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Design and Fabrication of a Solar Powered Vehicle and its Performance Evaluation

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***Abstract*:** *Recently rapid population growth, high volume of energy demand and depletion of fossil fuels intend to search for an alternative energy source in automobile industry. An abundant source of renewable energy like solar energy is proved as a better option to meet such challenge. The vehicle leaves no emissions like conventional IC engines to control the green house effect and other natural hazards. The design of the vehicle consists of PV cells, motors and other mechanism for both cost effectiveness and environment friendly to optimise the energy efficiency. The paper shows the design and analysis of a solar propelled vehicle and its performance test in terms of mileage, speed and emissions.*

***Keywords*:** *Solar panel, BLDC motor alternative energy source, solar propelled vehicle, PV cells*.

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I. Introduction

At present time, energy crisis has turned into a bulk around the world. Natural resources are decreasing with increase rate of population. Also more energy is required to sustain the current human development. In 2012, world averaged energy demand is 17 TW and 85% of this comes from fossil fuels (coal, oil, and natural gas) solar energy is radiant energy that is produced by sun. Every day the sun radiates, or sends out, an enormous amount of energy. The sun radiates more energy in one second than people have used since the beginning of time .This paper discusses about the usage of solar energy to propel the vehicle. It is a form of renewable energy resource may be used as a competitive fuel compared with fossil fuels. Vehicles were developed as a fast mean of transport and internal combustion engines soon found themselves in many applications ranging from cane harvesters to outback generator sets. In order to achieve the required power, the Photo Voltaic (PV) Module may be connected either in parallel or series. Thus to make it cost effective, power converters and batteries are been used. The provide comfort in lifestyle, vehicle consumes more gasoline fuel leaving exhaust gas contains high percentage carbon dioxide, carbon monoxide, nitrogen oxides and traces of compounds containing lead. The potency and increasing levels of these gases and compounds are causing gradual damage to the ozone layer and greenhouse effect. Active solar techniques use photovoltaic panels, pumps, and fans to convert sunlight into useful outputs. The charge controllers direct this power acquired from the solar panel to the batteries. According to the state of the battery, the charging is done, so as to avoid overcharging and deep discharge. The boosting device like solar panel, charge controller, battery, power converter and BLDC motor enhances the efficiency of the vehicle.

II. Literature Review

In 1970, the first hybrid type of photovoltaic devices and electric vehicles were manufactured. To generate more publicity and research interest in solar powered transportation, Hans Tholstrup organized a 1,865 mi (3,000 km) race across the Australian outback in 1987. The World Solar Challenge (WSC), competitors were invited from industry research groups and top universities around the globe. General Motors (GM) won the event by a large margin, achieving speeds over 40 mph with their Sunraycer vehicle. In response to their victory, GM teamed with the US Department of Energy (DOE) to hold the GM Sunrayce in 1990. The North American Solar Challenge in 2005 is held every two years across different routes. In 2005, the race set a new record for the longest solar vehicle race, covering 3960 km from Austin, Texas, USA to Calgary, Alberta, Canada.
Despite initially being dominated and funded by General Motors, the design and construction of solar vehicles has produced its own unique development process.

III. Description Of Components

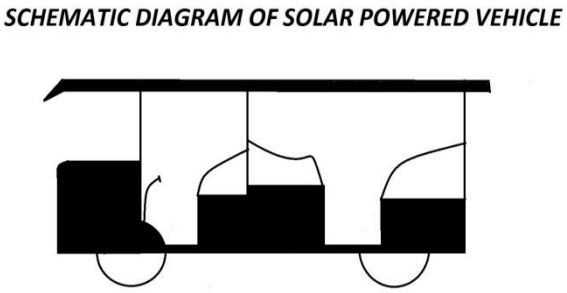
The following components are used in the vehicle to provide better drivability and efficient energy accumulation to propel the vehicle.

Chasis

It is the foundation for carrying the engine and body of the vehicle as well as steering, transmission, braking systems, etc. by means of spring, axle, and rubber pads.


Solar Panels

Solar panels are actually board containing p-type and n-type silicons which collects the sun energy from sun rays. Photovoltaic (PV) cells are made of semiconducting materials that can convert incident radiation in the solar spectrum to electric currents. PV cells are most commonly made of silicon, and come in two varieties, crystalline and thin-film type.



Power converter

This is used for converting the solar energy into electric energy. It is placed between battery and solar panel. It receives energy from solar panel and stores in battery. The storage energy runs the vehicle to attain required speed.

Batteries

Here generally lead acid batteries are used. These batteries are generally low in cost. It helps the vehicle to run not only in day but also in night because it has the capability to store energy which is stored in day time.

Brushless DC Motor

Brushless DC electric motor (BLDC motors, BL motors) also known as electronically commutated motors (ECMs, EC motors) are synchronous motors that are powered by a DC electric source via an integrated inverter/switching power supply, which produces an AC electric signal to drive the motor. In this context, AC, alternating current, does not imply a sinusoidal waveform, but rather a bi-directional current with no restriction on waveform. Additional sensors and electronics control the inverter output amplitude and waveform (and therefore percent of DC bus usage/efficiency) and frequency (i.e. rotor speed).

Table 1 Technical specification of solar vehicle

Sl no	Components	Specification
1	Dimensions	7ft X 3.8 ft X 6.7 ft
2	weight	300 kg
3	Passenger capacity	04
4	Battery	4 Nos. / 48 volts
5	Motor Capacity	1000 Watt / 48 volt
6	Approx. Mileage	40 KMS per full charge
7	Max. Speed	40 Km/hr
8	Braking	Hand & Foot Brake (Drum Type)
9	Suspension	Spring Type
10	Controller	Air Cooled Closed loop

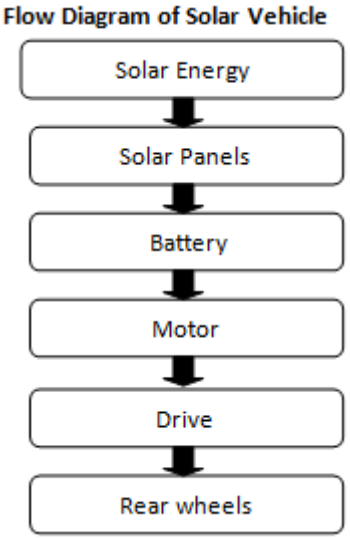


Fig 1 Block Diagram of energy flow of solar vehicle

The design of solar panels is fixed on the top to capture more solar energy and accumulate in the battery. The electrical energy thus obtained is being fed to the batteries that get charged and is used to run 24 V DC high torques DC series motor.

IV. Results And Discussion

The design of the solar vehicle is based on the previous review of hybrid vehicles and focused on to improve the efficiency and make it cost effective. The integrated system consisting of the solar module, charge controller modules, and BLDC motor, henceforth developed into the solar powered vehicle. The vehicle so designed to have a good mileage of 30-40km/hr on free road and the charging can be done on both stationary and running conditions. The vehicle can take the maximum load capacity of 2.5 quintal on full load conditions.

Performance Evaluation

A. Drag Force

Force exerted on the vehicle is due to its shape. The formula for calculating drag force is given by

$$F_d = 1/2 \, X \, C_d \, A \, \rho \, V^2$$

Where, F_d = Drag force; C_d= Drag coefficient; A= Projected frontal area; V = Velocity of the car; ρ = Density of air = 1.2 Kg/m³

For this car, $C_d = 0.338$,

$A = 1.77 m^2$,
$V = 11.11$ m/s
$F_d = (0.5 \times 0.338 \times 1.77 \times 1.2 \times 123.43)$ N
$= 44.30$ N

B.Frictional Force

Frictional force of the car,

$F_r = W \times F_r \times 9.81 = 300 \text{ X } 0.338 \text{ X} 9.8 = 993.72 \text{ N}$

Where, W= Total weight of the car; F_r = Rolling friction of wheel

C. Power produced

The required power to oppose all resistive force acting on car is,

$$P = F_{R.} V$$

Where, P = is the required power to overcome all resistance forces
V = is the velocity of the solar car
$F_{R.}$ = is the total resistance forc e
$= [F_d + F_r]$
= 44.30+993.72 = 1.038k N

Power generated to run the car coming from solar panel is given by

Power produced = Voltage x Current = (V X I)
= 4X17.1X5.7 =389.88 W

V. Conclusion

Solar vehicles have the easiest energy output around, yet our technology is still far. A solar car is really an electric vehicle powered by solar energy .The solar vehicle can solve the problems of environment for IC engine cars and is the best pollution free method. We need to make use of them so that we can reduce our dependence on fossil fuels. Solar vehicles have some disadvantages like less speed, initial cost is high, but these disadvantages can overcome in further research. The major problem of IC engine vehicles i.e. pollution can be solved through this method. We can also introduce solar air-conditioning which becomes totally CFC free and don't affect the ozone layer; it will run by the solar energy also. Finally this can overcome many problems just like economic cost, bad effects to environment, fuel crisis and many more.

Reference

[1]. D. Metz, mechanical engineering1983,105(1),80 2. "SOLAR VEHICLES AND BENEFITS OF THE TECHNOLOGY", by John Connors, ICCEP paper 2007.
[2]. J. Connors, "On the subject of solar vehicles and the benefits of the technology," in Proc. ICCEP'07, 2007.
[3]. Intelligent solar powered automobile-ventilation system," Applied Energy, vol. 80, pp.141–154, 2005.
[4]. K. D. Huang, S.-C. Tzeng, W.-P. Ma, and M.-F. Wu, "5. Rizzo, G. (2010), Automotive Applications of Solar Energy, IFAC Symposium Advances in Automotive Control, July 12 - 14 2.
[5]. Renewable Energy, Solar Energy http://en.wikipedia.org/wiki/Renewable_energy Solar energy,
[6]. Mohammad Asadul Hague and Jabalpur Rahman, "Power Crisis and Solution in Bangladesh" *Bangladesh J. Sci. Ind. Res. 45(2), 155-162,2010Power and Energy Sector Road Map : An Update, June 2011*
[7]. How Windshield Wipers Work, http://auto.howstuffworks.com/wiper.htm, (Last visited 22 January,2014

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