A PROJECT REPORT
ON
"STREET LIGHT SOLAR PANEL CLEANER"

Submitted by

SHAIKH ABDUL KALAM (16ME65)
SHAIKH ABDULRAHIM (16ME67)
SHAIKH ALTAMASH (16ME69)
SHAIKH SHADAB LATIF (16ME84)

In fulfillment for the the award of the Degree
Of
BACHELOR OF ENGINEERING
IN
MECHANICAL ENGINEERING
UNDER THE GUIDANCE
Of
Prof.ALTAMASH GHAZI

DEPARTMENT OF MECHANICAL ENGINEERING

ANJUMAN-I-ISLAM
KALSEKAR TECHNICAL CAMPUS NEW PANVEL,
NAVI MUMBAI-410206

UNIVERSITY OF MUMBAI

ACADEMIC YEAR 2019-2020

Internal Examiner Project Coordinator

Anjuman-I-Islam
Kalsekar Technical Campus NEW PANVEL

(Approved by AICTE ,recg. By Maharashtra Govt.DTE,
Affiliated to MUMBAI UNIVERSITY)

Plot No. 2 & 3, Sector - 16, Near Thana Naka, Khandagaon, New Panvel, Navi Mumbai, Maharashtra 410206

CERTIFICATE

This is to certify that the project entitled

STREET LIGHT SOLAR PANEL CLEANER

Submitted by

SHAIKH ABDUL KALAM (16ME65)
SHAIKH ABDULRAHIM (16ME67)
SHAIKH ALTAMASH (16ME69)
SHAIKH SHADAB LATIF (16ME84)

Of the Kalsekar Technical Campus, New Panvel is a record of bonafide work carried out by him under supervision and guidance, for fulfilment of the requirements for the award of the degree of Bachelor of Engineering in Mechanical Engineering as prescribed by University Of Mumbai is approved.

Signature of the Guidance	Signature of the HOD	Signature of the Principal
Prof.Altamash Ghazi	Prof.Zakir Ansari	Dr.AbdulRazzak

Anjuman-I-Islam
Kalsekar Technical Campus NEW PANVEL
(Approved by AICTE ,recg. By Maharashtra Govt .DTE,
Affiliated to MUMBAI UNIVERSITY)

Plot No. 2 & 3, Sector - 16, Near Thana Naka, Khandagaon, New Panvel, Navi Mumbai, Maharashtra 410206

DISSERTATION APPROVAL SHEET

This is to certify that this B.E. project titled, **STREET LIGHT SOLAR PANEL CLEANER**
submitted by

Shaikh Abdul Kalam
Shaikh Abdulrahim
Shaikh Altamash
Shaikh Shadab Latif

Approved for the DEGREE OF BACHELOR IN ENGINEERING, in MECHANICAL ENGINEERING from University of Mumbai. Certified further that, to the best of my knowledge this report represents the work carried out by this student.

Internal Examiner **Seal of the Institute**

Date:

Dedication

Dedicated to our beloved family and friends & staff members

ACKNOWLEDGEMENTS

In the name of Allah, the Most Benevolent, the most Merciful. I wish to record immeasurable gratitude and thankfulness to the One and The Almighty Creator, the Lord and sustainer of the universe, and mankind in particular. It is only through His mercy and help that this work could be completed and it is ardently desired that this little effort be accepted by Him to be of some service to the cause of humanity.

I am grateful and would like to express my sincere gratitude to my supervisors Professor **ALTAMASH GHAZI** for their germinal ideas, invaluable guidance, continuous encouragement and constant support in making this research possible. I also sincerely thank them for the time spent proofreading and correcting my many mistakes. I really appreciate the consistent support from the first day I applied to this graduate program to these concluding moments. I am truly grateful for their progressive vision about my training in science, their tolerance of my naive mistakes, and his commitment to my future career.

I would like to express my special thanks to my comrades Mr.Abdul kalam Shaikh, Mr.Abdurrahim Shaikh, Mr.Altamash Shaikh, Mr.Shadab Shaikh, for supporting me in this thesis.

My sincere thanks go to all my lab mates and members of the staff of the Mechanical Engineering Department, AIKTC, who helped me in many ways and made my stay at AIKTC pleasant and unforgettable.

I acknowledge my sincere indebtedness and gratitude to my parents for their love, dream and sacrifice throughout my life, who consistently encouraged me to carry on my studies in Mumbai University.

Shaikh Abdul Kalam
Shaikh Abdulrahim
Shaikh Altamash
Shaikh Shadab Latif

TABLE OF CONTENTS

LIST OF FIGURES

ABSTRACT

Energy is one of the major issues that the world is facing in India, the supply of energy has been one of the major problems for both urban and rural households. About 60% to 70% of the energy demand of the country is met by fuelwood and agriculture residues. Solar energy is a renewable source of energy, which has a great potential and it is radiated by the sun. Renewable energy is important to replace the using of electric energy generated by petroleum. Solar power has become a source of renewable energy and solar energy application should be enhanced. The solar PV modules are generally employed in dusty environments which are
the case tropical countries like India. The dust gets accumulated on the front surface of the module and blocks the incident light from the sun. It reduces the power generation capacity of the module. The power output reduces as much as by 50% if the module is not cleaned for a month. The cleaning system has been designed cleans the module by controlling the Arduino programming.To remove the dust in the PV modules to improving the power efficiency.

CHAPTER 1

1.1 INTRODUCTION:

Solar dynamism is one of the main energy sources in imminent of the world. The knowledge of Photovoltaic PV is always on incessant developing in many presentations, so it generates electricity without dangerous effect on environment. The entire world now was faced short supplying electric power due to not enough sources to generate electric power. Usually source that uses to generate energy or electric power is not renewable source such as fossil. Besides that, using fossil will lead to environment destruction to our planet such as global warming. The environment issue was being regarded by most critical problem when using fossil to generate the electricity. Therefore, the goal is to emphasize to obtain the clean energy supplies of the electric energy. Renewable source is now an alternative solution to generate the electric energy for example, sunlight. A free sunlight will produce energy that environmental friendly.

In recent times strength and environmental trouble as coexist. Thedevelopment of latest strength sources is pressured by the disaster of power and surroundings. As a source of clean power, solar power has to be greater successfully and rationally used energy. In current years, solar PV information has made fantastic development. However,most a part of the research at domestic and abroad targeted specifically on theoretical studies, design and construction, along with layout of photovoltaic panels in the direction of the inclination, effect of dust shelter on the performance and temperature of the battery and so forth. Inside the domestic "Technical specs about Civil software of sun Photovoltaic systems", therearea many applicable provisions about production website, geography, weather, sun resources, safe haven, effect oftemperature on the energy era and so forth. But studies at their impact of dirt, air cleanliness, rainfalland other elements on PV tasks areaalso little or no.

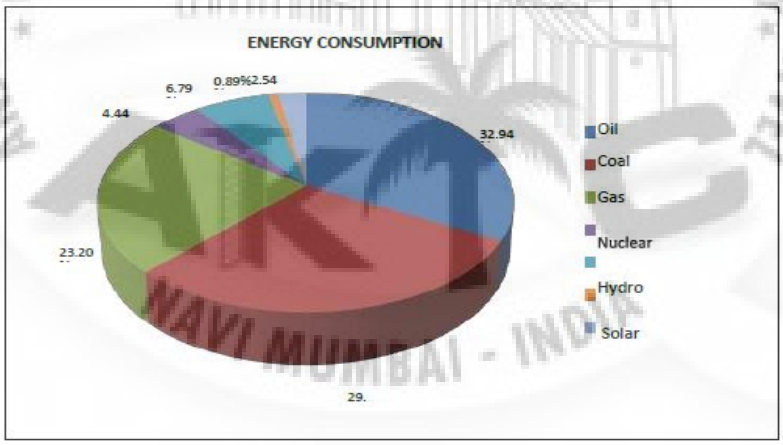


Figure 1. Pie Chart of Energy Consumption

Fig.1.1 pie chart

The name photo voltaic is resulting from photo, the Greek phrase for light and volt, relating to strength, photo voltaic chambers are made-up of a fabric known as semiconductors, the most usually used semiconductor fabric in solar panel is silicon. While the mild falls on the solar panel, it moves directly to the sun cellular which absorbs the sun radiation. These solar cells converts radiation into direct electric powered present day, every photo voltaic chamber in the solar panel can produce 0.5 volts of most present day. The maximum power may be finished by using putting these cells In-series and in-parallel can growth the total modern. Whilst manufacturing a sun panel it's far essential to vicinity an antireflective coating

including glass plate is susceptible to dirt from the surrounding surroundings. While this plate will become dirty, as a result strength performance of PV panels will reduces. The performance of these solar panel is reduces due to results likes shadow, snow fall, outside high temperature, bird droppings, dust and dirt. The solar panel cleansing technology can enhance the performance via putting off dirt and other impurities from the surface of the sun panel. There are several viable techniques like wind clearing, rainfall, washing with various liquids, wiping, rotating, vibrating the surface, dry cleansing, wet cleansing, Electrostatic cleaning, robot cleansing, heliotex generation, ability cleansing robotic. Here the dry cleansing and wet cleansing technologies are used to eliminate the dust and different impurities by using self-cleansing technology to get advanced efficiency.

Most of the applications in recent times like heating water, agriculture and industrial programs use the solar panels as an electrical energy source in preference to relying on the generators or the everyday sources for electricity. The maximum important a part of those systems is the sun panel in which the solar energy is transformed to warmness for water heating or converted electricity for the others. There are many forms of the sun panels. In the nations those have dusty surroundings accumulation of dust at the solar panels lead reduction of the transmittance of the panel. Sun desalination flowers in a number of the middle-east countrikes like the solar desalination plant of Abu Dhabi suffers from the deposition of dirt on its solar plates. The effect of the gathered dirt might be decreased with the increasing of tilt angle, due to the fact that the lean angle will affect the publicity time to the sunlight also. But the first-class manner to remove the impact of the accumulated dirt on the solar panels is to smooth the panels. Cleansing the solar panels is typically with the aid of washing that's tedious and cumbersome and additionally high priced in phrases of the labour involved and time. In practice cleansing of solar panels should be regularly executed which makes the technique greater exhausting and steeply-priced.

Fig 1.2: Street light solar panel

Solar power is excellent to be had as a maximum essential electricity source. The sun cells area used for plenty applications, such as road lighting fixtures to generate luminescent night. The buildup of dirt debris, deposits left by means of birds or the fallen leaves, at the floor of

picture-voltaic PV panel will mirror the incident mild falling at the panel, preventing a part of the radiation from getting used. This trouble ought to reduce the potential of cells to permit free entrance of photons and soak up sun electricity, which greatly impacts its performance, lowering the lifetime of its garage electricity after a few months from its instillation, leading to an everlasting or long-time period failure, mainly inside the wilderness regions. Different elements along with panel orientation or panel floor material can make a contribution to the deposition of the impurities.

The method involves the Mechanical and electric sections. The Mechanical element includes DC motor controlled through a power unit which moves a cleaning head on the panel upward sand downwardswithout or with the use of liquid spraying structures. Electrical part includes software programming which operates and controls the circuit structures of the self-cleaning technology. The software program specially includes two elements. One is essential programs and some other is interrupt process. The output strength is measured for the panels before and after cleaning and efficiency is calculated with the assist of voltage and contemporary graphs. Hence this is an innovative method of automatic cleaning of solar panel has been suggested.

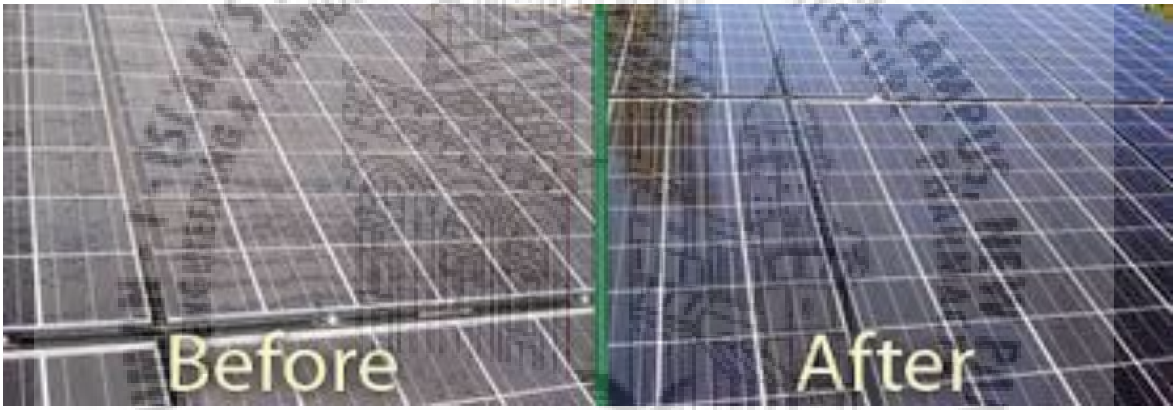
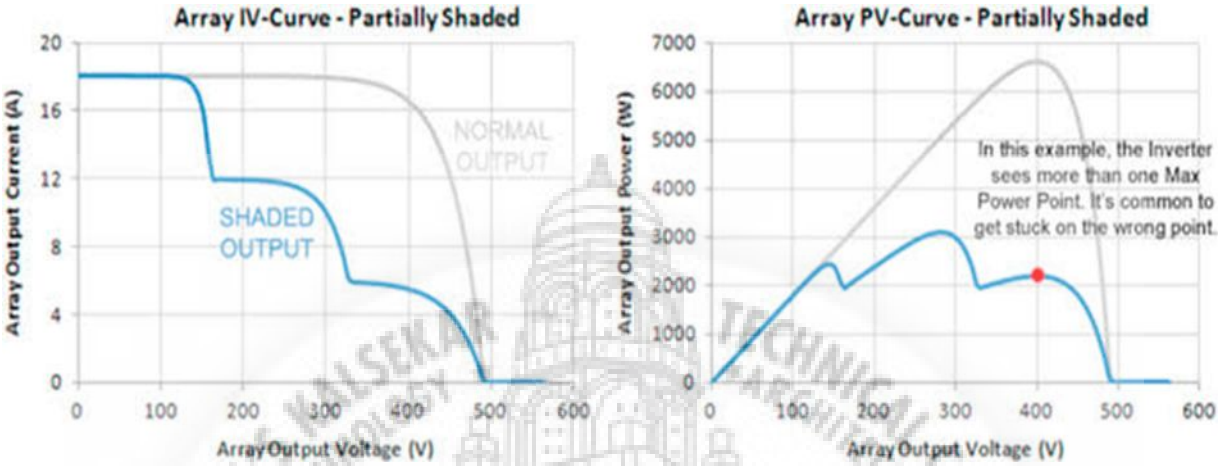


Fig 1.3:solar panel with & without cleaner

Why to clean solar panel ?

solar panels in very dirty environments saw a 35 % drop in efficiency from atmospheric pollution .(JFRNA)



CHAPTER 2

2 LITERATURE SURVEY:

Many research studied the effect of dust and other impurities on the solar panel and much experiments have been carried out to clear up this troubles. Under are a few theories and researches which can be related to this mission.

The phenomenon of converting light directly into electricity was discovered by Henri Becquerek back in year 1839. Then Albert Einstein explained the principle of photovoltaic in year 1905 using quantum theory. Significant use of PV power systems has started in space application in the 1905's and its modest use in global application began in the 1960"s. However, at the start of 1970"s and 80 saw a superior and substantial use of PV power system.

The performance of the solar system depends on the solar ray trap by the solar cell as the radiations trap by the solar cells on the solar panel is maximum the performance of the solar system is also maximum. Due to the dust on the surface of the solar panel the radiation falling on the system and trapping by the solar cell reduces which decreases the performance of the solar system. Here in this work we are finding the effect of cleaning of solar panel on the performance of the solar system. There are many parameters which are responsible for cleaning of the system. There in this work we are finding the effect of rotation of cleaning roller on the cleaning of solar panel. Finding the effect of number of pass of the feed roller on the surface finish of the solar panel, also calculating the effect of feeding speed on the cleaning of the solar panels.here in this work it also analyzed the effect of solar insolation on the performance of the solar system. To find the effect of solar insolation here we have considered 10 different solar isolation that is 20, 40, 60, 80, 100, 120, 140, 160, 180, 200 W/m2. With the help of voltmeter and ammeter we measure the value of voltage and current, find the value of power and calculate the efficiency of the solar system. The complete setup for the experimental analysis were shown in the below fig.

Fig.2.1: complete setup for the experimental analysis

Conventional methods of cleaning :

2.1 Manual Cleaning:

This method require human operator to clean manually with the help of any wipers with suitable support structures as shown in Figure 2. The quality of cleaned surface is judged by visual method by the operator himself for the satisfactory level or till the dust particles get wiped out completely. The process is found to be very tedious and challenging as the streetlight solar power plants installed at a height of 12 to 20 feet or more from the ground. The time required and safety of the person and panel is in threat. To clean the panels manually the fluids like cleansers or gels has to be used which act upon the panel and reduces the surface transparency if cleaning is not proper. There are quite chances of physical damages to the PV panels which cannot be avoided.

Fig. 2.2: Manual cleaning

2.2 Vacuum Suction Cleaning:

A vacuum suction cleaner is a device that uses an air pump to create a partial vacuum to suck up dust and dirt, usually from floors, window panes etc. In general the electrical supply is given to the vacuum cleaner motor which creates the suction pressure. The power consumption of the vacuum cleaner is in watts and it does not justify the effectiveness of the cleaner. The input power is converted into airflow at the end and is measured in air watts. The vacuum cleaner can clean the panel properly only on the surfaces other than the corners and this has to be handled manually as shown in Figure 3. The proper training to the operator is necessary as the physical movements on the panel with cleaner is inevitable. Over a period of time scratches and accumulated dust cause inefficient absorption of solar insolation.

Fig.2.3: Cleaning using vaccum suction

2.3 Electrostatic Charge System for cleaning:

Places with very scarce source of water such as deserts, dry areas like Saudi Arabia or even places with no water like Mars use electrostatic techniques for cleaning. Electrostatic charge concept for lifting and transporting charged particles of insulating materials has been used for providing standing wave-type electric curtain. In this case, we have a standing wave, and at any point, the electric field has a definite direction and amplitude oscillating at the imposed frequency. A single charged particle oscillates along the field line.

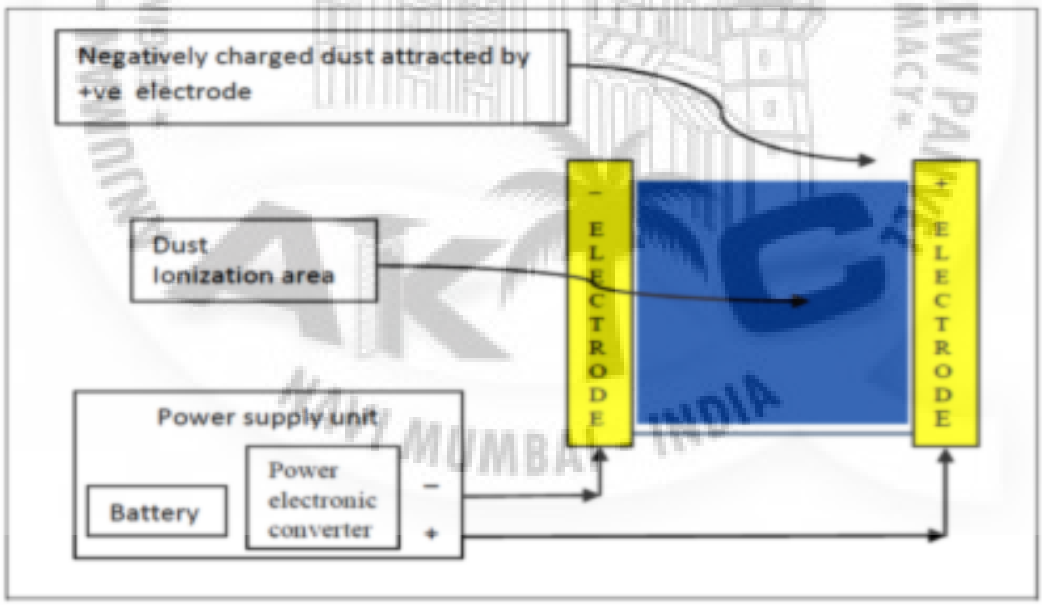


Fig.2.4: Electrostatic Charge System for cleaning

[1] Hottel and Woertz:first studied the dust effect on sun panel presentation with the aid of analyzing the dust collecting on such panels. A 3month test becomes done in a business location close by a four-tune railroad 90m away from Boston, Massachusetts. They located a mean of one% loss of occurrence solar radiation changed into caused by dirt that accumulated on the surface of the sun panel with a slant attitude ofa30°. The very best dilapidation defined for the duration of the check duration becomea4.7%. The researchers found out a correction issue, defined as the ratio of the transference from an polluted or exposed glass plate to clean one, of zero. Ninety nine, with a 45° slant angle; this value changed into general and hooked up in the layout of flat plate collectors till 1970.
Kimber et al. tested the consequences of soiling on large grid-linked PV panels in California, USA in 2011. The goal of the have a look at became to deliver a better model to correctly are expecting soiling patients all through the 12 months barely than presumptuous a continual annual fee. Every other objective changed into to illustrate the final results of soiling on PV arrangement for general area slightly than for a particular area. For that examine, to illustrate soiling losses over the dry season, a linear deterioration version changed into used. After except for websites with nonlinear conduct of soiling and large rainfall of the web sites, the information from 250 sites have been accumulated and later filtered to 46 machine records sets.

[2] Ali Omar Mohamed, Abdulazez Hasan:considered the southern area of Libya which usually carries the dust and sand in the period from February to May, which is also called as seasonal wind. So the small particles of the sand, trees, debris and droppings of birds are accumulated on the PV model surface, which yield a shading sunlight on the modules. Here the area of study divided as rural desert, where the amount of solar irradiance is large over the year. Thus it inspires to adopt the clean energy resource on desert region. Hence a framework of weekly cleaning on PV modules throughout the period involves the experimental set up and a simultaneous measuring is implemented in maximum operating voltage and currents on each module for both before and after washing modules. Weekly water washing is carried out through periods of February to May in order to evaluate performance of PV panels. So the maximum current and voltage is measured at the terminal using the digital multi-meter device, before and after washing in order to gain the maximum power at the operating point generated by PV module.
During study water wash is done once in a week on module without any automatic cleaning technologies, manually by mixed detergents with water and use of hand cleaning materials. Further more to wash surface module, spry nozzle is fixed at the top. Approximately each module consumes around 5liters of water. In fact it is necessary to maintain an optimum performance in desert region by regular cleaning of PV module. However accumulated dust causes the impact on output power and the system efficiency. Hence periodically cleaning, maintained performance losses between 2 to 2.5%. The cleaning interval is different from one place to another, hence it is very important to schedule such program to have a fully awareness of region environment contamination type and it is occur period.

[3] Mark N. Horenstein: supplied EDS (Electro dynamic screen) understanding for the automated and unceasing removal of dirt without water or shifting elements. They find the values of electrode association, excitation frequency, and voltage scale that harvest most detail elimination performance. Sun panel's floor, predominantly of the kind engaging semiconductor photo transducers, should be enduringly free of dirt to operate resourcefully;

the value of washing might need to be accounted for inside the gross end of the solar panel's financial assistances. There area several strategies are advised such as rain fall, washing with beverages of various type, wind clearing, shacking, air blowing, Wiping, rotating, Nano era containing sun sheet coat are suggested and surface vibration to put off the dirt particles from the surface of sun panel.

[4] R.Sharma, C.A.Wyatt:obtainable an electro-dynamic display, the overall performance of electrodynamics for superficial cleansing became categorized with admire to the efficiency of a display screen with diverse costs of dirt deposition; electric influence requirements on the display procedure with admire to dirt removal efficiency and the optical transmission efficiency of the translucent electrodynamics display screen and the corresponding power loss, while those monitors have been placed on sun panels.

[5] Chandimagomes:supplied a small experimental set up to smooth the sun strength. Many parameters of surroundings impact the efficiency of the photovoltaic. A good way to evaluate the impact of dirt debris from the PV two restore Flat Photovoltaic (FFP) became installed on the college put Malaysia. The regularly cleaned arrayais known as "easy array" and the opposite array taken for the duration of in the examine became "dusty array". Statistics become gathered from 1st April – 2013 December for both arrays at the c language every of 30 minutes. Output strength and power yield for each array were considered. The overly strength and power decreases because of dust have been observed from the studies. The results proven that the total electricity generated from the smooth array turned into greater than that of generated electricity from the dusty panel. it can be said that the dust is one of the main issue that can decreased energy yield from that studies.

[6] S. B. Halbhavi: Added an automated cleansing device, which senses the dirt on the sun panel as a way to easy the dirt frequently. If the panel isn't wiped clean then 50% of the module performance might be reduced. The 8051 microcontroller is used to control the tools motor and to implement the automated gadget. The mechanism consists of a sensor and also consists of the sliding brushes while cleansing the PV modules. The analysis of the dust can be examined below the different conditions with the deposition of the unique pollutants like ash, sand, silica, calcium carbonate and crimson soil. Later retaining the PV model.cool and clean, effects are acquired for effective device presentation. The strength generation in each instances become experimentally determined. Sooner or later by way of the use of the above said computerized cleaning scheme the power output can be expanded approximately 30%, as compared to other cleansing technologies. Also recurrent periodic cleansing guarantees that the panel works with true conduction step by step.

[7] A. Salam Al-Ammri, Areej Ghazi: lately in 2015, solar strength studies middle, Renewable strength Directorate and Salam Al-Ammri, Areej Ghazi were worked to give a layout of self-cleansing module, build a moist and dry cleansing gadget to the street light sun panel. It changed into simple, inconsequential, small to maintain, transportable, withstand the ecosystem; low-fee, lengthy existence, takes its strength from the battery of the solar panel, and controlled robotically, by using a far off manage or a timer. The investigational version changed into primarily based on a DC motor perceptively controlsby way of a devoted pressure unit that circulate a cleaningahead on the panel upwards and downwards without the use of, spraying system. The performance and characteristics of the self-cleaning device is experimentally analyzed. In that examine an independent simple and coffee estimate cleansing device which can smooth one avenue mild panel became advanced. The electronic par and mechanical part were separately built and later both are assembled using

microcontroller. The output power is measured in both the conditions i.e. after cleaning and before cleaning of the panel for dry and wet conditions. Finally the results obtained from output tables clearly shows that the dry, wet and solution, which are used in this process increases the efficiency and removes all the dirt from the surface. By that way, the water consumption and loss of power can be reduced.

CHAPTER 3

ANALYSIS OF STREET SOLAR LIGHT SYSTEM:

3.1 actual photo of street solar light system

3.2 Frame

This is made of mild steel material. The whole parts are mounted on this frame structure with the suitable arrangement. Boring of bearing sizes and open bores done in one setting so as to align the bearings properly while assembling. Provisions are made to cover the bearings with grease.

3.2 Solar Cell

Photovoltaic energy is the transformation of sunlight into energy. A photovoltaic cell, usually called a sun portable or PV, is the information used to convert sun strength immediately into electrical power. A photovoltaic mobile is a non- mechanical scheme typically made from silicon composite.

Fig 3.2: Solar Cell

The photovoltaic chamber is the basic construction block of a photovoltaic organization. Individual can differ in size from around 0.5 inches to about 4 inches through. Yet, one cell only yields 1 or 2 watts, which isn't adequate power for most submissions.

3.2.1 Solar Photo Voltaic (SPV) Module

The power generated by a single cell is small and therefore several cells are interconnected in series/parallel combination to get the required voltage and current. When a number of solar cells are connected in series to get a specific voltage the unit so formed is called as Solar Module. Charging batteries is the primary use of SPV module. Therefore normally 36 cells are joined in series to form a standard module, which is capable of charging 12 volts battery. A terminal box is provided on the backside of the module for external connections. A Bypass diode is connected across +ve and –ve in the terminal box. Cathode of the diode will be at +ve terminal and Anode will be at –ve terminal of the module. This diode protects the module cells from overheating due to shadowing of the module or any cell breakage. Generally the rating of bypass diode is 1.52 times of the maximum current of module. The Repetitive Reverse Peak Voltage Vrrm of the diode should be double the string open voltage. Standard Capacity/Ratings of SPV The wattage output of a PV module is rated in terms of wattpeak (Wp) units. The peak watt output power from a module is defined as the maximum power output that the module could deliver under standard test conditions (STC). The STC conditions used in a laboratory are

- 1000 watts per square metre solar radiation intensity
- Air-mass 1.5 reference spectral distribution
- 25 °C ambient temperature

The voltage output of a PV module depends on the number of solar cells connected in series inside the module. In India, a crystalline silicon module generally contains 36 solar cells connected in series. The module provides a usable direct current (DC) voltage of about 16.5 V, which is normally used to charge a 12-V battery.

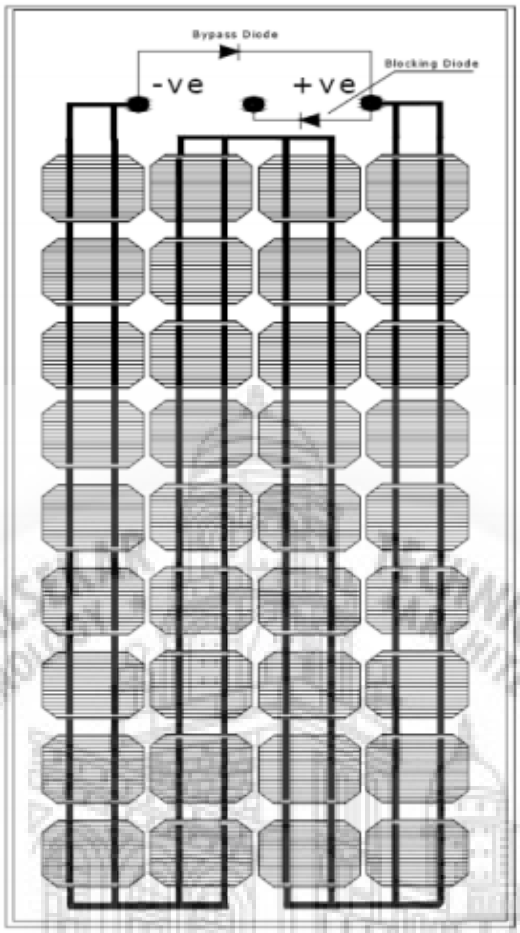


Fig.3.3: Solar Module

3.3 Types of Solar Panels:

Photovoltaic (PV) is a technology that changes light directly into electricity. Photovoltaic is also the field of study linking to this technology and thereareamany research institutes devoted to work on photovoltaic. Due to the rising need for solar energy, the manufacture of solar cells and solar photovoltaic array has expanded dramatically since 2002 making ait the world's fastest growing energy technology. There are 3 types of solar panels and are explained below.

1] Mono Crystalline:

Mono crystalline sun panels are made from a huge crystal of silicon. These varieties of solar panels are the maximum green as in absorbing sunlight and converting it into strength; but they may be the maximum high priced. They do particularly higher in decrease light conditions a then the alternative types of solar panels.

Fig 3.4: Mono Crystalline Solar Plate

2] Poly Crystalline:

Poly crystalline sun panels are the maximum common types of solar panels available on the market today. They appearance plenty like shattered glass. They're slightly much less efficient than the mono crystalline sun panels and much less highly-priced to supply. Instead of one massive crystal this kind of solar panel includes more than one quantities of smaller silicon crystal.

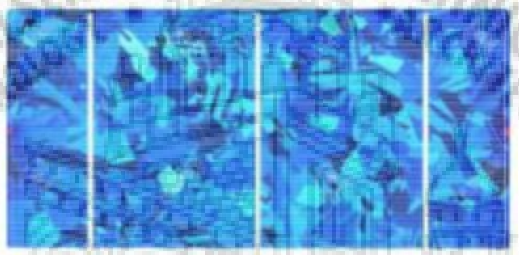


Fig 3.5: Polycrystalline Solar Plate

3]Amorphous Solar Plates:

Amorphous solar panel includes a thin film crafted from molten silicon this is spread directly throughout massive plates of stainless steel or similar cloth. Those kinds of solar panels have lower performance than the alternative varieties of sun panels, and the cheapest to produce. One advantage of amorphous sun panels over the alternative two is that they may be shadow blanketed. That means that the sun panel keeps to rate at the same time as part of the sun panel cells is in a shadow. Those paintings excellent on boats and different types of transportation.

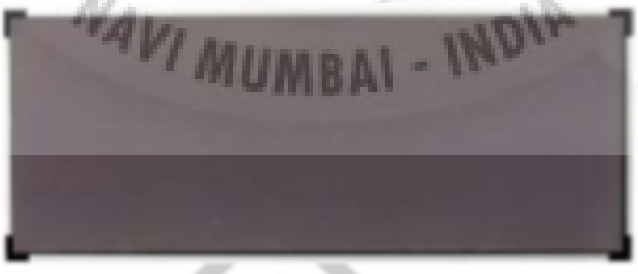


Fig 3.6: Amorphous Crystalline Solar Plate

3.4 Solar Panel Efficiency Details:

1] Mono crystalline -18 Percent

2] Poly crystalline-15 Percent

3] Amorphous (thin)-10 Percent

3.5 Module description:

The array is used for massive scale of generation from solar panel. That array is made from several modules and each module is crafted from different kinds of modules as noted in previous bankruptcy's i.e. Mono crystalline, Poly crystalline and amorphous solar panels. But on this observe the single Poly crystalline module of 36 cells is hired with 100wp technology capability and 1080mm* 655mm. the same old trying out situations (STC) is 1000 w/m², 25°C is considered.

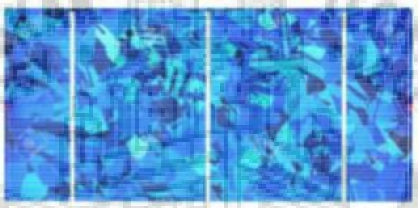


Fig 3.7: Experimental module

Consistent the PV module made of SitaraAkshayaUrja 100wp Poly crystalline module. Similarly, this requires the use of parameter of PV module. Together with open circuit voltage at STC, quick circuit contemporary at STC, Voltage, and current and temperature energy coefficients. Right here the sun module is attached to the weight lamp.

Sl. no.	Parameter	Pmax
1	Maximum power (w)	100wp
2	Voltage (V)	17.28V
3	Current (I)	5.40A
4	Short circuit current	5.7A
5	Open circuit voltage	21.87V
6	Maximum system voltage	600V

Table 3: Characteristics of PV module

3.6 MOUNTING THE SOLAR MODULES:

While mounting the solar modules, following points should be considered for getting maximum output from the solar modules:

- Modules should be oriented south facing to receive maximum sunlight.
- The Modules produce more power at low temperature and full sun.

The Solar panels are generally installed in such a way that they can receive maximum direct sunlight without shade from any building/trees nearby falling on them at any part of the day. As we know that the Sun rises in the East and sets in the West as a result of Earth's rotation around its own axis. Also the Earth revolves around the Sun. Due to these two movements there is variation in the angle at which the Sun's rays fall on Earth's surface over a year. At any particular place on Earth this variation in angle in one year may be up to 45 degrees. Considering these facts the following guidelines are to be kept in mind while installing solar panels:

1. Solar panels should be installed South facing in the Northern hemisphere and North facing in the Southern hemisphere. Since India is in the Northern hemisphere, Solar panels will be installed always- South facing in our country.

2. The rule of thumb for fixed (never adjusted) is to set them pointing south at an angle = latitude. If it is to be adjusted twice in a year, winter is latitude + 15 deg and summer is latitude - 15 deg. For the angle for "now", point them so that a stick perpendicular to the panel casts no shadow at solar noon (when the sun is at it's peak -- close to noon standard time).The directions North- South may be found with the help of Magnetic Compass. The picture given in fig 1.5 illustrates this.

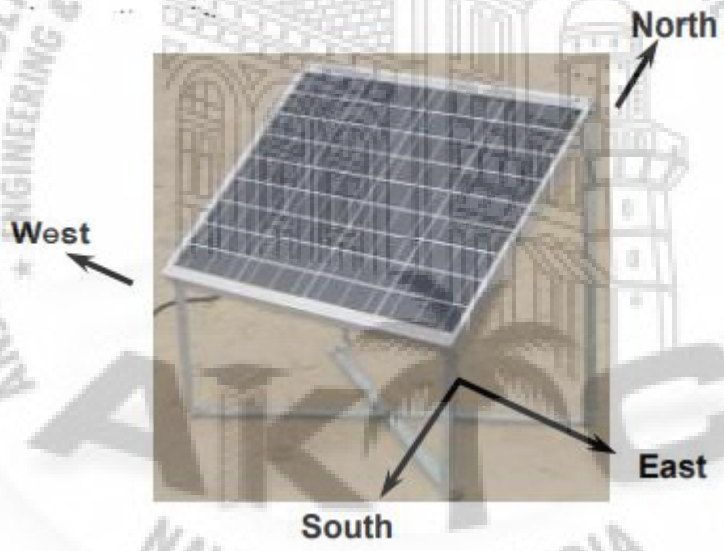


Fig.3.8: A Solar Panel installation

3. Any obstruction (such as tree or building) should be avoided in East, West or South of the place of installation.

The following is the criteria:

(i) East or West: The distance between solar panel and obstruction should be more than double the height of obstruction.

(ii) South: The distance should be more than half the height of obstruction.

4. The support for the Solar panel need to be a robust one and should not be accessible to general public. It should be so installed that rainwater, bird dropping, leaves etc. do not accumulate and the top surface can be cleaned easily.

3.8 Latitude:

usually denoted by the Greek letter phi (φ) gives the location of a place on Earth (or other planetary body) north or south of the equator. Lines of Latitude are the imaginary horizontal lines shown running east-to-west (or west to east) on maps (particularly so in the Mercator projection) that run either north or south of the equator. Technically, latitude is an angular measurement in degrees (marked with °) ranging from 0° at the equator (low latitude) to 90° at the poles (90° N or +90° for the North Pole and 90° S or −90° for the South Pole). The latitude is approximately the angle between straight up at the surface (the zenith) and the sun at an equinox.

3.9 MAIN COMPONENTS:

his street lighting system may be used for uninterrupted illumination of the streets, pathways & surroundings of the buildings from dusk-to-dawn for security & safety. This lighting consists of the following components:.i. SPV Module to convert solar radiation directly into electricity.

ii. 6 m height MS pole painted with corrosion resistant paint with necessary accessories.

iii. Battery bank to store the electrical energy generated by SPV panel during day time.

iv. Charge controller to maintain the battery to the highest possible State of Charge (SOC) while protecting the battery from deep discharge (by the loads) or extended overcharge (by the PV array).

v. Blocking diode, preferably a Schottky diode, connected in series with solar cells and storage battery to keep the battery from discharging through the cell when there is no output or low output from the solar cell, if such diode is not provided with the module itself.

vi. 15 W, 12 V DC LED based luminaire as a light source.

vii. Interconnecting wires/cables & hardware.

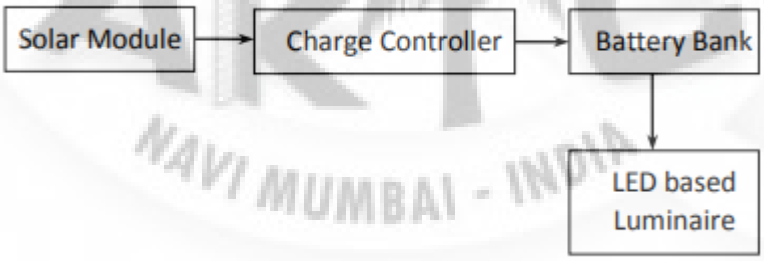


Fig. 3.10: Block Diagram

3.11 SALIENT FEATURES OF SYSTEM & ITS COMPONENTS:

i. The system is designed to have 4 days autonomy (i.e. system will run for 4 consecutive days without charging from the panel).

ii. The street light pole should be mounted clear of vegetation, trees & structure so as to assure that they are free of shadow throughout day light hours during each season of the year.

iii. The entire system is designed and built to withstand the extreme environmental conditions prevailing at site.

iv. All wiring, enclosures and fixtures that are mounted outdoor are resistant to high humidity conditions, corrosion, insect and dust intrusion.

v. The solar module consists of the following four main components:

- An assembly of suitable inter-connected crystalline silicon solar cells.
- The solar cells are provided with surface antireflective coating to help to absorb more light in all weather conditions.
- Toughened, high transmissivity glass in front side of the module for improved visibility & protection against environmental hazards, such as, rain, hail & storm and weather proof TEDLAR/POLYSTER back sheet.
- The transparency of toughened glass used is > 91%, when measured in actual sunlight by placing the glass plate perpendicular to the sun's rays through an air mass of 1.5.
- The complete solar module is provided with water-proof sealing in an anodized aluminium frame.
- A bird spike is provided at the highest point of the array/module structure to avoid bird sitting on the solar module.

Fig.3.11: Solar Module Top Side

vi. The output terminals of the module are provided on the back of the solar PV module.

vii. Terminal block is made of Nylon-6 or equivalent material with weather proof design (IP-65) and have a provision for opening for replacing the cables.

Fig.3.12: Solar Module Back Side

viii. All metal equipment cases and frames in the system should be well grounded.

ix. The Sun is not always available and it is not regular. However, lights are to be fed daily. Therefore power should be stored in a battery bank.

- The storage battery bank have enough capacity to keep the system going on without break down when the weather is not favorable for generation of electricity due to cloudy days and rains.

- LMLA or VRLA batteries are used for this purpose. LMLA batteries are provided with micro porous vent plugs & electrolyte level indicator.

- Suitable battery Box made of Plastic OR M.S fabricated is provided to house the battery.

Fig.3.13: Battery Box

xi. Charge Controller suitable for both tubular LMLA as well as VRLA battery is used. This charge controller uses PWM charging technology.

- When battery discharges more at the end of autonomy days, in such a situation charge controller automatically boost charge the battery.

- On availability of sun shine (after autonomy days), the night load energy is delivered by the battery through the solar charge controller.

CHAPTER 4

PROPOSED STREET SOLAR LIGHT CLEANING SYSTEM:

3.1 Circuit Description (Design)

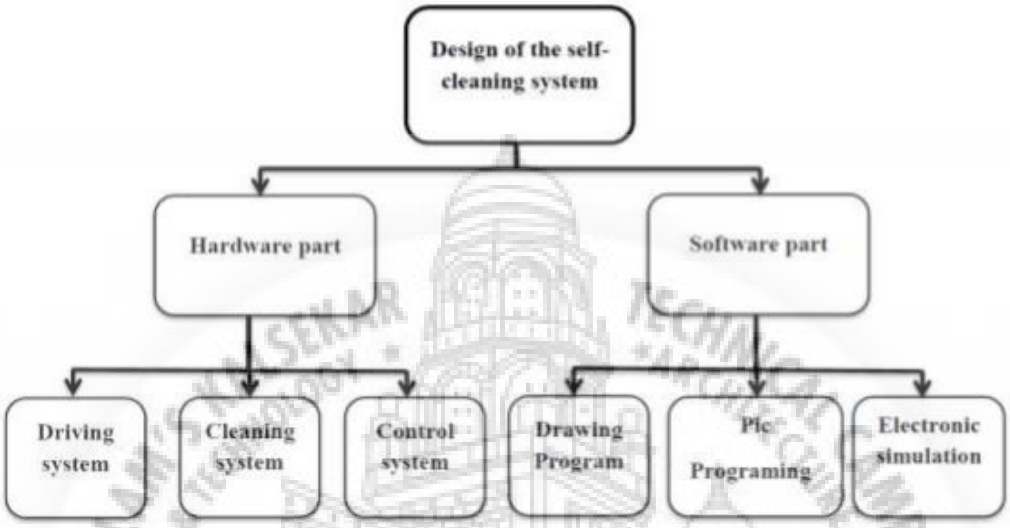


Fig.3.1:Block Diagram

The scheming of self-cleaning structure contains of hardware and software parts. The hardware structure includes of driving, cleaning and control arrangements is shown in the figure. The hardware classification components are a Solar Panel (specifications- 100W,12V), DC motor of 12V and 60RPM ratings, DC motor which has ratings of 12V and 60RPM, Arduino UNO and Battery of 100Ah).

The self-enough solar panel washing shape consists of a solar panel together with a software program device and cleansing rolling brush. Due to the fact that sun panel is positioned somewhere in the outside ecosystem and collects the daylight hours continuously. Whilst glass panel now not being wiped clean often it turns into dirty. This dust on sun panels may be noticed based totally upon the most strength effectiveness of sun cellular, if sun mobile electricity output is low and it can feel software and pledge the DC motor to start the cleaning technique of sun panels.

COMPONENT REQUIRED :

1) **Battery**

Sealed lead acid battery with voltage 12v and nominal capacity of 7Amp is used for the energy storing purpose. The battery usage and maintenance is of free type. The battery is charged during the day in the presence of sun i.e., solar energy and use when necessary. The batter after charging can be used up to 5-6 hours Continuously.

Figure 3.14: Battery

2) DC Motor

The motor is used to drive cleaning unit, 12V 1.2 Amps DC motor. This single phase motor work on the Fleming hand rule and generate electric current and this electric current converted to mechanical work like to rotate the blade and cut the brush.

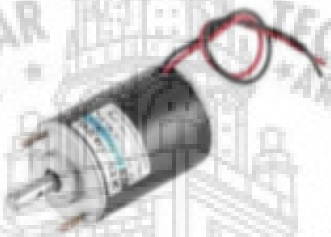


Figure 3.15: DC Motor

3) Arduino Microcontroller:

It is the intelligent controller used in the Automatic streetlight solar panel cleaning system. When the weight of panel increases due to accumulation of dust the weight sensor activates the Arduino. The Arduino give the command by applying power input to the motor and the dust particles get clean by wiper arrangement. The picture of the Arduino controller is shown in Figure 9.

Figure 3.16: Arduino UNO kit

4) Cleaning wiper (brush):

For cleaning of solar panel a soft cloth roller brush or rubber wiper is required

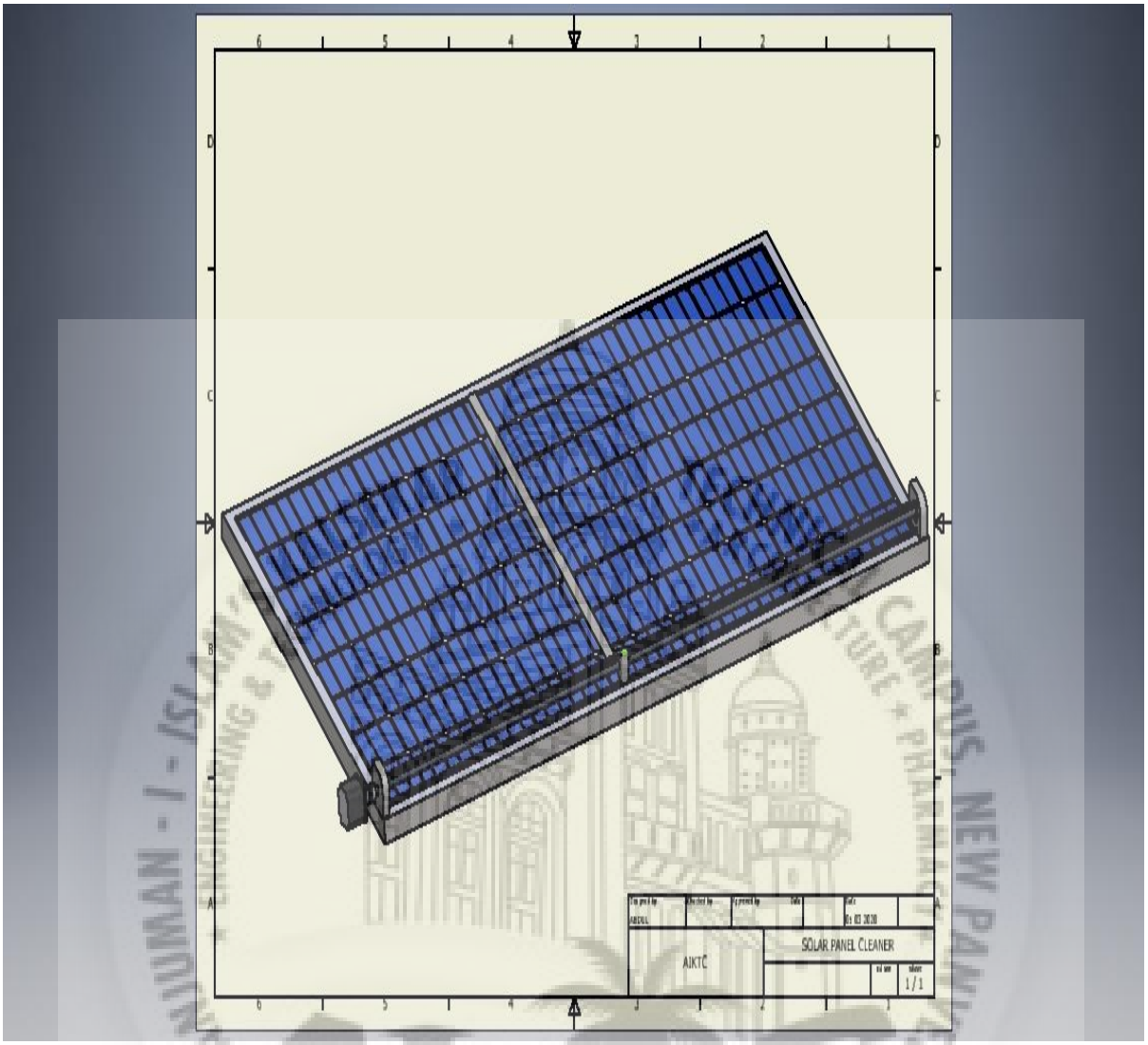
Fig. 3.17: Cleaning Brush

Charge Controller circuit:

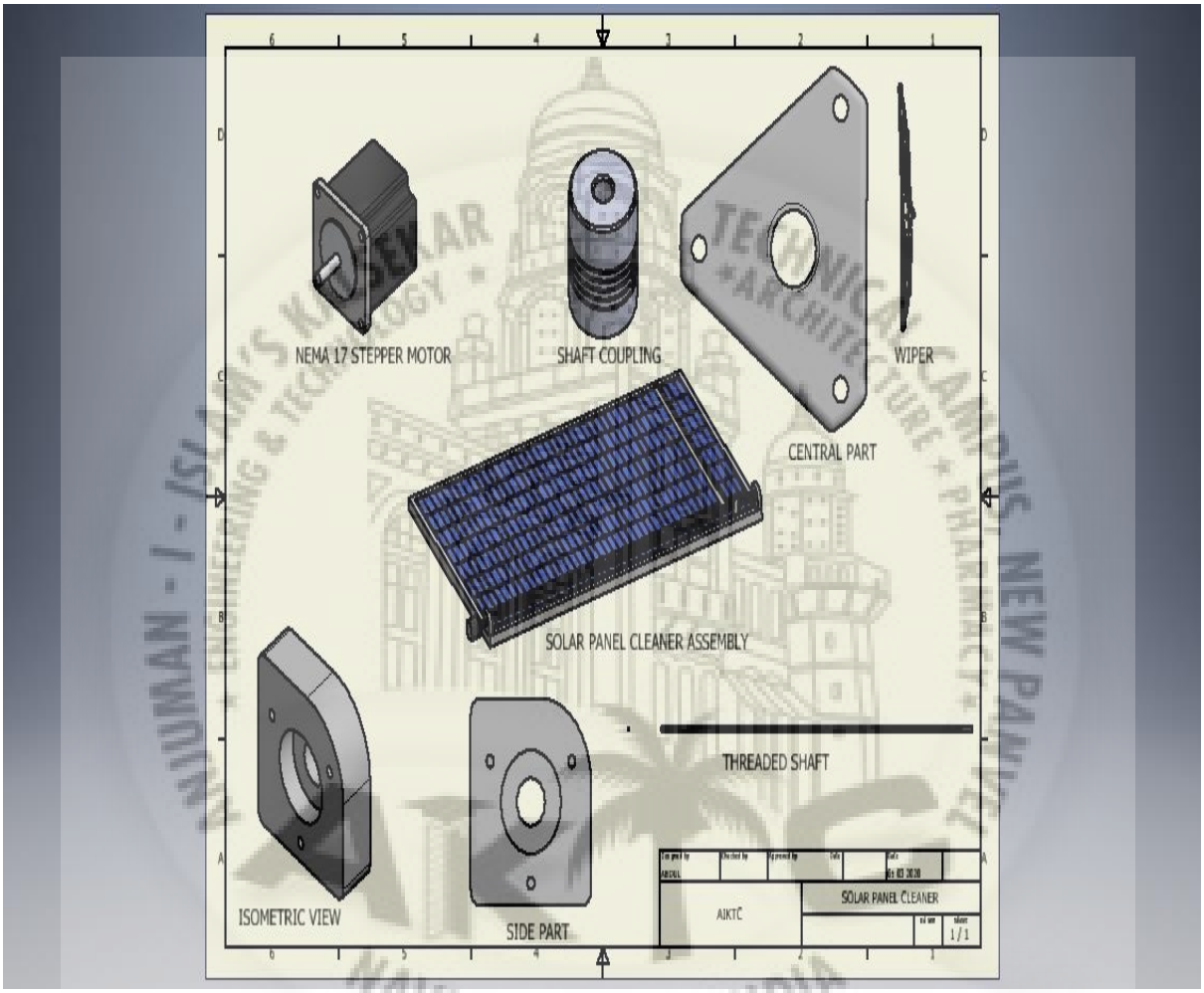
i. Charge controller has automatic dusk-dawn circuit for switching on/off the street light cleaning system without manual intervention.

ii. It is capable of handling the module's rated current

Fig. 3.18: Solar charge controller



ASSEMBLY OF SOLAR PANEL CLEANER



PARTS OF SOLAR PANEL CLEANER ASSEMBLY

CHAPTER 5

WORKING OF CLEANING SYSTEM (METHODOLOGY):

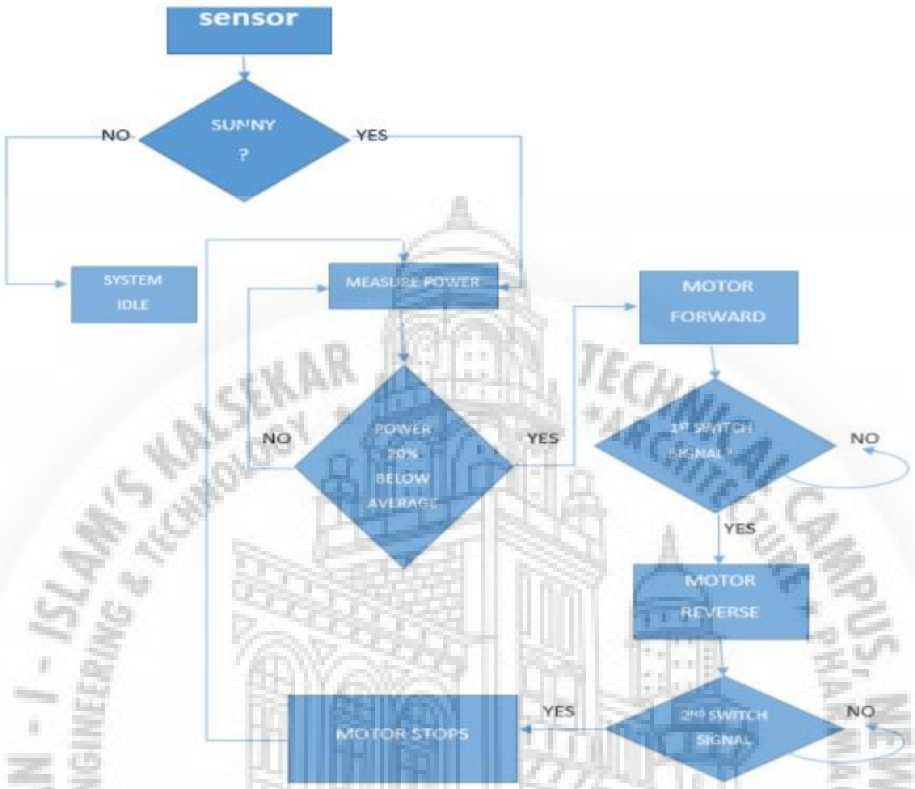


Fig 3.19: Flow Diagram of Cleaning System

In accord with the measurements of the flat plate panel, the model consists of brushes pushed with the aid of DC motors via belt gadget. The movement of the brushes is managed by using sign generated through a microcontroller with the suitable sensor used to sense the amount of dust collected on the panel. But here we aren't using sensor rather than that the timer is ready the use of microcontroller to clean the panel routinely on time base. The DC-motor will produce a rotational motion that's converted in to linear movement over belt. Via belt device, the rotational movement is transformed into linear movement which is produced by way of DC motor. The electrical strength which is applicable to pressure the DC motor may be furnished from the solar plate itself however right here the external ac supply is used to avoid the energy loss, since the operation of the cleansing meeting is not non-stop. Following steps are involved in the methodology.

(a) Gathering and analyzing more extra info concerning the effects of gathered dust at the flat solar panels.

b) Designing the basic model of the automobile cleaning gadget.

c) Deciding on the right microcontroller to govern the auto cleansing version and timer to easy the dust at the sun panel.

d) Designing the microcontroller's set of rules such that the microcontroller can manage the assembly within the accurate route.

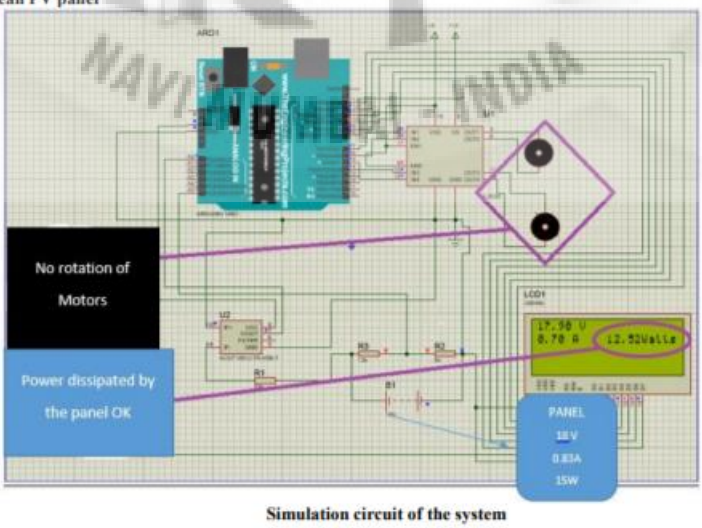
Simulation circuit of the system

The system consisted of the two DC motors connected to the Arduino UNO via control circuit of the L293D motor driver. The monitoring circuit and the light sensor were also connected to the Arduino UNO board. The sensor was used to detect the presence of light and microcontroller responds to this by measuring output power from the panel if it is clear day or the output is "HIGH". The cleaning mechanism becomes active only when the efficiency or the output power is low. The whole circuit was built by proteus 8 professional software as shown in the figure below. circuit was incorporated with limit switches stop and change direction of rotation of the motor.

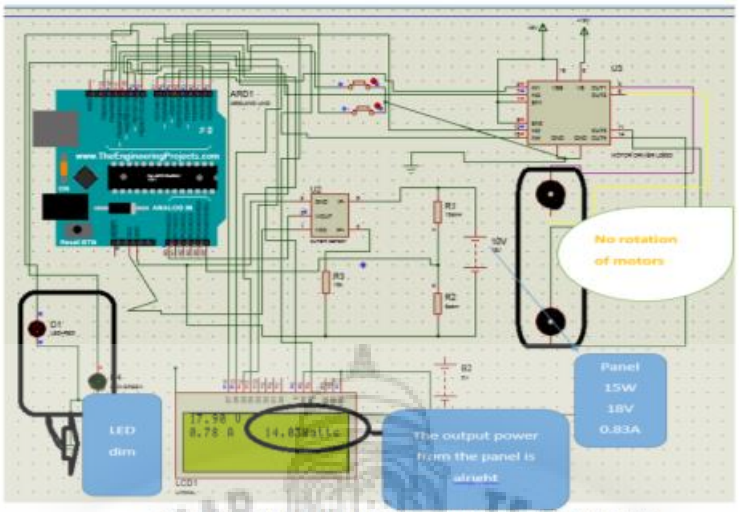
Simulation circuit of the system

Analysis And Discussion Of The Results

Clean PV panel

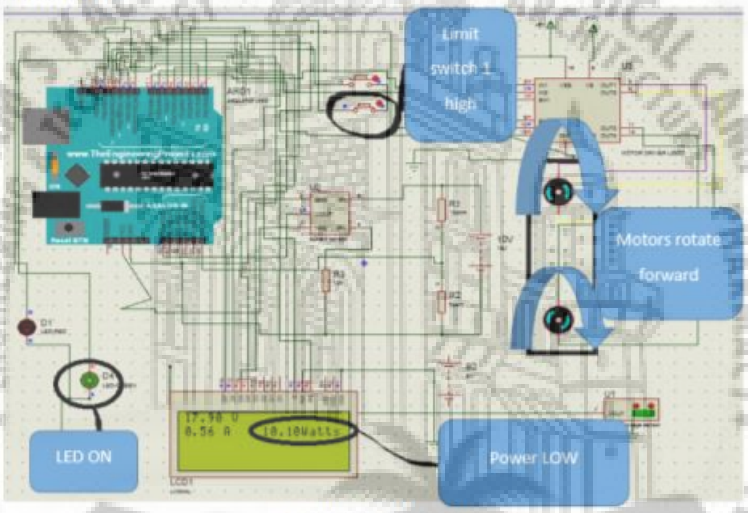


Simulation circuit of the system

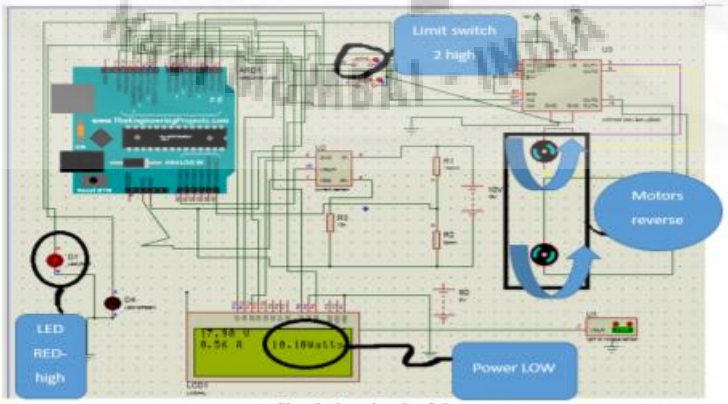


shows high performance of the PV module producing high power

Soiled PV panel



Simulation circuit of the system



Simulation circuit of the system

The automatic wiper based cleaning incorporate a rubber wiper and water pot for the spray of water with additives and cleaning. The process is exactly like vehicle glass cleaning and require a automatic mechanism to operate and complete the task. Mechanism is battery operated as shown in Figure 4. This method is simillar to earlier one and operated automatically by the suitable control mechanism but the impacts are simillar to those earlier ones.

The cleaning unit moves on the central spline in a back and forth motion. The cylindrical Brush mounted on the cleaning unit rotates in the clockwise direction. The cleaning unit along with the rotating brush moves along the central spline towards the bottom of the panel. Along the entire path, it forces the dust to move in the direction of the motion of the cleaning unit and finally blows it away at the edge of the panel. Once the cleaning unit reaches the lower end of it, it again returns back. Once it reaches the top of the spline, the cleaning unit stops there. Then the locomotion units come into action and release the suction cup which keeps the system in rest. Then the wheels move in the direction parallel to the edge of the solar panel until it reaches the part of the panel that is not cleaned. Then the suction cups are again engaged to make the system still. After this the cleaning unit again come into action and the process keeps on going until the entire array is cleaned. Once one array of the solar panel is cleaned, it is moves to another array.

A DC Motor is a class of electrical machine that convert direct current electrical power into mechanical power. The most common type rely on the forces produced by the magnetic field. DC motors speed can be controlled over a wide range by using a variable supply voltage or by changing the strength of current in the field winding.

CHAPTER 6

RESULTS AND DISCUSSIONS:

Here in this section the effect of feed speed of cleaning roller on the cleaning of solar panel where analyzed in order to analyzed the effect of feed speed here we considered three different feed speed that is 0.1, 0.2 and 0.3 m/s. the efficiency at 0.1 m/s were already analyzed in the above section. For velocity 0.2 and 0.3 m/s were analyzed here in this section. The speed of the roller was controlled with the help of controlling system shown in the below fig. The value of efficiency of the solar panels for different feed velocity of the cleaning roller where mention in the below table. The cleaning roller having velocity 0.1 m/s is shown in the below fig.

S.No.	Insolation (W/m2)	Power (W)	Efficiency (%)
1	20	0.878	12.14
2	40	1.58	11.8
3	60	2.24	10.43
4	80	2.87	9.94
5	100	3.25	9.48
6	120	3.64	8.89
7	140	4.28	8.56
8	160	5.02	7.93
9	180	5.79	7.54
10	200	6.48	7.13

Table.5 showing the value of different parameters for roller speed 0.1 m/s

S.No.	Insolation (W/m2)	Power (W)	Efficiency (%)
1	20	0.925	11.42
2	40	1.84	10.91
3	60	2.79	9.53
4	80	3.24	9.16
5	100	3.91	8.68
6	120	4.22	8.36
7	140	4.87	8.08
8	160	5.72	7.73
9	180	6.23	7.58
10	200	7.06	7.08

Table.6showing the value of different parameters for roller speed 0.2 m/s

S.No.	Insolation (W/m2)	Power (W)	Efficiency (%)
1	20	0.865	11.23
2	40	1.23	10.837
3	60	2.14	9.38
4	80	2.89	9.14
5	100	3.11	8.421
6	120	3.87	8.23
7	140	4.25	8.013
8	160	4.98	7.639
9	180	5.88	7.324
10	200	6.76	7.053

Table.7showing the value of different parameters for roller speed 0.3 m/s

After calculating the efficiency of solar panel at different velocity of feed roller, comparison of efficiency were carried out in the below table and graph.

S.No	Insulation (W/m2)	Efficiency (%) at 0.1 m/s	Efficiency (%) at 0.2 m/s	Efficiency (%) at 0.3 m/s
1	20	12.14	11.42	11.23
2	40	11.8	10.91	10.837
3	60	10.43	9.53	9.38
4	80	9.94	9.16	9.14
5	100	9.48	8.68	8.421
6	120	8.89	8.36	8.23
7	140	8.56	8.08	8.013
8	160	7.93	7.73	7.639
9	180	7.54	7.58	7.324
10	200	7.13	7.08	7.053

Table.8showing the comparison of Efficiency

Here it compares different input parameters on the basis of different performance parameters. The comparison of different parameters where shown in the below fig.

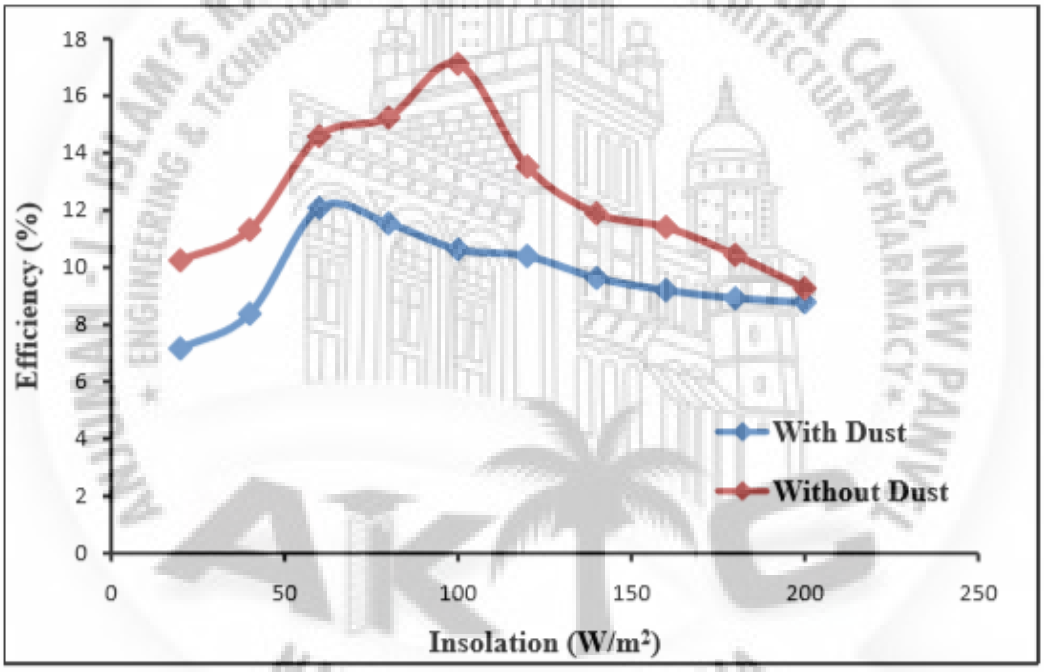


Fig.showing the comparison of efficiency

Comparison Graph of the Efficiency of different rotation speed is shown in the below fig

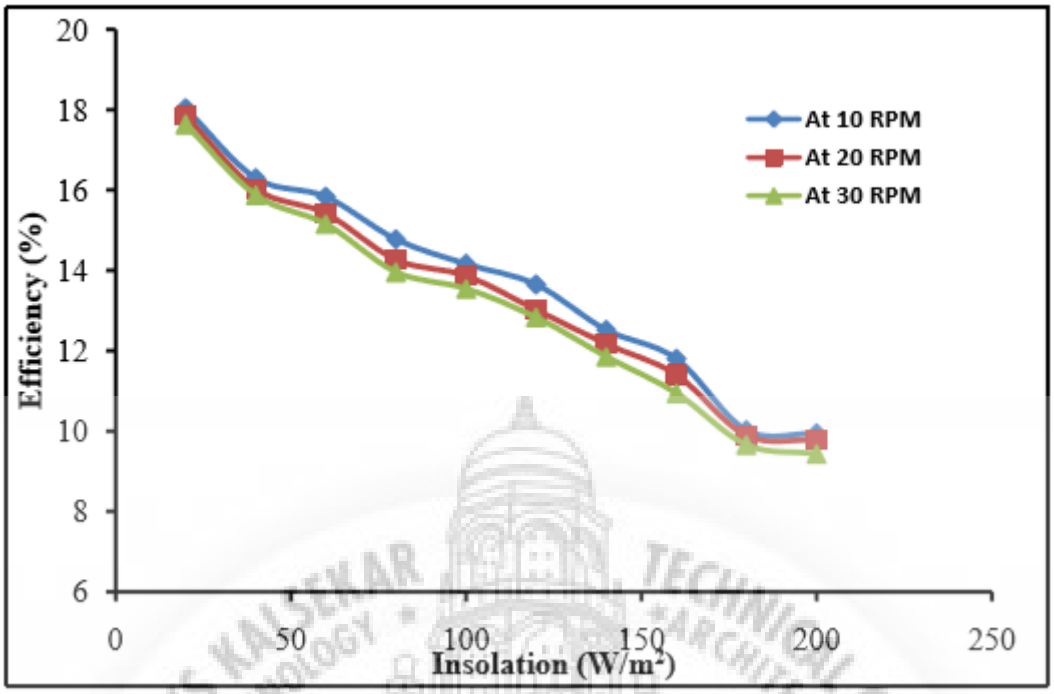


Fig comparison of efficiency for different Isolation

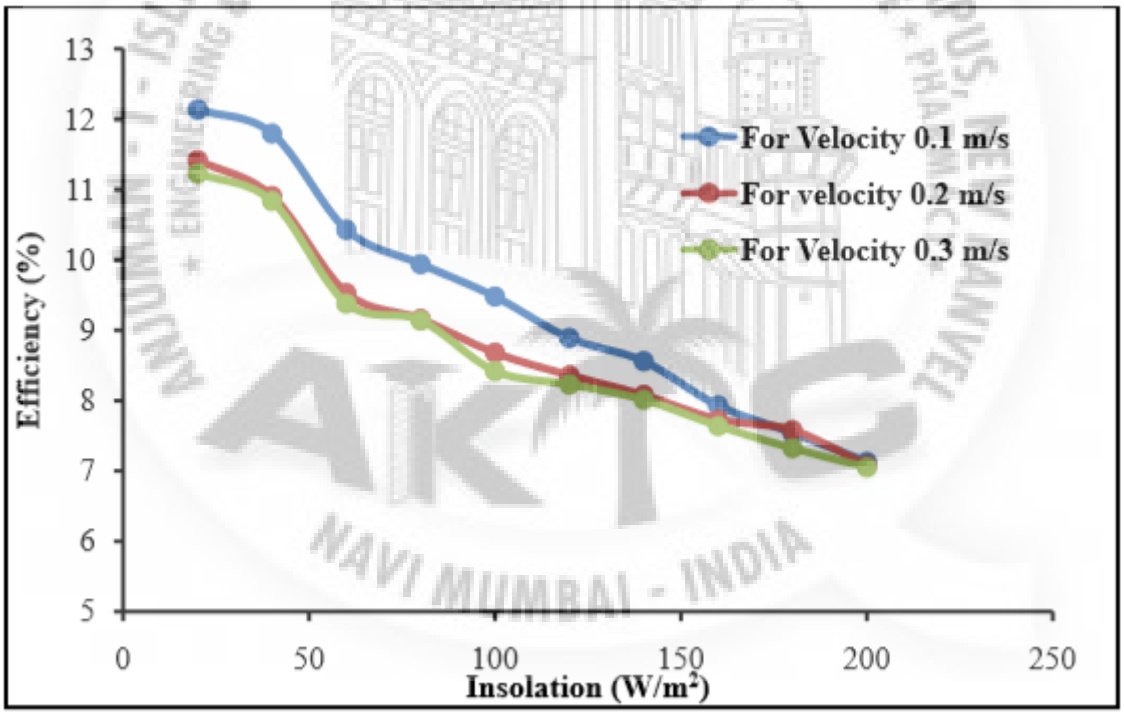


Fig. comparison of efficiency for different velocity of feed roller mechanism

From the above analysis it is found that the value of efficiency is maximum for feed velocity 0.1 m/s where as it is minimum for feed velocity 0.3 m/s. so it is concluded that as the velocity of feed roller increases the surface cleaning of the solar panel reduces due to this the radiation falling on the solar panel where less trap by the solar cell which is responsible for reducing the efficiency of the solar system.

The graph is drawn by considering the readings taken from Table. The time is taken in x-axis and power generated by the solar panel is taken in y-axis. The red curve shown in all graphs is the power generated by the dusty panel i.e. before cleaning which is taken in watts, whereas the black curve in the graph is power generated by the panel after cleaning of the dust accumulated on the panel. The time interval is taken in hours from morning 10am to evening 4pm in the month of July and August. An assessment of result for the experimental module is evaluated by the study of above graphs. Figure 1 shows the performance of the power generated by the solar panel for the reading 1. The power generated from morning to evening in one day is considered. The readings are tabulated separately as shown. Due to varying weather conditions in the month of July the minimum power generated is 77.9Wh before cleaning and 78.31Wh after cleaning. The maximum power generated is 83.64Wh before cleaning and after cleaning it is found to be 84.05Wh i.e. 0.41Wh is the increased power in the reading.

According to figure 2, the performance of the power generated by the solar panel for the reading 2 is considered. Here also the power generated from morning to evening in one day is taken. Due to same varying weather conditions in the month of July the minimum power generated is 81.18Wh before cleaning and 81.38Wh after cleaning. The maximum power generated is 84.46Wh before cleaning and after cleaning it is found to be 84.66Wh i.e.0.20Wh is the minimum power increased and 0.41Wh is the maximum increased power in the reading. The highest number of power generated by the solar panel for the reading 3 is found according to the figure 3. The maximum power generated is 83.64Wh before cleaning and after cleaning it is found to be 83.76Wh at 1pm. The minimum power generated is 80.36Wh before cleaning and after cleaning it is found to be 80.56Wh at 10am. The power increase in both before and after cleaning is observed to be 0.12Wh and 0.20Wh respectively.

In the month of August, due to improved weather conditions the generation of power is increased in reading 4 and reading 5 as compared to previous readings. The optimum power is obtained from 12pm to 2pm. The maximum and minimum power generated is found to be 83.64Wh and 81.18Wh before cleaning of the panel. The power gets increased to 83.76Wh and 81.38Wh after cleaning. A quantity of 0.12Wh and 0.20Wh power is increased in the reading 4.

Similarly in the reading 5 also the quantity is increased by 0.16Wh and 0.12Wh. in this case the maximum power generated before cleaning is 85.28Wh and the minimum power generated is found to be 81.59Wh. But after cleaning of the panel the maximum and minimum power generated in a day is observed to be 85.44Wh and 81.71Wh respectively.Since the readings of all tables were not taken in definite intervals of days i.e. the gap between every reading is indefinite. But the readings of before and after cleaning were taken in two consecutive days. Hence we cannot find much difference in the variation of voltage generated by the panel. Since the load used in the circuit is lamp, the current drawn by the load is almost remains constant for all the readings.

Sl. No.	Before Cleaning	After cleaning
	Total mean power per day	Total mean power per day
Reading 1	80.47	80.97
Reading 2	83.11	83.32
Reading 3	82.02	82.21
Reading 4	82.46	82.62
Reading 5	83.17	83.32

Table : Comparison of power between before and after cleaning

CHAPTRER 7

PREDICTED VALIDATION OF RESULT:

From the above study it is analysed that as the surface of the solar panel clean, solar ray falling on the plate are more utilized to convert in to work. So it is found that as the surface of the plate maintained clean the efficiency of the solar panel get also increase. So it is necessary to clean the surface panel of plate at regular interval. Some of the methods are given

1. High potential of solar energy or solar hotspots are present in India.

2. The efficiency of SPV can be increased by various techniques ¬ Solar tracking of SPV plates Removal of dust from the SPV surface

3. Dust accumulation on SPV may reduce its efficiency up to 50%. Some methods used to remove dust from surface are as follows,

i. Natural removal of dust

ii. Mechanical removal of dusted cleaning of these array

iii. Electrostatic removal of dust

iv. Electro mechanical removal of dust

v. So to increase the efficiency of the SPV array we must timely remove the dust from its surface of insulation. Automated cleaning of this array is preferred because it may increase the efficiency of SPV array up to 20% No manual interference so the running cost of cleaning system is less.

CHAPTER 8

CONCLUSIONS:

The performance analysis of the experimental setup is purely based on the amount of power generated on the dusty panel and a cleaned panel. The output power may reduce considerably by the large amount of dust accumulation on the panel. Dry cleaning can eliminate the dust particles on the surface but the effective cleaning is observed in wet cleaning. A bulk of the dirt dropped on the panel can be removed by cleaning the solar panel with water. No external power supply is required for the cleaning technology because solar panel itself can generate the sufficient power required for the microcontroller operation, which can be stored in a battery. The assembly is found to be lightweight. In comparison of costs in manual operation cleaning and automatic cleaning, the cost for automatic cleaning is demonstrated to be more economic and significantly less burden particularly in the system having large number of solar panels. The microcontroller is used because of its applications by pic programming and also because of lower installation cost. The power output is varying for the different weather conditions. A regular periodic cleaning ensures the variation of power measured in both before and after cleaning conditions by showing the significant performance of the cleaning technology.

CHAPTER 9

FUTURE SCOPE:

i. It can be implement on street light solar panels.
ii. Useful at such places where humans can't reach to clean the PV panel.
iii. It can inbuilt into the solar panel while manufacturing.

CHAPTER 10

TOTAL COSTING OF THESIS:

Sr .no	Particulars	Quantity	cost
1	BLDC motor rated torque 0.3 Ncm	1	500
2	Wiper	1	100
3	Motor driver	1	250
4	Timer circuit	1	150
5	Connecting wires		100
6	Mounting structure		500 (approx)
7	linkages		200
		total	1800

REFERENCES

i. 1) Automatic Solar Panel Cleaning System Abhishek Naik, NageshNaik, Edison Vaz, AbdulkareemAnjuman Institute of Technology and Management, Bhatkal. Papers-Volume: 06 Issue: 04 | Apr 2019 pISSN: 2395-0072, e-ISSN: 2395-0056

ii. 2) A Comparative Study of Dust Cleaning Methods for the Solar PV Panels Mallikarjun G. Hudedmani*, Gita Joshi, Umayal R M, AshwiniRevankar Department of Electrical and Electronics Engineering, KLE Institute of Technology ISSN: 2456-7108 Volume 1, Issue 1,

iii. Automatic Solar Panel Cleaning System Manju B 1 Abdul Bari 1 and Pavan C M 2 UG Student1 and Assistant professor2 Department of Mechanical Engineering G Madegowda Institute of Technology Bharathinagar, Mandya,http://doi.org/10.31695/IJASRE.2018.32778

iv. Solar Photovoltaic Panels Cleaning Methods A Review Saravanan V. S. 1, Darvekar S. K.2, Department of Mechanical Engineering, 1Bhivarabai Sawant College of Engineering Research, Symbiosis Institute of technology, Pune, IndiaInternational Journal of Pure and Applied Mathematics Volume 118 No. 24 2018

v. Kiran M. R, PadakiRekha G, Self-cleaning Technology for Solar PV panels, International Journal of Scientific Development and Research, Vol. 1, Issue 9, pp 148-173, 2016.

vi. FawadAzeem, G.B.Narejo.Design, development and performance evaluation of solar panel cleaning kit for street lights and ground mounted systems. 2016; 4357-4360.

vii. Rahul B. Ingle, Ravindra S. Chavan. Automatic dust detection mechanism for solar panel cleaning system. IJARIIE. 2017; 3(3): 2546-2549.

viii. Dr.G.Prasanthi ME, Ph.D., T.Jayamadhuri. Effects Of Dust On The Performance Of Solar Panel And Improving The Performance By Using Arm Controller And Gear Motor Based Cleaning Method.IJISET.2015;2(9):329-334.

ix. Kiran M R, Rekha G Padaki.Self-Cleaning Technology for solar PV Panel.IJSDR.2016; 1(9):148-173.

x. Akhil Mishra, Ajay Sarathe. study of solar panel cleaning system to enhance the performance of solar system.jetir.2017; 4(9):84-89.

xi. 5] Chandima Gomes, "Impact of Dust on Solar Energy Generetion Based on Actual Performance", IEEE International conference Power & Energy (PECON), 2014.

xii. 6] S.B. Halbhavi, “Microcontroller Based Automatic Cleaning of Solar Panel”, International journal of latest trends in Engineering and Technology, Vol.5 issue 4 July 2015.

xiii. 7] A.Salam Al-Ammri, Areej Ghazi, “Self Cleaning Control System for PV Solar Panel Street Light”, IEEE 6th international renewable energy congress, “978-1-4799-7947-9/15$31.00, 2015.