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DIFFERENT TECHNIQUES FOR SOLAR MODULE PERFOEMANCE AND EFFICIENCY IMPROVEMENT

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ABSTRACT

The recent trend in the demand of Photovoltaic systems is due to the fact that they produce electric power without affecting the environment because they directly convert the solar radiation into electric power. Solar energy is non-conventional natural source of energy .It is eco-friendly source of energy as it does not causes any harmful effects on the environment . So it is very important and necessary to use this natural source for the generation of energy. This paper deals with the various methods used for the improvement of solar panel efficiency and performance. One of the best method for improving the efficiency is by using solar tracker with panel which is used for continuous tracking of sunlight for the whole day, so it is useful for getting the maximum solar energy. Another method Dust cleaning is also used for the improvement of the efficiency. In this method Dust act as an obstacle between sunlight and solar panel. Another method is cooling method. Cooling panel has an important role because as the temperature of panel increases the output voltage of solar panel decreases. Another method is anti-reflecting coating method, for improvement of efficiency of panel. This paper deals to study the different techniques for increasing the performance, efficiency and output of the solar panel.

Keywords: Solar panel, Solar Tracker, Dust Cleaning, Cooling Technique, anti-reflecting coating technique

1. Introduction

One type of nonconventional energy source is the photovoltaic (PV) cell; the photovoltaic cell converts sunlight energy to electrical energy. PV modules can be made by connecting photovoltaic cells together. The efficiency of solar panel depends on various factor like solar intensity, temperature, dust which decreases the efficiency of panel etc. Following methods can be use to improve the efficiency of solar panel to get better performance and output of solar panel.

2.Solar Tracker

In solar tracking system, solar tracker changes their orientation for whole the day according to the path of sun's to capture maximum amount of solar radiation and hence to generate maximum amount of energy . In PV systems, trackers help for minimizing the angle of incidence between the incoming light and the panel .Due to this the output of solar system increases .

2.1 Types of Tracker

1. Single-axis tracker
2. Dual-axis tracker

Single-axis solar trackers acts as axis of rotation. They rotate on one axis moving backward and forward in only single direction. Dual-axis trackers continuously follow the sun because they are able to move in two different directions. Dual-axis tracking is used the mirror and redirect sunlight, along a fixed axis towards a stationary

receiver. Because of these trackers can follow the sun vertically and horizontally, so it is very helpful for generating the maximum solar energy. Solar trackers can be driven by using various methods. Passive trackers move from a compressed gas fluid driven to either side. Motors and gear trains used to active solar trackers by using controller which responds to the direction of sun as shown in fig1.1.The system receives sunlight onto the Cadmium sulphide (CdS) photovoltaic cells where the CdS acts as the main solar tracking sensor. The sensor feeds back to the FPGA controller, through an analog-to-digital (A/D) converter.The processor is the main control core and adjusts the two-axis motor, so that the platform is optimally located for efficient electricity generation. Selecting a solar tracker depends on system i.e. size, electric rates, land constraints, government incentives, latitude and weather. Utility-scale and large projects. usually use horizontal single-axis solar trackers, while dual-axis trackers are mostly used in smaller residential applications.

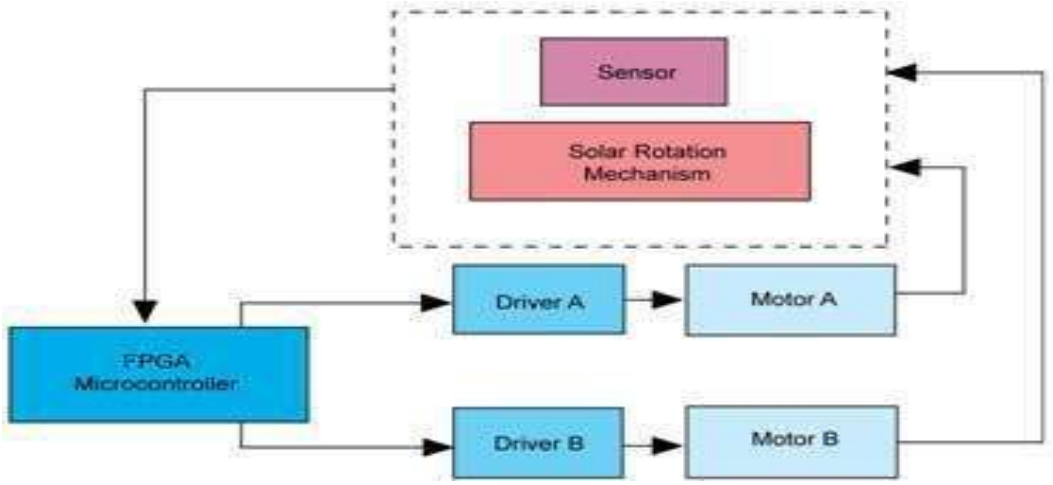

Fig.1.1 Bloch Diagram of Solar Tracker systems.

Boost converter is a DC to DC power converter for which output voltage is larger than input voltage. It consists of at least two semiconductors elements i.e. diode and transistor. Also it consists of at least one element for storing of energy like capacitor, inductor or the combination of both capacitor and inductor. Generally, the switch can be MOSFET, IGBT or BJT. Power can be supplied to a boost converter by using suitable DC source such as solar panel, batteries , DC generators or rectifiers. Sometimes a boost converter can also be called as Step-up converter as it increases or steps up the output voltage.

2.2 Advantages

The use of solar trackers system can increase electricity production, by around a third, and some claim by as much as forty percent in some regions, compared with modules at a fixed angle. In any solar application, the conversion efficiency is improved, when the modules are continually adjusted to the optimum angle solar angle as the sun traverses the sky.

2.3 Disadvantages

Adding a solar tracking system means added more equipment, moving parts and geasystemsrs that will require regularmaintenance and repair or replacement of broken parts. If the solar tracker system breaks down when the solar panels are at an extreme angle, the loss of production until the system is functional again can be substantial.Following methods are used to clean dust from solar panel.

3. Dust cleaning

3.1 Effect of dust on the performance of solar PV panel

The electrical parameters of solar panel are very sensitive to the dust density, so it is very important to provide auto cleaning mechanism to remove the dust particles from surface of the solar panel in order to ensure high performance. Dust is the lesser acknowledged factor that significantly influences the performance of the Photovoltaic.

3.1.1Rugged Robot

Deserts are sunny, so they are ideal for solar power. But they're also very dusty, so solar panel efficiency decreases. (Lose about 0.4-0.8% in efficiency per day). But hosing panels down with water in the middle, of anarid area is problematic on so many levels. And anything that requires a lot of human labor in the middle of aremote desert where temperatures can go over 122 degrees Celsius Fahrenheit it during the day.These are the problems that the **NO**-water **M**echanical **A**utomated **D**usting **D**evice (NOMADD) robot fromSaudi Arabia is trying to solve in following fig 2.

Fig 2 No-water Mechanical Automated Dusting Device

As shown in fig 2 little robots are mounted on tracks along rows of panels, and at least one day they pass over the panels, cleaning them with a brush designed and without any water required. This makes a big difference over manual cleaning and robot, which only happens every week or two most of the time. A single NOMADD can clean row of solar panels about 600 feet long, with plans to upgrade that up to 900 feet. Because each row of panels has its own NOMADD robot, they can work in parallel, and it doesn't take longer to clean a gigantic solar farm.

3.1.2 Self-Cleaning Technique

The self-cleaning technology was developed by, Boston University professor Malay K. Mazumder and his colleagues, in association with the National Aeronautics and Space Association, and was originally intended for use in rovers and other machines sent to space missions, to the moon and to Mars.The technology involves in the deposition of a transparent, electrically sensitive material on glass or on a transparent plastic sheet that cover the panels. Sensors monitor dust levels on the surface, of the panel and energize the material when dust concentration reaches a critical level.The electric charge sends a dust-repelling wave cascading over the surface of the material, lifting away the dust and transporting it off of the screen's edges. Within two minutes, the process removes about 90 % of dust on a solar panel. The mechanism reportedly requires only a small amount of the electricity generated by the panel for it work.Coating the surface of solar cells can increase their efficiency and reduce maintenance costs, especially for large-scale installations. Self-cleaning solar panels would be especially effective, in large installations.

The desert environments where many of these installations reside often challenge the panels with dust storms and little rain. Currently, only about 4 % of the world's deserts are used in solar power harvesting Conventional methods of cleaning solar panels usually involve large amounts of water which is costly and scarce in such dry areas.

3.3 Robotic Vacuum Cleaner

This system is implemented using two subsystems, namely a Robotic Vacuum Cleaner and a Docking Station. The robot uses two stages, cleaning process to remove dust effectively from the solar panels. A rolling brush is placed in the front to disperse the dust towards the vacuum cleaner. A high speed motor is use to capable of creating suitable suction is used for removing dust from the solar panels. It traverses the solar panel using a pre-defined path i.e. controlled by the accelerometers and ultrasonic sensor. It is designed in this way to work on inclined and slippery surfaces. A control strategy is formulated to navigate, the robot in the required path using an appropriate feedback mechanism systems. The battery voltage of the robot is determined periodically and if it goes below, then it returns to the docking station and charges itself automatically using power drawn from the solar panels. It is robust, commercially viable product, which provides a simple, cost-effective solution to the clean small solar panels.

Cooling Technique

Photovoltaic panels get overheated due to the excessive of solar radiation and high ambient temperatures over heating reduce the efficiency of the panels. The ideal *P–V* characteristics of a solar cell (panel) for a temperature variation between 0 °C and 75 °C are shown in Fig.3.The *P–V* characteristic is the relation between the electrical power output *P* of the solar cell to the output voltage, *V*, while the solar irradiance, *E*, and module temperature, T_m, are kept constant. The principle of this technic's is to maximum power output from the solar cells decreases as the cell temperature increases, as seen in Fig.3. This indicates that, heating of the PV panels can affect the output of the panels significantly.

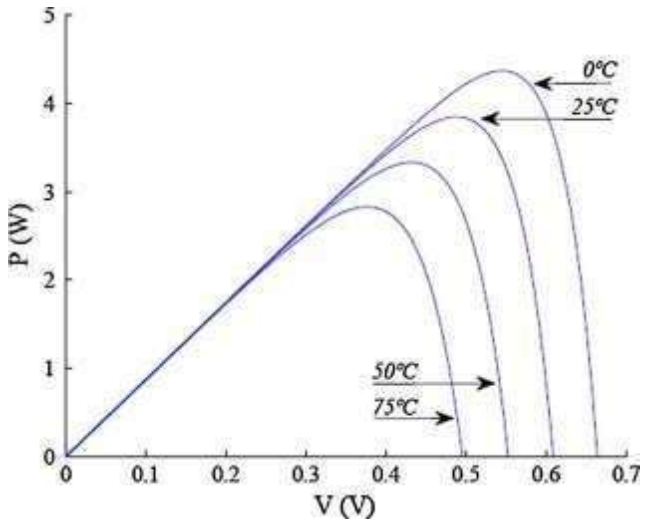

Fig .3 P V characteristics of solar cell

Hybrid Photovoltaic/Thermal (PV/T) solar system is one of the most popular methods for cooling the photovoltaicpanels.Nowadays shown in fig4.

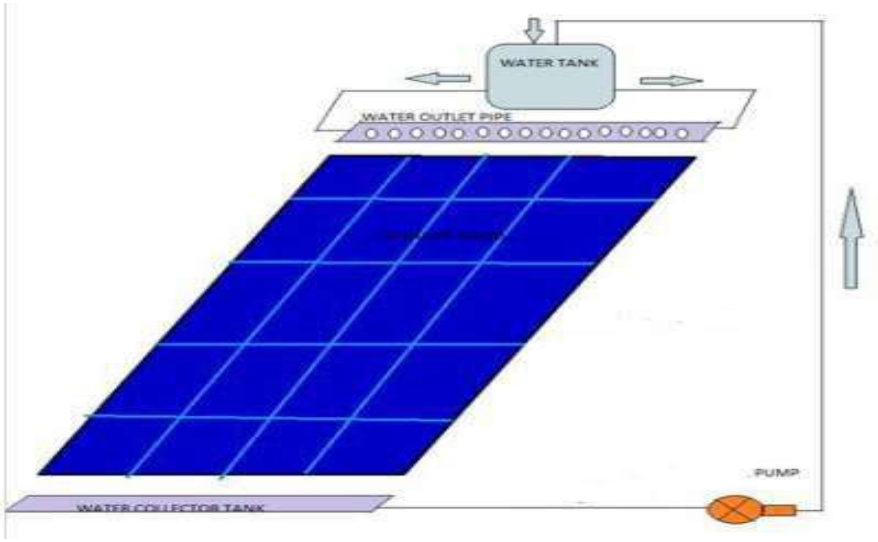

Fig 4 PV hybrid systems

The hybrid system consists of a solar photovoltaic panels combined with a cooling system. Water is circulated around the PV panels for cooling the solar cells, and the warm water leaving the panels pump back to water tank. Warm water mixed with cool water of tank.

It is concluded that the cooling system could solve the problem of overheating the solar panels due to excessive solar radiation and maintain the efficiency of the panels at an acceptable level by the least possible amount of water.

1.1 Antireflective Coating (ARC)

When light strikes the silicon cells, packets of solar energy are absorbed and converted into electrical energy. Because bare silicon plate has a high refractive index, more than 35 % of incident light is reflected away from the panel's surface before it can be converted into usable energy.

1.2 Solar Cell Device

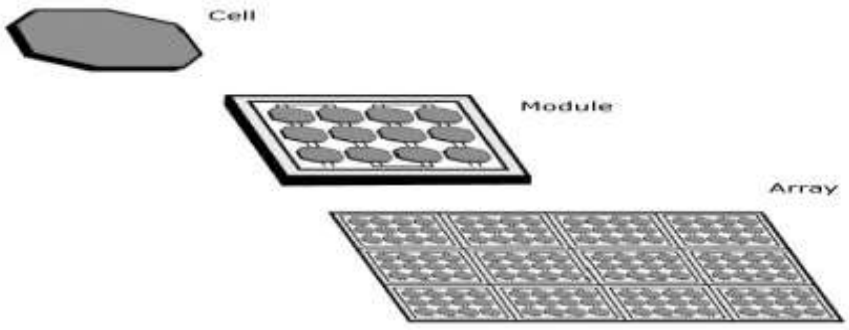

Fig.2.2.1 Basic Structure of solar cell, solar module and solar array

A photovoltaic system is the system which uses one or more solar panel to convert light energy to electricity. It consists of multiple components including the photovoltaic modules, mechanical and electrical connections and mountings to regulate electrical outputs.

The basic component used in photovoltaic system is solar cell. PV cells are made of semiconductor materials such as silicon. For solar cells, a thin semiconductor wafer is specially treated to form an electric field, positive on one side and negative on the other. When light energy strikes the solar cell, electrons are knocked loose from the atoms in the semiconductor material. If electrical conductors are attached to the positive and negative sides, forming an electrical circuit, the electrons can be captured in the form of an electric current that is electricity. PV cells can either in rectangular shape or in circular shape. As the solar cells generates the voltage around 5V, these solar cells can be grouped together to form solar module. The solar modules are generally flat. Also they are available in various ranges of heights and widths. These solar modules can be grouped together to form photovoltaic array. The panels can be connected in series and/or parallel depending on the design of array. To avoid reverse current ,separate diodes are required .Also, separate diodes are required in case of partial and complete load shedding and also in night period. The solar module is rated by the DC output power. This rating is given by standard test conditions. Solar panels are usually used in residential, commercial, institutional applications and light industrial application.

II. CONCLUSION

The reasonable quality and effective utilization of solar energy is an important way which can deal with the global energy crisis at present. Photovoltaic cell, which converts sunlight in to electrical current, without any form for mechanical or thermal interlinks. So the study on improving the efficiency of solar panel is very necessary, I have proposed several methods (using solar tracker, cleaning dust from panel, cooling technique of panel, using anti-reflecting coating etc.)to improve the efficiency of solar panel, Practice has proved that the use of these above methods can effectively improve the efficiency of solar power generation.

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