MODIFICATIONS OF SOLAR TRAIN

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***ABSTRACT*:** *Now a days we are experiencing a lead shortage in a electrical energy. The non renewable sources that are we going to used get exhausted and the renewable energy is vital for future. We are also experiencing shortage of batteries in marked and hike in fuel price. The train is the main source of public transportation. Train requires maximum electric energy but sometimes all requirements of train are not get fulfilled by accessible electrical energy. Hence we are propose use of solar energy in the train to modify the application of normal train. The solar train technology is still in developing stage. The principle of the solar train is used to store energy in the battery during and after charging it from solar panel. This idea will help to protect fuel extenuation.*

I. INTRODUCTION

Fossil fuel are having limited availability and that lead to shortage and hike in fuel price. There is need for reduction in carbon emission public transport must be more eco-friendly solar plane on roof of train will produce much of the required power. The amount of solar train energy that reach on the surface of the planet each year is about twice the amount of energy that will be obtained forever from coal, natural gas, oil and mined uranium. The ultimate energy source of much of the word's is the sun, which provides the earth with light, heat and radiation. Since generating electricity directly from sunlight does not deplete any of the earth's natural resources and supply the earth's with energy continuously, solar energy is renewable source of electricity generation. Solar energy is earth's primary source of renewable energy. To manufacture inexpensive solar cell with the same efficiency as current technology. Although this new technology only capable of supplying low power devices with sufficient energy, its effect on society would still be tremendous. The solar energy flux reaching the earth surface represents multiple of few thousand times the current use of primary energy by humans. The potential of resources is enormous and make solar energy crucial component of a renewable energy and it reduces greenhouse effect. Travelling the train is better for planet than petroleum powered car. The exciting areas of potential for rail is solar energy. which absorb the sunrays as a source of energy for generating electricity or heating purpose. In 2015, 1.05% of the world's energy was produced by solar panels. The U.S. State which is the home of Solar Trains who start-up proposing the construction of solar canopies over miles of train track. They state that one 300 watt solar panel can provides up to 7,000 miles of a person's train commuting per year. London Black friars installed 4,400 photovoltaic panels on the roof of the bridge to provide up to half of the energy required to power the central London station in 2015. In Belgium the first train high-speed rail line was being generated by 16,000 solar panels in 2011. In India the Delhi Metro Rail Corporation in New Delhi has been fitted solar panels on top of the rooftops of its stations and offices by 2017. They are

expected to generate 20MW of solar energy by the end of 2017. The Northern Railways had fitted one coach of the Rewari - Sitapur broad gauge passenger train with solar panels in 2015. However, this is the first (DEMU) Diesel Electric Multiple Unit train, in which all coaches have solar panels. Valley Metro revealed their plans to install solar panels on their networks to power their transit facilities in Tempe, Arizona (pictured left). The 537kW solar project aims to power 33% of its power needs. 1,704 panels will be fitted on top of bus ports to increase the cities renewable energy use from 6.5%-8% and save the company more than $411,000 in utility cost over 20 years.

II. LITERATURE

The main aim of this paper is to developed solar power at high speed passenger rail system. These paper is the research, present case to carry out research towards the development and commercialization a light weight solar railway system. (1)

This paper gives an information about reduction of diesel consumption of the end of generating system. The paper estimated that one solar train coach can generate at least 18 KWh of electricity in a day, leading to an annual diesel saving of 1700 liters under ideal condition. The Indian railway operates 63.511 coaches and hence under ideal condition, it Can save around 108.5 million liter of diesel annually. (2)

The battery driven light rail vehicle developed by railway technical research Institute consumes the electricity of 2.5kWh per kilometer. The charging device are also mounted on the railway system. When the railway stops at the station, Electricity is rapidly transmitted from the charging device of the station to the charging device of the railway. Electrical double layer capacitor are used as charging device. If required electric power can be supplied, It is feasible in the calculation to run the light rail only by renewable energy. (3)

III. REVIEWE OF INDIA'S FIRST SOLAR TRAIN

Indian Railways on July 14th launched first solar-powered train from the Safdarjung railway station in Delhi. The train will run from Sarai Rohilla in Delhi to Farukh Nagar in Haryana. A total of 16 solar panels, each producing 300 Wp, are fitted in six coaches. The cost of these solar panels, manufactured under 'Make in India' initiative, is Rs 54 lakh. This is the first time in the world that solar panels are being used as grid in railways. The train has a power back-up and can run on battery. Amount of power generated**:** The solar panels generate about 17 units of power in a day which enables the lighting system in the coach. Currently Railways will be installing solar panels on non-AC coaches only Huge Saving: By saving an estimated 1.2 lakh kilo liter of diesel every year, the railways will be able to pocket Rs 672 corer per year. The solar power will also help in reducing 2.7 lakh tones of carbon dioxide emission per year. Railways has plan to generate 1000 MW solar power in the next five year.

IV. GENERAL SURVEY REPORT

The purpose of survey is to collect information about how much amount of power consumed in one bogie, With the help of this data we can calculate total electrical power require to the railway. After getting this information we can simulate this information with our project which we are doing with the help

of the solar panel. After considering the information about first solar train , We have got that they had use total 16 SOLAR panel on railway roof. The train has a power back-up and can run on battery for at least 72 hours. A total of 16 solar panels, each producing 300 Wp, are fitted in six coaches. The cost of these solar panels, manufactured under 'Make in India' initiative, is Rs 54 lakh. The solar panels generate about 17 units of power in a day which enables the lighting system in the coach. Currently Railways will be installing solar panels

Watt. non-AC coaches only. By saving an estimated 1.2 lakh kilo liter of diesel every year, the railways will be able to pocket Rs 672 corer per year. The solar power will also help in reducing 2.7 lakh tones of carbon dioxide emission per year. Railways has plan to generate 1000 MW solar power in the next five years. We are considering the station of Kolhapur, in which we are found that how much power get consumed in one bogie. There is total 27 fans in each bogie and each fan is rated at 36 watt. And there is total 28 tube lights in each bogie, and each tube is rated at 18 watt. The Alternator used for the starting of railway is of 4.5 watt. And the regulator rectified unit(RRU) is also of 4.5 There is total 16 batteries, And each cell is of 6 volt. The total load required for one bogie is 37.5 amp.

Calculation: The no. of electrical equipment and their power generated in one bogie is explained below:

1. TABLE
CALCULATION DETAIL

Equipment	Total no.	Wattage	Voltage	Total power(watt)
Fan	27	36	110	27*36=972
Light	28	18	110	28*18=504

Total wattage= Fan wattage +Tube wattage
=972+504
=1472 watt
Total current required=V*I
1472 =110*I
I=13.41amp.

V. WORKING OF SOLAR PANEL

Basic element –Silicon:

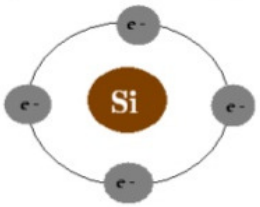


Fig. 1.Silicon in natural state

The basic element of solar panel is pure silicon. Silicon atoms have room for eight electron in there outer brand but carries four in their natural state. These means they have room for four more elements

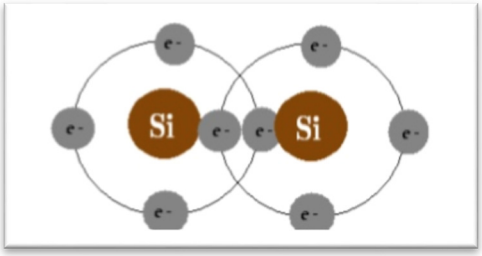


Fig. 2.Silicon Silicon combination

If one silicon atom contact with another silicon atom each receives four electrons from other atoms four electron. These creates a strong band. There is no positive or negative charge because the eight electrons satisfies the atoms needs. Silicon atoms combined for years to result in a large piece of silicon. This material is used for the plates of solar panel.

- Negative charge**:**

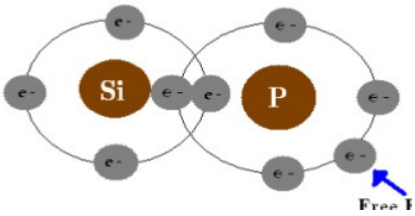


Fig. 3.Silicon-Phosphorus combination

Two plates of silicon atoms will not generate electricity, because they do not have positive and negative charges. Solar panel are created by combining silicon with the other element like phosphorus. Phosphorus has five atoms to offer to the other . If silicon and phosphorus are combined chemically, the result is stable eight electrons with an additional free electron along whit ride. It cant leave because it is bounded to the other phosphorus atom ,but it is not needed by the silicon. Therefore, this new silicon phosphorus plate is considered to be negatively charged.

- Positive charge:

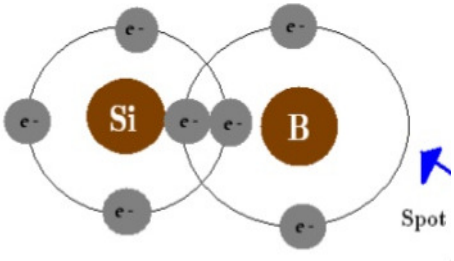
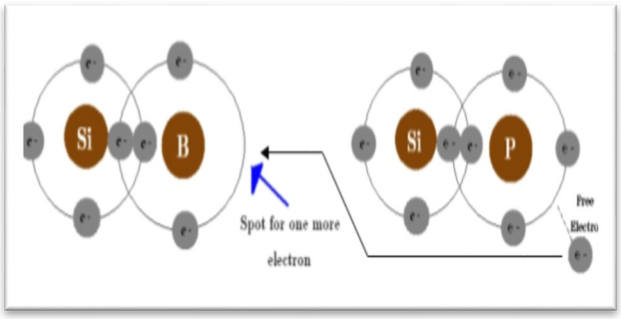


Fig. 4.Silicon boron combination.

In order of electricity to flow, Positive charge also be considered. This is achieved by Boron element, Which has three elements to offer. A silicon-Boron plate still has one spot left for another electron. This means the plate has positive charge. The two plates are sandwiched together in solar panels, With conductive wires running between them..

9th Electron:



The 9th electron which wants to be free anywhere ,is knocked out the outer ring. This electron doesn't remain free for long, Since the positive silicon plate draws it into the open spot on its own outer band.

Type of solar panel: 1.Mono crystalline solar panel. 2.Polycrystalline solar panel.

1] Mono crystalline solar panel:

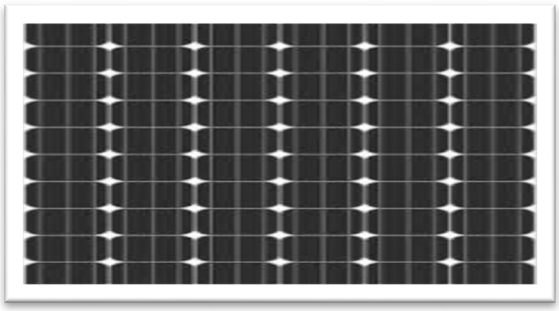


Fig. 5.Mono Crystalline solar panel

The typical mono crystalline solar cell is a dark black colour. And the corners of cells are usually missing as a result of the production process and the physical nature of mono crystalline silicon. It uses single crystal of silicon.

2] Polycrystalline solar panel:

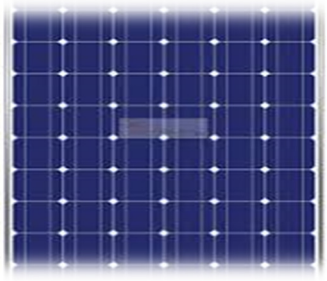


Fig. 6.Poly crystalline solar panel

The crystal is having high purity. Instead of using single crystal of silicon manufacturers melt many fragment of silicon together to form the wafers of the panel. They have many crystal in each cell, there is a less freedom for the electron to move. But it has lower efficiency rating than mono crystalline panel.

2. TABLE
COMPARISON OF MONO AND POLY CRSTALLINE

Parameters	Mono crystalline	Poly crystalline
Cost	More expensive	Less expensive
Efficiency	More efficient	Less efficient
Color	Black	Blue
Longetivity	25+year	Less than 25 year

V-I characteristics of solar panel:

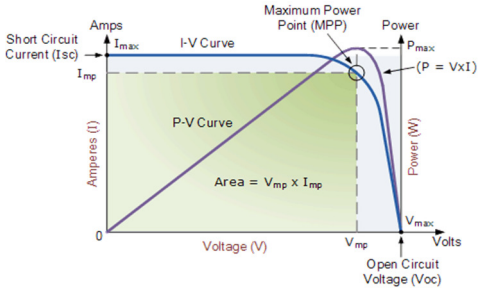


Fig. 7.V-I characteristics of solar panel

Open circuit voltage (Voc): When the solar cell is open circuited, the current will be at its minimum (zero) And the voltage is maximum. Short circuit current (Ioc): When solar cell is short circuited, The voltage is at minimum level. But the current is maximum.

- Solar charge controller:

Fig. 8.solar charge controller.

A charge controller may be used to power, DC equipment with solar panels. The charge controller provides a regulated DC output and stores excess energy in a battery. Also it monitors the battery voltage to prevent under or over charging. More expensive units will also perform maximum power point tracking. An inverter can be connected to the output of a charge controller to drive Ac loads.

Types of solar charge controller: 1. PWM charge controller
2. MPPT charge controller.

1] Pulse width modulator:

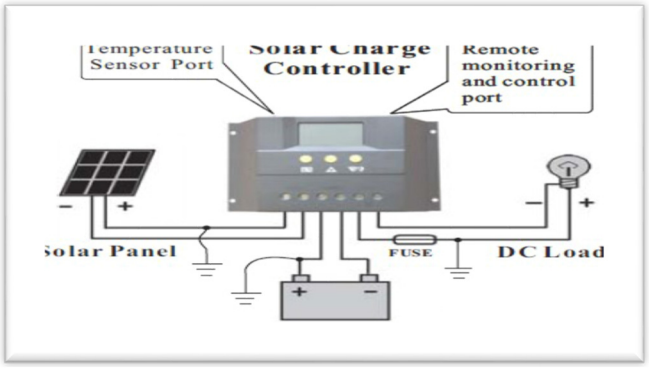


Fig. 9.Solar PWM modulator .

Pulse-Width Modulation (PWM) comes into play when the battery bank is full. During charging, the controller allows as much current as the PV panel/array can generate in order to reach the target voltage for the charge stage the controller is in. Once the battery approaches this target voltage, the charge controller quickly switches between connecting the battery bank to the panel array and disconnecting the battery bank Which regulates the battery voltage holding it constant. This quick switching is called PWM and it ensures your battery bank is efficiently charged while protecting it from being overcharged by the PV panel/array.

MPPT solar charge controller

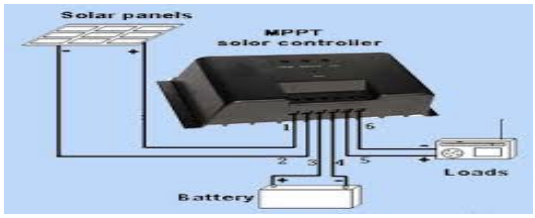


Fig. 10.MPPT solar charge controller.

VI. Battery

As the world increasingly comes to rely on electrical and electronics systems for its functions, it is also becoming increasingly dependent on batteries.

As electrical and electronics systems become more efficient, batteries provide the key for operation and, even with stationary systems, batteries are becoming increasingly important to provide power supply backup or keep essential functions operational when the main power is not available.

Lead acid batteries/cell are utilized extensively on Indian Railways on passengers coaches for train lighting and air conditioning. These batteries/cells operate under sever environmental conditions like high temperature, vibrations and dusty atmosphere. These batteries/cells requires frequent topping on the line (which is not a desirable feature). There is a need to develop batteries for these applications, which are lighter, occupy less space, require less frequent topping up and have higher charge retention capacity Indian Railways has adopted 24 V as well as 110 V train lighting system on self generating passengers coaches. In 24 V system 12 lead acid 2 V cells, in 110 V system 18 monoblock each monoblock have 3 cells are used in series and 56 cells are used in series for 110 V air conditioning system. The capacity of

the batteries range 120 AH, 210 AH to 1285 AH depending upon the applications used in Indian Railways.

Importance of battery:

The battery as a part of train lighting system is much important than the alternator and deserves greater care and attention for its installation and maintenance than any other equipment of the train lighting system. Cell is the heart of the train lighting system and its electrolyte is like blood in human body, every drop of which is to be maintain at very high standard of quality. Over charging and over discharging of cell is like over eating and over dieting both of which are very injuries to body.

In order to get the best out of the cell its proper care and maintenance is indisputable and requires a details knowledge of the cell and its behavior.

The batteries in passenger coaches are subjected to severe environment conditions. The ambient temperature varies from 1 degree C to 50 degree C and humidity varies from 30% to 100%. The batteries have also to withstand vibrations and bumps during service. The batteries are installed on the under frame of the coach, as such have to work successfully in extreme dusty and corrosive atmosphere.

Types of battery:

1 .Primary cells or non rechargeable battery

2. Secondary cell or rechargeable battery :

1. lead acid battery
2. lithium ion battery

3. TABLE

COMPARISON OF LEAD ACID AND LITHIUM ION BATTERY

Factors	Lead acid battery	Lithium ion battery
1.Energy density	60-110wh/L	250-693wh/L
2.Specific power	180w/kg	250-340w/kg
3.Charge & discharge efficiency	50-95%	80-90%
4.Cycle durably	200-300	400-1200
5.Self discharge rate	3-20%per month	2%per month
6.Internal Resistance	8.3miliohm	155miliohm (cadmium)
7.Charging temperature	20-50degreecelsius	0-5degreecelsius
8.Discharge temperature	20-50degreecelsius	-20 to 60degree celsius
9.Maintenance requirment	3-6 month	Less than lead acid battery

In most of the solar train uses the lead acid battery to stored solar energy.

Principle of battery:

A lead cell consists of lead plates separated by wooden or PVC fiber separators. The active material of +ve plate is lead peroxide (PbO2) and the -ve plates is spongy lead (Pb). Dilute H_2SO_4 decomposed given the ions of H_2 and SO_4. The H_2 ions more towards the positive PbO_2 plate and SO_4 towards the lead plate.

On positive plate

$$PbO_2 + H_2 + H_2SO_4 = PbSO_4 + 2H_2O$$

On negative plate

$Pb + SO_4 = PbS$

Both anode and cathode become lead sulphate (PbSO4) which is somewhat whitish in color.
Due to formation of water specific gravity of the acid decreases. The present and most efficient procedure for the maintenance of lead acid cells is to carry out through overhauls, repair, rigid tests and quality control of POH work in the shops. The work in the maintenance depot is confined only to regular and routine examination, essential topping up of cells and charging whenever needed. Train lightening batteries of coaches by the very nature of service conditions cannot be expected to have steady rate of charge/discharge. Such strenuous service of these cells therefore calls for systematic and thorough examination while in service, prompt remedial of defects/replacement of cell and quality POH work in shops to achieve the expected life without any loss of efficiency below 80%.

Types of lead acid battery:

1. Flooded battery
2. Sealed battery
3. VRLA (Valve regulated lead acid)
4. AGM (absorbent glass mat) GEL (silica type gel).

4. TABLE
TYPES OF BATTERY

Types of battery	Typical float voltage range	Typical absorption voltage range
Flooded	13.2v to 13.5	14.2 v to 13.5v
Sealed	13.2 v to 13.5v	14.2v to 14.5v
VRLA	13.2 v to 13.5v	14.2v to 14.5v
AGM	13.2 v to 13.8v	14.4v to 15v
GEL	13.2v to 13.4v	14v to 14.2v

4.Power supply system for normal train

In Indian railways, there are three power supply systems are provided to illumination, fan, air conditioning and other needs of electricity.

1.Self generating:

For AC coach 2*25 kw alternators and for Non-AC coach 1*4.5kw alternator is mounted. It is driven by a pullet belt arrangement, When driving pulley is mounted on coach AC that is output is rectified and charges 110v DC battery.

2.End of generation:

It supplies Three Phase power at 750v AC power to each electrically interconnected air conditioned coach. The voltage is stepped down to Three Phase 440v and then supplied to standard voltage equipment. This system is used for fully air conditioning train.

3.Head-on-generation:

For this type of system, Single Phase 25kv transformer is used. It is provided with hotel load winding which is converted to Three Phase AC at 750v using 2*500KVA inverter and supplied to the same system as end of generation.

- CONTROLLING SYSTEM

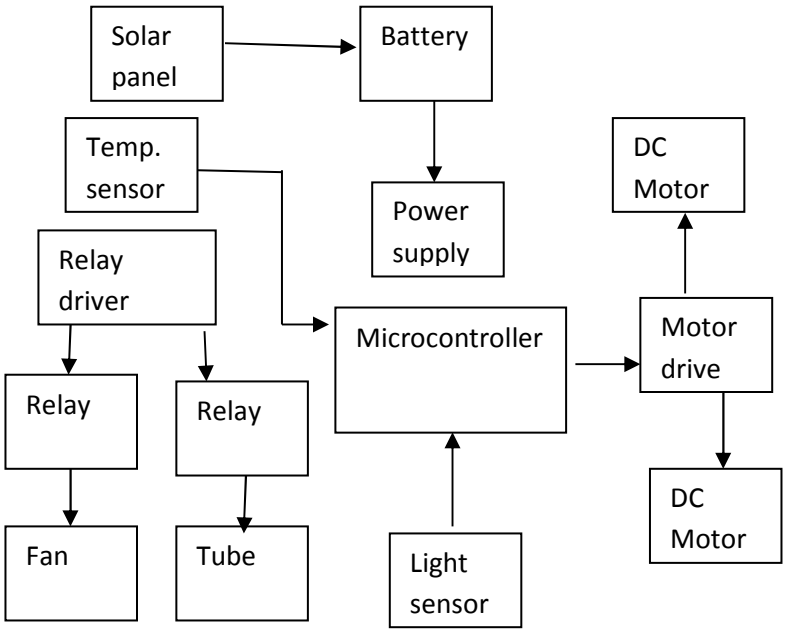


Fig. 11.Block diagram

Basic principle:

The basic principle of solar train is to store energy in the battery during and after charging it from solar panel. Then, this charged battery are used to drive motor and lighting purpose of train. The power produced by solar panel depends upon whether and sun's positions. Here the photovoltaic effect is used to convert solar energy into electrical energy.

Modifications of India's first solar train:

- Use of light sensor to operate the lighting system automatically: Operating automatic light system using LDR. The LDR is operated when light is not available that is dark. It is in off state when light is available. The LDR is inversely proportional to light. In working of automatic light system, when light is falls on the LDR, then it send command to microcontroller to operate the relay drive. The relay are used for ON/OFF of tube.
- Use of Temperature sensor, which will sense temperature of bogie, and automatically get on or off fans: The LM35 sensor used in automatic fan system. The LM35 sensor is temperature sensor.The LM35 sensor senses the temperature and convert into an electrical signal, This signal given to ATmega328 microcontroller. The analog to digital convert is ADC are used to convert the analog signal to digital signal. The signal from LM35 sensor are given to ATmega328 microcontroller through ADC. According to the signal microcontroller give command to relay drive. The relay drive operate relay to switch OFF/ON the fan.
- Digital display of station by using solar: The display device is commonly associated with output device that offers an information in the visual form. LCD display combine a light source, with polarized light and liquid crystal. While doing modifications in normal local train Digital display of station in each bogie using solar is an important factor.

VII. ADVANTAGES

Solar energy is freely available and it is renewable. Solar modules have unlimited life, fast response and high reliability. Fuel sources for solar panel is infinite and direct. Hence external fuels is not required. For this type of application minimum maintenance is required. Solar energy causes minimum pollution. It generates low transmission losses as it installed in the vicinity of the load. The oil reserves will last for 30 to 40 year on the hand, solar energy is infinite

VIII. CONCLUSION

The solar train technology is in the developmental stages. But use of solar energy in the local train is helpful to improve the features of normal train. With the help of solar energy, lighting and fan system can be successfully automated. The LCD display is also possible with the help of solar energy which is stored in the battery.

IX. ACKNOWLEGMENT

It is great opportunity for us to write about our project " solar powered train". At time of preparing this paper we gone through different paper ,books and websites which help us to get information about project. We focusing on the topic which improve our project demand. We are acknowledge with gratitude to professor Devendra Gowada. Who has always sincere and helpful in making our problem easy regarding the paper of project.

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