Solar Powered Tadpole Car

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Abstract- *In the field of automated era of machines there are many drawbacks of an energy that we are using today, which has some limitations and cost effective so we are in at a stage that we have to think something optimistic solution for this problems. This project deals with a new and optimistic solution for energy conversion that is solar car.*

In the era of automation, there is rapid growth in the transportation through vehicles. Because of pollution and problems of conventional sources of fuels many problems are invited like global warming, ozone layer depletion etc. In order to protect our earth from such kind of problems, implementation of solar powered car play vital role for energy crisis.

Keywords- solar car, solar panels, battery, controller, MPPT charges controller, BLDC motor, power transmission.

I. INTRODUCTION

A solar car is a car which utilized with solar power as a renewable source of energy. As we already aware about conventional public transport vehicles which are powered by conventional fuels (i.e. petrol and diesel) this fuels are very cheap and eco hazardous, which effects on environment like global warming and ozone depletion due to CFC.

There are various forms of energies available in nature that are renewable and non-renewable sources of energy. All the conventional sources like petrol, diesel, thermal, nuclear etc. are non-renewable sources and very costly and eco hazard sources.

Here we should go for a source of energy that is not depleted by use such as renewable energy sources.

We can use solar energy to run a car for public transport. A car which runs through 3 wheels known as tadpole design of car which is very economical and simple in design of car, because of differential is minimized and many complications are minimized.

Hence our research going towards making a vehicle which will solve problems increased by conventional powered cars.

In tadpole design of car we have given driving power to the rear wheel. BLDC motor is mounted on rear swing arm and power is transmitted through chain drive to the rear wheel. According to research BLDC motor is exposed to high heat dissipation than hub motor because of fins provided on the casing of BLDC motor. We have used positive drive that is chain drive to transmit power efficiently. Hence, we can say that our car is rear wheel drive car.

The closest thing you can find to a "green" car today is a *hybrid* vehicle. Although also fairly new, hybrid vehicles are becoming the new wave of the future in the auto industry. One company was reportedly considering placing solar panels on the roofs of hybrid vehicles. Perhaps this will start a new wave of solar-powered hybrid vehicles and one day lead to solar cars readily available to consumers.

II.DESIGN& CALCULATIONS

2.1. Acceleration

Top speed 40 kmph consider because the drag force becomes increasingly noticeable at speed above 40kmph due to being proportional to the square of the speed.

Thus the maximum power needed to supply to achieve different values of acceleration while car is at its maximum assumed speed of 40 kmph can be obtained by plotting a graph.

But we are assume practical condition in the busy streets of Aurangabad city. Especially at rush office hours, it is hardly possible to accelerate freely without dragTraffic. Thus assuming time of 1.5 minute to accelerate freely from 0 to 40kmph.

$$V = \frac{40 \times 103}{3600} = 12 \text{ m/s},$$

t= 12/ (1.5×60)

a= V/t

Where,

V = Velocity

t = time

= 12/ 90

$$\mathbf{a = 0.134\ m/s^2}$$

2.2. Drive Selection:

Objective: To design a solar car having weight 300 kg (assumed)

Data:

W = 300 kg
Speed = 40 kmph
= $40 \times 10^3 / 3600$
= 12 m/s
Drag Co-efficient = 0.35
Frontal area = 0.635 x 0.812
= 0.516 m^2
Mass density of air = 1.225 kg/m^3
Acceleration = 0.134 m/s^2
Coefficient of rolling for tire= 0. 01

Solution:

I) Rolling Resistant = μ_R x W
= 0.01 x 300 x 9.81
F_R = 29.43 N

ii) Aerodynamic Drag = $(\mu_D x A_c x \rho x V^2)/2$
= $(0.35 \times 0.516 \times 1.225 \times 12^2)/2$
F_D = 15.928 N

iii) Force of acceleration = m x a
= 300 x 0.134
F_A = 40.2 N

∴ Total force = $F_A+F_D+F_R$
= 29.43+15.928+40.2
F = 85.63 N
∴ Total Power = F x V
= 85.63 x 12

2.3 Motor Selection:

Hence, to overcome all forces we need 1027.56 watt power drive but we are choosing

Roughly 2000 Watt electric drive.

Motor Specifications:

Rated torque = 7.6 N-m
Speed=2800 rpm

Torque requires moving vehicle:

a. T=F x rsin ϴ
Where,
F= Total Force
r= radius of the wheel
ϴ= 90^0 for normal plane road condition
∴T = 85.63 x 0.2 x sin (90)
∴T= 7.126 NM

Motor rated torque = 7.6 Nm

Hence, we can easily get that amount of torque, but for our benefit we can select appropriate gear ratio. We can reduce the torque of the motor required to move vehicle.

But if we are going to climb a slop
ϴ= 90+30 =120^0
Then torque will be
T= F x r sin (120)
=86 x 0.2 x sin (120)

T=15 Nm

So, we should select appropriate gear ratio to achieve that much amount of torque.

By taking Factor of safety into account we are choosing 4:1 speed reduction ratio. Then wheel rpm will be = 700 rpm and torque require from motor will be

For case (a)
Tr_1 =T/4=7.6/4=1.9 Nm
For case (b)
Tr_2 =T/4=15/4=3.5 N. m
Speed for speed reduction ratio 4:1 in kmph
Motor speed=2800 rpm
Wheel's speed =2800/4=700rpm
We know,
Linear velocity = πDN/60
Where,
D= Diameter of wheel in m
N=speed of rear wheels rpm
Linear velocity =14.66 m/s
Speed = Linear velocity x 3600/1000
= 14.66 x 3600/1000
Speed = 50.4 kmph

Hence, from above we can say that we can achieve 50 kmph of max.speed of vehicle if we are choosing gear ratio 4:1

Motor specs:

- Power: 2000 watt
- Speed: 3000 RPM
- Voltage: 48 V
- Commutation: Brushless
- Phase: Three Phase
- Type: Permanent Magnet BLDC
- Voltage (V): 48v
- No Load Current (A): 5
- Rated Current (A): 45
- Rated Speed (RPM) : 3000±100
- Rated Torque (Nm) : 7.6
- Max. Output Torque (Nm) :22
- Rated Power (W): 2000
- Max. Power Output (W): 3000
- Efficiency(η): >83%
- Number of poles: 8
- Motor Diameter (mm): 145
- Insulation class: B

Fig. 2 kw BLDC motor

2.4 Controller:

- Rated voltage: 48 V
- Peak protection current: 60A
- Rated power: 3000 W
- Under Voltage Protection: 42 V
- Throttle voltage: 1V to 4.5V
- Phase commutation angle: 120 degrees

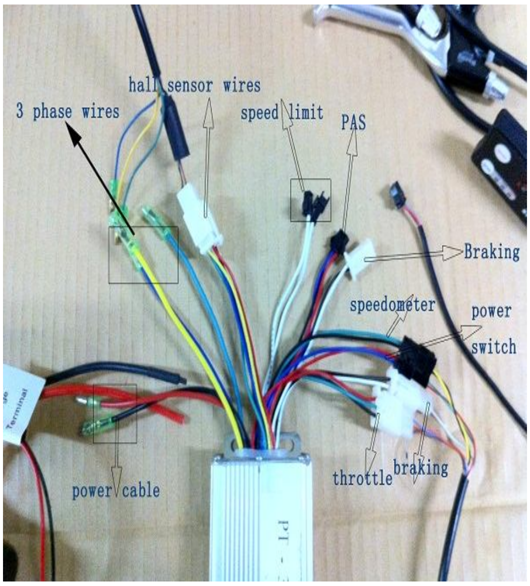

Fig. Controller

2.5 Battery Selection:

We have a power drive having power capacity 2000w, if we want to run motor from 0 to 3000 rpm then according to motor test parameter we need 13.2 amp current at a 49.5 voltage, to drive car weighing 300 kg at normal road condition.

Hence from above we can say that we will need 48 volt battery of capacity 100 ah

$$Battery\ backup = \frac{100}{13.2} = 7 \text{ hrs.}$$

According to our research, Battery selected should be large in capacity in order to provide better battery backup at any road condition.

SPECIFICATION	DATA
48 volts 100 amp hours	Lithium Iron Phosphate Battery
Charging Current	1 - 400 amps
Charging Voltage	58.4V
Max continuous Discharge Current	400 amps
Cold Cranking Amps	1000A
Height	10"
Width	17.5"
Length	24.4"
Weight	120 lbs.

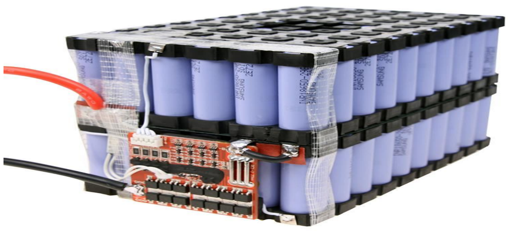

Fig. Lithium Ion Deep Cycle Battery.

2.6 Charge Management System:

To charge battery having capacity 100 ah from solar panels within a less time we should select highly efficient and large capacity panels

To select proper capacity panels for a charging of a battery having capacity 100ah 48 volt

$$p = V.I$$

Where,

P = power in watt.
V= voltage in Ω.
I = current in ampere.

$$P = 48 \times 100$$
$$P = 4800Wh$$

From above we can say that we will need 4800Wh power to charge battery within an hour. But taking available space for mounting panels into consideration and available day time to charge our battery we are roughly choosing 2 modules of 300 watt capacity each (300×2=600).

<u>Electrical</u>	
Power Max (Pm)	250
Short Circuit Current (Isc)	8.95 A
Max Power Current (Imp)	8.35 A
Maximum Voltage (Vmp)	29.95
Open Circuit Voltage (Voc)	37.25
System Voltage	1000 VDC

<u>Mechanical:</u>

Type	Multi Crystalline
No of Cells in Series	60
Frame Type	Aluminum
Y-Axis Mounting Hole	946
X-Axis Mounting Hole	6.9
Junction Box Cable	4mm
Glass Type	Tempered 4mm

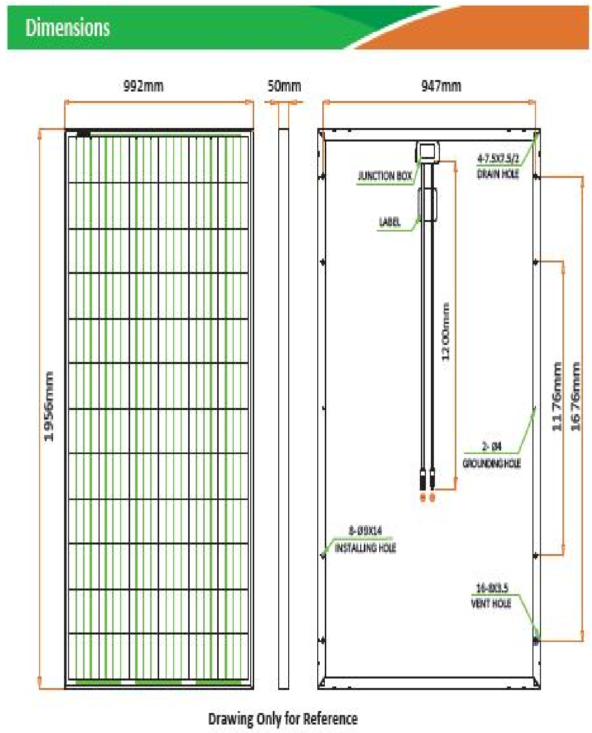

Fig. Mono crystalline Solar Panel

This panel can produce 13amp current at 48 volt. Time require to charge our battery will be 7 to 8 hrs.

2.7 Charge Controller:

There are many types of charge controllers available in market it may be a MPPT or PWM.

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. 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.

PWM controllers are built on a time tested technology. They have been used for years in Solar systems, and are well established. PWM controllers have limited capacity for system growth.

Hence, we will required 48 volt charge controller to charge our battery efficiently

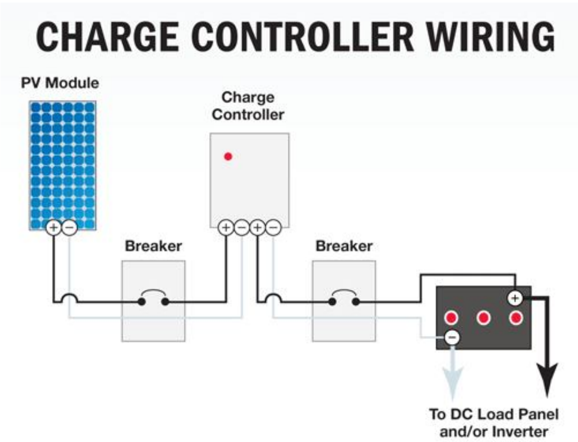

Fig. MPPT Charge controller

2.8 Power Transmission:

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycle and motorcycle. It is also used in a wide variety of machines besides vehicles.

III. CONCLUSION

Hence, solar car has been achieved better performance as a public transport car. Solar car satisfies all the road running conditions in practical.

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