



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 5, May 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

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Solar Powered Electric Vehicle

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ABSTRACT: The solar electric vehicle is the most eco-friendly electric vehicle with minimum maintenance. The negative aspects of a plug-in electric is that the sources of electricity generation are still by means of fossil fuels and the range that the current electric vehicles offer are limited. With the help of solar PV modules both the negative aspects can be eliminated as the vehicle can be charged while on drive.

KEYWORDS: Solar PV module, BLDC motor, Battery capacity

I.INTRODUCTION

The entire automobile sector is moving towards electric vehicles due to the environment hazards caused by internal combustion engines. These electric vehicles have reduced the pollutions by a great extent but they have their own disadvantages of limited range and the electricity generated in the charging stations are with the help of fossil fuels. The vehicle can only run up to the battery capacity and once it is completely discharged, we need to plug it in and wait until it charges. This limitation of the battery capacity can be eradicated with the help of adding solar PV modules to the vehicle. By adding solar PV modules, the vehicle can be charged while driving and by this the driving distance can be increased. The solar panel would harness energy from the sun and convert it into electricity which can be stored in the battery. A solar panel is packaged, connected assembly of solar cells, also called photovoltaic cells which are solid state devices that can convert solar energy directly into electrical energy through quantum mechanical transitions. They are noiseless and pollution-free with no rotating parts and need minimum maintenance. The electricity thus generated would then fuel the battery that would run the car's motor.

In our model we are using a single motor which is connected to the differential on the rear axle. The mechanical parts such as gearbox, clutch etc. can be eliminated, so the regular maintenances are required. As the electricity is produced by a renewable source of energy, it is eco-friendlier and unlimited.

II.LITERATURE SURVEY

With the increasingly severe environmental problems around the world, exploitation of clean renewable energy has been a crucial topic. As indispensable transportation in modern society, vehicles are ubiquitous but also one of the main sources of pollutants. Because of their status, it is almost impossible to decrease the volume of vehicles. One solution to lowering emissions is the electric vehicle. Overall, the electric vehicle is more energy efficient, environmentally friendly, and cleaner than the vehicle that relies on fossil fuels.[1]

An electrically powered vehicle has essentially three major electrical components these include energy source (usually are chargeable battery bank), an inverter or, motor controller and an electric motor. In case of a solar car, the energy source is typically a bank of batteries, which may be recharged by photovoltaic solar panels. The motor controller is typically a power electronics device which when supplied with the driver's input commands, controls the torque and speed of the electric motor. [2]

The solution is SPEV is supported with a charging cable that plugs in to the vehicle and into a 230v wall socket. The electric vehicle has a built-in features like security system, Seatbelt Detection system, Collision detection.[3]

Hence, by incorporation of the solar photovoltaic panels, the range of the Battery powered cars can be increased. Electric vehicles are currently emerging in the present market and the automobile industry is investing a lot of their R & D resources for the development of electric solar vehicles. These are the future of zero carbon emissive car

transportation. The present work aims to develop a model of plug-in electric solar vehicle and discusses the design parameters of these vehicles to come in the market.[4]

III. PROPOSED SYSTEM

The proposed vehicle is not a complex one. It is very simple in construction compared to fuelled vehicles. Electric vehicle's layout is shown in fig 1. System mainly consists of two motors with controllers, reversing circuit, battery pack, solar PV module with charge controller and an accelerator.

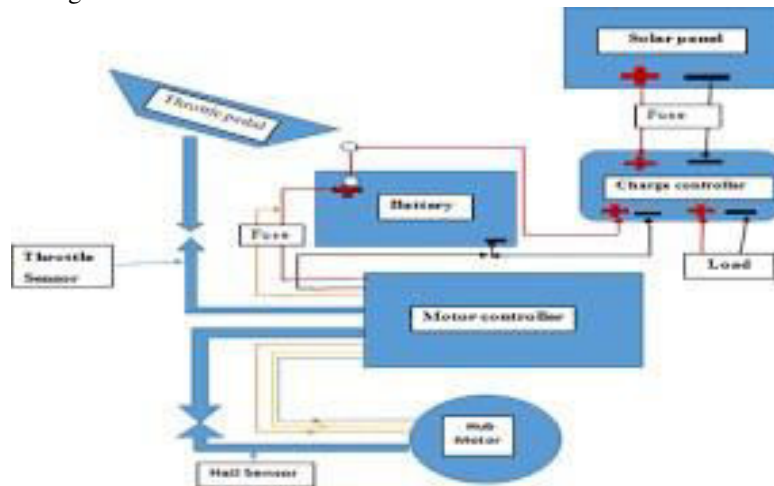


Fig.1 basic block diagram

A common accelerator is used for triggering both controllers. Brake switches will turn off motors while brake is applied. One of the motors will turn off while turning the vehicle to opposite to the motor position. The vehicle needs to be reversed while driving here the two phases and two control wires are interchanged for reversing. Reversing switch is mounted on steering column.

IV. HARDWARE COMPONENTS

A. ACCELERATOR

Accelerator is used to trigger the motor controllers. Here we use a cable to attach accelerator pedal to accelerator circuit mechanically. Accelerator consists of a Hall Effect sensor and a magnet. An accelerator is shown in fig 2.



Fig 2. Accelerator

The two wires are for working voltage and other one is the switch wire through which Hall Effect sensor output is carried to motor controller. It has a linear type Hall Effect sensor on the fixed part and a permanent magnet on the rotating part.



B. MOTOR CONTROLLER

The motor controller is the heart of the vehicle. All the electric parts of the vehicle are controlled by this. A BLDC motor controller is shown in Fig 2. It controls the speed of motor, breaking, battery voltage calculation, speedometer control and electrical accessories control. It has two wires from battery pack, 3 phase wires, 5 rotor position sensor wires, wire to accelerator, brake sensor wires from brake pedal, speed.

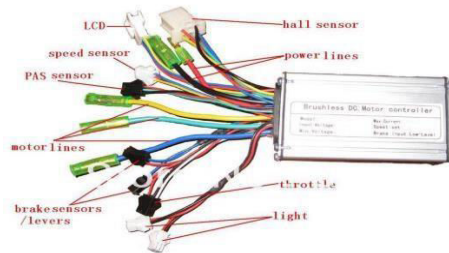


Fig 3. BLDC motor controller

C. BLDC Motor

A brushless DC motor (BLDC motor) is an electronically commuted DC motor which does not have brushes. BLDC motor is shown in Fig 4.



Fig 4. BLDC motor

D. BATTERY PACK

The batteries are the essential part of an electric vehicle. In our vehicle we use four lead acid batteries in series to get working voltage of 48V. We have used this to reduce the cost, Li-ion batteries can also be used to reduce the weight and it also has 3 times the life. A lead acid battery is shown in fig 5.



Fig 5. Lead acid battery

E. SOLAR PV MODULE

Here the PV module is used for charging the vehicle on running mode from sunlight. Here we use Polycrystalline solar cells. Polycrystalline solar panels generally have lower efficiencies than mono crystalline options. In addition, polycrystalline solar panels tend to have a blue hue instead of the black hue of mono crystalline panels. Polycrystalline solar panels are also made from silicon. However, instead of using a single crystal of



silicon, manufacturers melt many fragments of silicon together to form the wafers for the panel. Polycrystalline solar panels are also referred to as “multi-crystalline” or many-crystal silicon. Because there are many crystals in each cell, there is less freedom for the electrons to move. As a result, polycrystalline solar panels have lower efficiency ratings than mono crystalline panels, but their advantage is a lower price point. Solar PV module is shown in figure 6. Polycrystalline solar panels tend to have slightly lower heat tolerance than mono crystalline solar panels.



Fig 6. solar PV module

Polycrystalline solar panels will tend to have a higher temperature co-efficient than solar modules made with monocrystals. This means that as heat increased output for this type of cell will fall less. However, in practice these differences are very minor.

Solar PV module specifications

Capacity 160W Output voltage 0-48V

F. CHARGE CONTROLLER

An MPPT, or maximum power point tracker is an electronic DC to DC converter that optimizes the match between the solar array (PV panels), and the battery bank or utility grid. Fig 7. MPPT Solar Charge Controller. To put it simply, they convert a higher voltage DC output from solar panels (and a few wind generators) down to the lower voltage needed to charge batteries. The charge controller looks at the output of the panels and compares it to the battery voltage. It then figures out what is the best power that the panel can put out to charge the battery. It takes this and converts it to best voltage to get maximum AMPS into the battery. (Remember, it is Amps into the battery that counts). Most modern MPPT's are around 93-97% efficient in the conversion. You typically get a 20 to 45% power gain in winter and 10-15% in summer. Actual gain can vary widely depending on weather, temperature, battery state of charge, and other factors.



Fig 7. solar charge controller

PROTOTYPE MODEL OF THE SOLAR ELECTRIC VEHICLE



V. WORKING

The BLDC motor is driven by an electronic drive which switches the supply voltage between the stator windings as the rotor turns. The rotor position is monitored by the Hall Effect sensor which supplies information to the electronic controller and based on this position, the stator windings to be energized is determined. These electronic drives consist of IGBTs (2 on each phase) which operate motor drive. For obtaining the rotor position a Hall Sensor is embedded on the stator. As motor rotates, the hall sensor senses the position and develops a high or low signal, depending on the poles of magnet. Control voltage is implemented by microelectronic device has several high-tech choices.

This may be implemented using a microcontroller. Speed control of BLDC motor is essential for making the motor work at desired rate. Speed of BLDC motor can be controlled by controlling the input DC voltage. The higher the voltage, more is the speed. When motor works in normal mode or run below rated speed, input voltage of armature is changed through PWM model. When motor is operated above rated speed, the flux is weakened by means of advancing the exciting current. In this scheme, current is controlled through motor terminals one pair at a time, with the third motor terminal always electrically disconnected from the source power. THREE Hall devices embedded in the motor are usually used to provide digital signals which measures rotor position with 60-degree sectors and provide this information to the motor controller. Because at any time, the currents in two of the windings are equal in magnitude and the third is zero, this method can only produce current space vector having one of six different directions. As the motor turn to the motor terminals is electrically switched every 60 degrees of rotation so that the current space vector is always within the nearest 30 degree of the quadrature direction. The controller provides pulses of current to the motorwindings which control the speed and torque of the synchronous motor. These types of motors are highly efficient in producing a large amount of torque over a vast speed range. In brushless motors, permanent magnets rotate around a fixed armature and overcome the problem of connecting current to the armature. Commutation with electronics has a large scope of capabilities and flexibility. They are known for smooth operation and holding torque when stationary.

The solar panel absorbs energy from the sunlight by PV cells in the panel. This energy creates electrical charges that move in response to an internal electrical field in the cell, causing electrical flow. This electrical flow is then directed to the batteries with the help of a solar charge controller. The solar charge controller measures the required amount of charge and helps to recharge the battery.

Output from the solar panel – 40W

Number of solar panels – 4



Total output – 160W

V_{max} – 16.509

I_{max} – 2.543

Efficiency of the solar panel – 14.684%

Solar output (kWh/Day) = 160W * 6h * 0.75 = 0.72kWh Time

taken to charge the batteries = 1.68/0.72

= 2.3 hours approx.

V. CONCLUSION AND FUTURE WORK

To cope with the increasing demands for fuel and the disastrous environment pollution due to driving carbon-based vehicles, it is quite necessary to switch to a new source of energy, i.e., the solar power which would be a cheap, efficient, limitless and of course an eco-friendly alternative. Solar-powered electric vehicles are safe with no volatile fuel or hot exhaust systems. They are zero emission vehicles, odorless, smokeless and noiseless. They require minimal maintenance, are more reliable with little or no moving parts and can be efficiently charged nearly anywhere. It is very much cost efficient The Solar Powered EV would benefit by the end users like Industries, university campus, amusement parks. The technology used in SPEV contributes its supports to green transportation.

If the solar technology is developed and the panels produced have higher efficiencies of 45 – 60% then we could use solar power as the main source of electricity generation. Smaller solar panels can be used to in place of the huge panels used now to generate similar amounts of power.

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