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Solar Powered Electrical Car

S. Nagaraju (Associate Professor)
Department of Electrical and Electronics Engineering
Aditya Institute of Technology and Management, Tekkali, Andhra Pradesh
P. Manikanta, Y. Manoj Naidu, J. Venkat Sai, M. Tejesh
Department of Electrical and Electronics Engineering
Aditya Institute of Technology and Management, Tekkali, Andhra Pradesh

ABSTRACT:

This paper presents research on a solar-powered electric vehicle that can be used in campus. Solar energy is among the most significant sources of renewable energy that may serve as a valid substitute for petroleum and coal. The sun's radiation produces around 800-1,000 watts of energy per square metre of the earth's crust on a clear, sunny day. The phrase "solar power" explicitly refers to the process of producing energy by utilising solar radiation. A grid of solar cells is used to build photovoltaic cells. These cells take up solar energy and transform it into electricity. Solar vehicles now capture solar energy and convert it into electricity. This electricity charges the battery, which powers the vehicle's motor. Instead of a battery, a few solar road vehicles send power directly to an electric motor. Solar vehicles are now categorised as "green vehicles," because they are energised by renewable energy and emit no carbon dioxide.

KEYWORDS:

Permanent magnet synchronous motor (PMSM)
Solar powered electric vehicle (SPEV)
Solar cells
Green vehicle

1. INTRODUCTION:

Electric vehicles have grown in popularity in recent years as people seek clean and efficient, more sustainable modes of transportation. As we continue to deal with the consequences of climate change and depletion of natural resources, electric vehicles provide an exciting way to reduce our dependence on fossil fuels. Photovoltaic arrays are an even more environmentally friendly choice for powering electric vehicles. solar-powered electric vehicles have become a new way to combine the advantages of solar energy with the convenience and efficiency of electric vehicles.

solar-powered electric vehicles (SPEV) can be charged using renewable energy by harnessing the power of the sun, decreasing emissions of greenhouse gases and air pollution. Furthermore, because they do not consume energy, solar-powered electric vehicles provide greater energy

independence. Furthermore, because they do not rely on traditional energy sources like oil and gas, which are often subject to price fluctuations and supply chain disruptions, SPEVs provide greater energy independence [1].

Overall, SPEVs are a promising step forward in the search for environmentally friendly transportation. SPEVs provide such a powerful example of how renewable energy and electric vehicles can work together to create a more sustainable future as we continue to explore new technologies and approaches for reducing our environmental impact.

2. THE MAJOR COMPONENTS IN SPEV:

The primary energy storage system for this solar-powered electrical vehicle is the battery, which can be charged using either a solar panel or a plug-in charger. It is equipped with a motor controller to keep track of a variety of factors, including temperature, voltage, and speed. Using a DC converter, which reduces the input voltage from the battery pack to a lower voltage, such as 5V, other electronic equipment in a car can be operated by the battery packs [2].

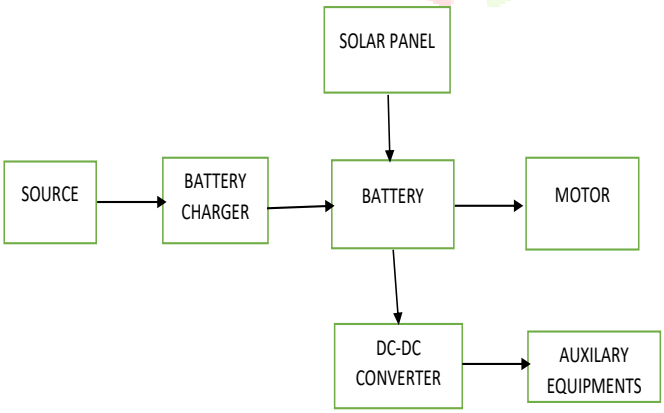

Figure.1: components in SPEV

3.PERMANENT MAGNET SYNCHRONOUS MOTOR:

Permanent magnet synchronous motors are widely used to create high-performance and high-efficiency motor drives (PMSM). High performance motor control features include free rotation over the whole motor's speed range, full torque control at zero speed, and rapid acceleration and deceleration. Both the spinning magnetic field of the stator and the constant magnetic field of the rotor are required for the operation of the PMSM [4]. By using permanent magnets as the rotor, which rotates and locks at synchronous speed, a continuous magnetic flux is generated. These kinds of motors are similar to brushless DC motors. The most prevalent steady-state 3-phase AC motors used in electrical systems are synchronous motors, which convert electrical energy into mechanical energy [4].

Specifically, this kind of motor rotates at synchronous speed, which is constant, synchronous with the supply frequency, and whose rotational period is equal to the sum of the AC cycles. In other words, the motor's speed is equal to the magnetic field's rotational speed. Most often, this kind of motor is used in power systems to increase power factor. Both DC excited and non-excited synchronous motors operate based on the motor's magnetic field strength. Reluctance motors, hysteresis motors, and permanent magnet motors are examples of non-excited synchronous motors [4].

4.LEAD ACID BATTERY:

The lead acid batteries help in reducing the emission of greenhouse gas by the usage of conventional and renewable sources. They also give great energy as power input for the solar car.

The lead acid batteries are rechargeable, which were introduced in the year 1859. These lead acid batteries have very low density in terms of energy when compared to contemporary batteries which are also rechargeable. In lead acid batteries there are cells which have a power weight ratio which gives the currents [3]. These batteries are used even though there is no presence of currents, and they even give high energy as they are really expensive when compared to modern technology.

In a four-power system, the standalone systems have high availability emergency power systems in hospitals and require power stations like backup power in telephone stations and lead acid designs for storage. To improve the storage and to reduce the requirement for maintenance [3].

There are two electrodes in lead acid batteries which are immersed in sulphuric acid. There are two types of electrodes. One is positive and the other is negative. The electrode which is positive is made up of grains of lead oxide and the negative one is blenched to lead oxide. The flooded type and valve regulated are two types of lead acid batteries.

Flooded type lead acid battery.

The flooded type of lead acid battery contains sulphuric acid. The content of sulphuric acid is 35 percent, and the content of water is 65 percent. In a flooded type of lead acid battery, the electrodes are dipped into the dilute solution of sulphuric acid.

In flooded type lead acid battery, there is a gas build up due to pressure as there are openings at the top vents. These batteries need regular maintenance due to the gassing in. The battery electrode may decline, so it is necessary to have regular maintenance of these batteries [3].

Valve-regulated lead acid battery

These batteries are also called a sealed type of lead acid battery. It is also one of the types of lead acid battery that contains a limited amount of electrolyte [3]. This electrolyte is called the star type electrolyte. It is absorbed on a plate and separated into a gel. This battery has the presence of a valve in the battery which remains or retains the battery contents which are independent of the cells.

The absorbent glass mat and gel cell battery are two types of valves regulated lead acid battery. The electrolyte which is present in the gel battery contains silica dust in it. There is a fibre glass between the battery which uses electrolyte between the plates. There are many advantages and disadvantages to both the valve regulated lead acid battery and the flooded type of battery.

In these two types of batteries, we have used flooded type lead acid battery. The efficiency of these battery is 85 percent, and the main advantage of these battery is cost effective and the lifetime of these batteries is from 3 to 5 years and even long last for 12 years. We can even get a great efficiency of 95 percent and a great life span if we use lithium-ion batteries. But the only we opted for lead acid battery is due to economic issues [3].

We used five batteries having ratings 12v and 100mah. These batteries are connected in series with each other so that we can get a voltage output of 60v ...which can drive the motor of 3kw.

5.WORKING:

Usually, the charge controller generates power from solar panels mounted on the top of the automobile for the battery. To ensure that the battery packs will always be charging, the battery packs are first charged before being attached directly to the photovoltaic panels. The motor, which turns the wheels of the car, is powered by the batteries. We are employing lead acid batteries with 60V and 12V ratings. Five 12V batteries are used to power the motor, which has a 60V rating. Solar charging takes around 17 hours to fully charge the battery pack. So, we opportunistically set up additional charging to the battery pack from a single-phase supply, which entails employing a charging circuit rated at 48v/60v 15A and directly fed to a battery pack via a charging pin positioned in the rear left corner of the automobile. The battery pack requires around 3.5 hours to fully charge when charged by an external 230v AC source. To maximise torque and speed, start the motor in top gear and raise the entire weight. Drivers' needs can be met by adjusting the speed [5].

6.CALCULATION:

MOTOR POWER RATING:

In general, the motor we have selected has to overcome three Forces namely,

1. Rolling force (F_r)
2. Gradient force (F_g)
3. Aerodynamic drag force (F_d)

These forces can be determined as below:

Let the total weight of the System is rounded as 800 KG,

Rolling Force:

Rolling Force $F_r = C_r M g$…… (1)

For our model F_r=78.48 Newtons

Gradient Force:

Gradient Force F_g = M g sin α….. (2)

(As assumed only straight path with no slope)

For our model F_g= 0 Newtons

Aerodynamic drag Force:

Aerodynamic drag Force F_d = 0.5 Cd p A V2. (3)

For our model $F_d = [92.66 Newtons]$

Total Force $F_t = F_r + F_g + F_d$

= 171.14 Newtons

Converting Force in newtons to the power using speed in meter/ second Considering 85% efficiency:

Power P = 3000 Watts

Battery and Solar Panel Calculations:

In order to meet the Voltage requirement of the PMSM motor 60 V, we need 5 batteries each battery of 12 V.

Battery charge time calculation

1)Battery capacity in watt hours, product of voltage of the battery-by-battery amp hours.

Then, Battery capacity = 6000 W-h

2) Discharged battery's capacity, simply multiply rechargeable batteries watt hours by rechargeable batteries depth of discharge. Let the battery is discharged 50%

Discharged battery capacity (Watt - hour)

= 3000 W-h

3) Energy required for full charge (Watt - hour)

=3529 W-h

4) Multiplying the wattage of the solar panels by the charge controller efficiency (PWM: 75%; MPPT: 95%) will give solar output

Assume you have a 250W solar array and an MPPT charge controller.

Then, Solar output = 237.5 W

5) To account for system losses, multiply solar output by 100% minus a fixed percentage.

The National Renewable Energy Laboratory's PV Watts Calculator defaults to 14.08% for system losses.

Adjusted solar output=204.06 W

6) To find the estimated charge time, divide the amount of energy required to fully charge the battery by the adjusted solar output. Then, Charge Time is 17.29 hours

Similarly, if the battery is to be charged from 100% of DoD, then the charging time is calculated and it will be as follows.

Discharged battery capacity (Watt - hour) = 6000 W-h

Energy required for full charge (Watt - hour) =5100Wh

Charge Time =24.99 hours

SPECIFICATIONS

Motor specifications**:**

Rated Voltage=60V

No load current=6A

Rated current=60A

Rated power=3000W

Motor controller specifications:

Rated voltage=60V

Peak protection current=110A

Rated power=6600W

Solar panels specifications:

Power=50W

Efficiency=14.305%

CONCLUSION:

Nowadays, fossil fuels are decreasing day by day. So, we must look after some other source which is not dependent on fuel, and it is none other than solar. So, the solar powered car takes the power from the sun in terms of photovoltaic cells and converts it into energy, which is further used by the motor and, finally, the car runs. These electric vehicles will use sunlight energy fully or partially from the sun. As it is a renewable resource, we can take as much energy as we can and use it in an effective way. This solar car also has regenerative braking which also helps the solar car.

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