand rule. The motor develops the torque on operation as depeicted in the figure 4. The conductorfield due to the current supports the main field above the conductor, but disapproves the main field below the conductor.

It is found that a force acting on the conductor, try to push the conductor downwards. If the current in the conductor is inverted, the flux lines is strengthened and occurs below the conductor, which pushes conductor up-wards.

To produce flux a DC is given to the field poles. The conductors are connected to the DC supply through brushes.

A simple motor has 6 parts, shown in the diagram Figure 4.

- An armature or rotor
- A commutator
- Brushes
- An axle
- A field magnet
- A power supply (DC)

An electric motor works on magnets and magnetism. Magnets are used to create motion.Here and like poles repel and opposite poles attract. A magentsof two bar marked their ends as north and south, then the South end of one magnet will attract the North end of the other. Conversely, the South end of one magnet will repel the South end of the other and likewise North will repel North. Alternating repelling and attracting forces creates rotational motion.

Tricycle: A tricycle is a mode of transport/equipment which is pedal-driven, having two wheels Behind and one wheel in front.A person who reides a triycle is called a cyclist. They were the primary means of transportation in many regions. They also give a means of recreation, and used as children's toys. It is also means for general fitness, and used in tricycle racing.

The tricycle's invention had an massive effect on society, both in terms of culture and of advancing modern industrial methods.

Construction: The selection of different mechanisms as per the requirement was done to achieve the final design.

Brake Mechanism: The Rim brakes hasfriction pads or brake pads which is made of cork,leather or rurubber and sticked to metial shoes. As the rider presses the hand lever on the handlebar a force is applied by friction pads and

the rotating wheelrim,which creates a frction between them and thus rotation of wheel is slowed down.This results in breaking which needs less mechanical effort and least maintenance.

Mechanical Drive: Mechanical drive consists of sprocket and chain drive. A sprocket or sprocket-wheel has teeth on it periphery that mesh with a chain, track or other perforated or indented material. The sprocket has radial projections on which a chain passes. it. Chain drive transmits mechanical power from one point to another. This conveys power toehe wheels of tricycle.This type of chain drive is used to transmit power in many driving equipments or machines.

Vehicle: The vehicle depicted inthe figure 5 is basically built up of mild steel mainly because of the following reasons.

- MS is readily available in market.
- Morein-expensive.
- Obtained in Standard sizes.
- It has good mechanical properties i.e. it is easily machinable.

Moreover itshas moderate factor of safety, because FS results in unnecessary wastage of material and heavy selection. Low factor of safety results in unnecessary risk of failure

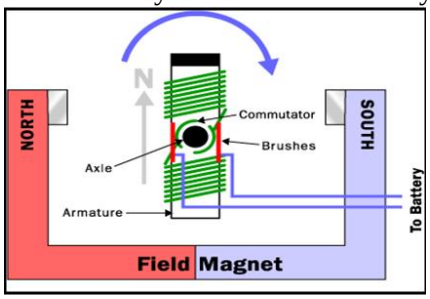

Figure.4. Simple DC Motor

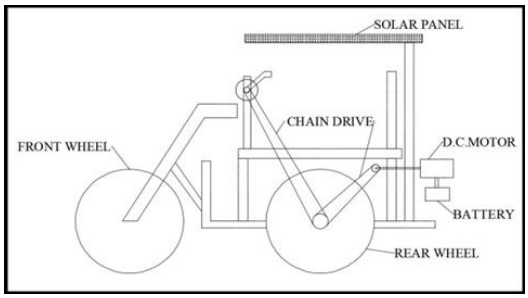

Figure.5. 2D Sketch of Vehicle

Hybrid Tricycle Design Calculations

Power Required for the Motor drive:

Power = Total weight x g x speed x gradient (watts)

Where,
Total weight = 90 kg
Speed = 20 kmph = 20 x 5/18 m/s
Gradient = slope (assume 3%)
Power = 90 x 9.81 x 20 x 5/18 x .03
= 147.15 watt
Consequently, power required is about 150 watt approximately.
Thus a Motor of 24 Volt and 150 W will be required for tricycle

Battery: System voltage 24 Volt,
Load current = 150w/24v= 6.25 A
Estimate 2 hours of tricycle running per day
Load current = 2 x 6.25 x 1.2 = 15 Ah/day
Assume 20% overall losses,
Size of battery = 15 x 1.2 = 18 Ah/day
Energy required for 150 W motor
= 18 Ah x24 V
= 432 Wh/day.
Therefore 18 Ah/day, 24 Volt power is required for the system .
This can be achieved with the help of two 12 Volt batteries of 18 Ah/day.

Charging Time: To calculate charging time needed to charge the battery of 10 Watt ,12 Volt solar charger
Ampere per hour =10 Watts /12 Volts
of the charger = 0.83 Amperes
Therefore = 7 amp hours / 0.83 amperes
= 8.43 Hoursof direct sunlight

Design of Solar Panel: Total energy needed forPV Panels= 432 x 1.3
= 561.6 Wh/day
Total Power of PhotoVoltaic panels needed = 561.6/3.4 = 165.18 W
Number of Photo Voltaice panels needed = 165.18/125 = 1.32 module

Actual requirement = 2 modules

Fabrication

Fabrication of Tricycle chassis and cage: Five Mild steel closed channels of rectangular cross section of dimension 4x2x300 cm are used to fabricate composite structure of chassis and cage of tricycle.By means of metal cutting operations like sawing and drilling, the channels were sawn into required size to obtain the structure. The CAD drawing of the tricyleis shown in figure 6.

Fabrication of Solar Pack Carrier : It forms in a rectangular shaped frame made up of MS channel shown in the figure 7. The carrier is fabricated such that it accurately fits in the grooves on the back side of solar panel which allows the same to be held on the roof without the risk of panel falling down.

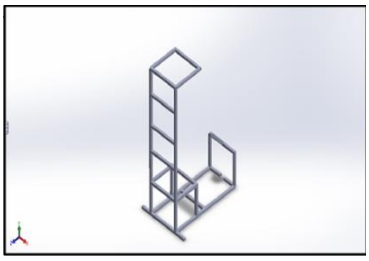

Figure.6. CAD Model of tricycle

Figure.7. Solar Carrier

Fabrication of Drive Mechanism: The solar hybrid tricycle has two kinds of drives. The backs wheels are driven by a motor. The motorpower is conveyed to rear axle using a chain-sprocket system shown in figure 8. The rear axle was fitted with a large sprocket wheel. The motor shaft was extended, on which a small sprocket wheel was mounted. These two sprockets were then connected using a chain.

The front wheel is driven manually with hand pedals is depeicted in the figure 9. It uses the same chain-sprocket setup like that of rear wheel. The larger of the sprocket of this system is provided with 2 projections on which the 2 hand pedals were attached.

Figure.8. Rear wheel drive

Figure.9. Front wheel chain sprocket drive

Fabrication of Battery Platform: A metal tray was fabricated using thin metal sheets of corresponding dimensions of 15.2x6.4x9.5 cm to that it can hold 2 batteries in it. A latch setup was provided to lock the 2 two batteries in place using screws and a U shaped metal scale. Battery pack platform is depicted in the figure 10.

Figure.10. Battery pack platform

Installation: The solar module was fitted on the solar pack carrier which in turn on top roof of the tricycle by fastening. The PV panel was then connected to the battery using wires and wires were stuck to the frame of vehicle using tape, to avoid the dangling of wires. Motor was mounted by fastening it to mounting tray. The sprockets are fixed and aligned to facilitate transmission from motor to rear axle. The rim break was installed on the top of the left side rear wheel.

The lever near to the driver was connected to the rim brakes by metal wires so that when the lever was pulled, the rim break would contract and brush against the left rear wheel thus breaking the speed of the tricycle.

Testing and Modification: After the fabrication and installation, finally testing was under taken. The figure11 depicts the beginning of the cycle drive(motion) during the tesing. Initial drive was given manually to given initial run for the vehicleand motor switch is switched on to drive the vehicle further.

At the end the brakes were applied successfully and the test was verified. The vehicle travelled a 150 m distance without any problem and issues. The power was enough to carry a person of 56 kg along with a 40 kg vehicle. The battery was successfully charged using the solar panel.

Vehicle Weight - 38 kg
Individual Weight - 56 kg
Distance Travelled - 150 meter
Time taken 9 to10 seconds
Speed- 4.5 to 5 kmp

Figure.11. Vehicle running after charging

CONCLUSION

The " Solar Assisted Hybrid Tricycle" uses solar energy for charging the battery in addition to conventional electrical power charging. This vehicle is free from any pollution as in fossil fuel driven vehicle. The weight of the tricycle is less and mainly dependent on solar energy.

This vehicle has dual mode charging, where during rainy season the battery can be charged with conventional electrical power. Further this vehicle has hand driving facility, which is used in case of any unprecedented situations like sudden battery drain, non-availability of solar or conventional power and any failure in the hybrid system components.

During the testing the tricycle travelled 150 m distance in 9 to 10 seconds with the speed ranging from 4.5 to 5 kmph. The weight of vehicle was around 38 kg and could carry an individual weighing 56 kgs. Thus the "Solar Assisted Hybrid Tricycle" was developed which helps in achieving low cost automation. The operating procedure of this system is very simple.

Advantage

- The solar vehicles will replace the fossil fuel mobiles in future.
- They are highly feasible and can be manufactured with ease.
- Solar hybrid tricyle is pollution free means for mankind in future.
- By harvesting the renewable sources of energy like the solar energy we are helping in preserving the non-renewable sources of energy.
- The maintenance of tricycle is less and user friendly.

Applications

- This projects has practical application in provideding less or no efforet to ride.
- The solar tricycle is green-friendly and does not pollute the environment
- Covers more distance using solarpower.
- It is cheap,simple and low in maintenance.

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