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METHODS OF IMPROVING THE EFFICIENCY OF ROOFTOP SOLAR PANELS

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ABSTRACT

In this paper we will discuss the methods of improving efficiency of roof top solar panel. The problem associated with the decreasing efficiency, maintenance, and the degrading solar panel. A special focus is given on increasing the efficiency of solar panels that are already in use since few years. Various methods of increasing the efficiency are also discussed. We have described in detail about the need of increasing the efficiency and the problems related with degrading efficiency. The importance of solar energy and benefits are also discussed. The calculation of efficiency with the degraded and normal efficiency are also shown.

Keywords: Solar energy, solar panel, panel efficiency, cooling technique, solar tracker, dust cleaning

I. INTRODUCTION

Gradual increase in the demand of energy results in depletion of non-renewable energy sources thereby increasing the need of renewable energy source. India is going through a power crisis with its major dependency on coal, crude oil imports to meet the sharply growing energy needs thus solar energy comes in power. The solar energy is clean and abundantly available in nature. Solar technologies use the sun to provide heat as well as electricity, etc. The photovoltaic (PV) cell convert sunlight to electrical current without any form of mechanical or thermal interlink. The PV cell generates DC voltage and Power depending on the temperature and solar irradiation received. The Efficiency Depends on various factors such as temperature, solar intensity, radiation received and dust which decreases the efficiency etc. The degradation of PV module is inversely proportional to power and efficiency that is the more the degradation the less will be the power produced, less the efficiency and therefore reduces future cash flow. Various methods such as solar tracking, dust cleaning and cooling techniques can be used to increase the efficiency of solar panel. The solar tracker continuously tracks sunlight throughout the day to get maximum solar energy, Dust cleaning technique removes the dust that act as barrier between the solar panel and sunlight and the cooling technique reduces the rate of thermal degradation by reducing the operating temperature.

1. Solar Tracker

Solar tracker directs the panels towards the direction of sunlight. These devices follow the sun's path throughout the day by changing their orientation and captures maximum energy. In the photovoltaic (PV) system the solar trackers help in minimizing the angle of incidence between the panel and the incoming sunlight thereby increasing the amount of energy that is produced by the system. The motors and gear trains direct the solar tracker by the help of a controller responding to the direction of sunlight. The photovoltaic (PV)

system receives sunlight into the cadmium sulphide (CdS) which acts as a main solar tracking sensor. It feeds back to the micro controller that is field programmable gate array (FPGA) controller through an analog to digital (A/D) converter. The processor unit is the main control unit that adjusts the two-axis motor, so the platform is optimally located for efficient energy generation.

Selection of solar tracker depends on various factors such as system size, land constraints, latitude, weather etc. The large projects usually use horizontal single axis tracker while smaller projects use dual axis tracker. The use of solar tracker can increase the efficiency by at least around a third.

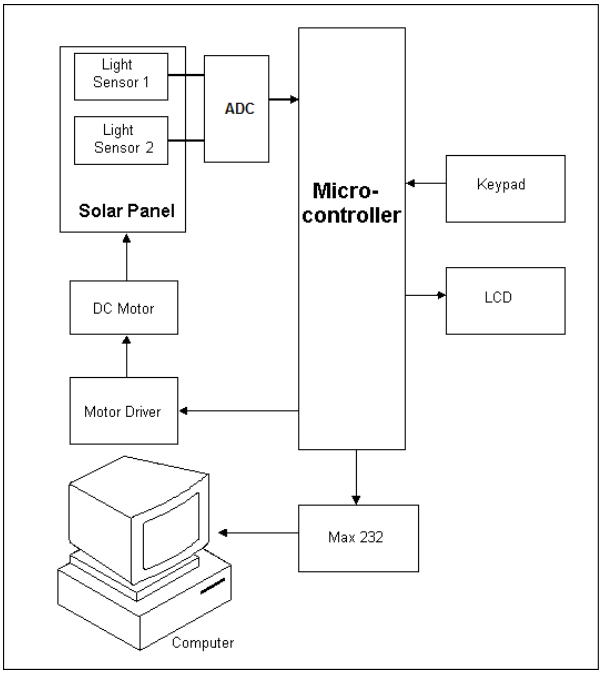
a) Single Axis Tracker:

It has only one axis of movement usually aligned with north and south. This allows the panels movement from east to west tracking the sun from the direction it rises till the direction it sets.

It comparatively costs less than dual-axis tracker and is often considered more reliable and have a longer lifespan as there are very few moving parts. However, it has a very low energy capture capacity thus decreasing its efficiency. This is further split into centralized and decentralized tracker type. Centralized tracker uses a single motor to power a driveline between row which moves an entire segment of solar panel but decentralized system have one motor per tracking rows.

b) Dual Axis Tracker:

It has two axis of movement aligned with North-South and East West giving it a wide range of coverage of sunlight. It can optimize the amount of solar energy captured. It comparatively is more expensive due to the higher degree of mechanically moving part, it also requires more maintenance and have a lesser lifespan. These are used mostly in residential and smaller commercial application.



2. Dust Cleaning:

The electrical parameters related to the solar panel are very sensitive to any foreign particles, so it becomes extremely important to employ an auto cleaning mechanism to ensure the high performance of the solar panel. Dust is lesser-acknowledged factor that affects the performance by a very high margin it prevents the sunlight from directly reaching the photovoltaic (PV) cell in the solar panel due to this the efficiency decreases. Dust cleaning can be done by using three different techniques rugged robot, self-cleaning and robotic vacuum cleaner.

a. Rugged Robot:

The solar panel loses about 0.4-0.8% of efficiency per day due to the dust that accumulates in it. The cleaning of dust regularly by human effort is a difficult task on various level. A robot can be employed to clean the solar

panels; each robot is assigned with a row of panels the robots work in parallel thus saving time and the loss of efficiency.

b. Self-Cleaning:

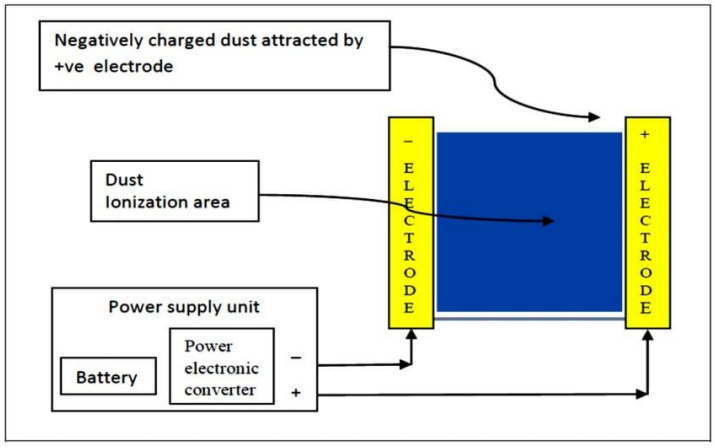
This technology covers the panels using the deposition of transparent, electrically sensitive material on glass or plastic sheet. Sensors monitors the dust level and when it becomes high, energizing of the sensor takes place the electric charge created sends a dust repelling wave over the surface thus lifting the dust and shedding it to the corner. By approx. 2 minutes almost 99% of the dust on the panel is removed.

c. Robotic Vacuum Cleaner:

There are two subsystems present in this system one is robotic vacuum cleaner and the other is docking station. It uses two stage cleaning process to remove the dust from solar panel. Designed to work on slippery and inclined surfaces. A control strategy is used to navigate the robot in a predefined path using an appropriate feedback mechanism when the battery goes down a specified level the robot is to return to the docking station and charged using energy received from the solar panel. A rolling brush is attached in front of the robot in order to collect the dust and carry it to the vacuum cleaner. A high-speed motor is used to suck the dust from the panel.

d. Electrostatic Precipitator:

It works with non-contact mechanism preventing scars and scratches like marks in the panel. It is a filtration device, which uses the force of induced electrostatic charge to remove the dust particles. The mechanism consists of electrodes which are charged suitably, the electrodes obtain power through relay when the controller signals after obtaining the weight of the panel after the comparison of the weight then the negative electrode induces negative charge on the dust particle thus the dust particle gets attracted by the positive electrode. This way the dust cleaning of the panels is done without any contact.



3. Cooling technique:

The solar panels tend to overheat due to excessive solar radiation and high ambient temperature. Overheating of the panels can reduce the efficiency of the panel by approximately decreasing by 0.4- 0.5% per rise of 1

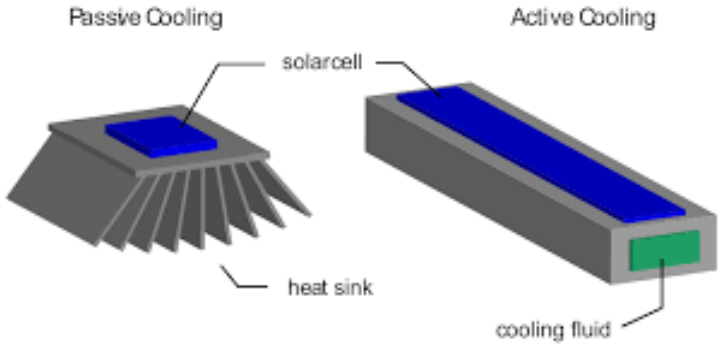
degree Celsius over its standard test condition (STC). Cooling can improve the efficiency and reduces the rate of thermal degradation by reducing the operating temperature. The different methods are active cooling system and passive cooling system.

a) Active Cooling System:

It requires additional power assistance to provide power to pumps, fans and fluid flow. It uses the help of input power and reduces the temperature of solar cell by approximately 7.5 degree Celsius. However, a disadvantage requires additional cooling component requiring power source. Fans can be used for cooling of solar panel the power requirement of fan can be met by the electricity generated by the solar cells.

b) Passive Cooling System:

It does not require additional power source. A heat sink can be used for the cooling of the panel or cooling the panel using water. The heat sink will prevent the rise of temperature, use of fins also ensures effective decrease. The use of fins increases the efficiency by approximately 1.8% higher than without fins. Heat sink are designed using material that have high ability to absorb and dissipate heat. Copper heat sink with additional aluminum fins have been found to reduce the working temperature by 6.1 degree Celsius and electrical efficiency by 1.77%.



II. EFFICIENCY OF PANEL

The more efficient the panel the more energy it will generate. Most solar panel provides energy efficiency rating between 11 and 15 percent which is the percent of solar energy that is converted into useable electricity. Considering that the efficiency of the panel is increased by approximately 2 % by employing any of the above technique the efficiency will then be:

Assuming the data as

1) The total solar units generated throughout the year =131228 KWh

2) Radiation received in the area = 5.5 KWh/m^2 (approx.)

Therefore for 365 days = 5.5 * 365 = 2007.5

3) Area of solar panel = 3ft * 6ft = 0.914m * 1.829m =1.671 sq. m

Assuming 320 panels = 1.671 * 320 = 535(approx.)

$$\text{Efficiency of rooftop solar Panel} = \frac{\text{Total units generated by solar panel in a year}}{\text{Radiation received in the area in Kwh/m2}} * 100 = \frac{131228}{2007.5 * 535} * 100$$

$$= 0.12218 * 100$$

$$= 12.21\%$$

If the efficiency is increased by approximately 2% the new efficiency will become 14.21%.

Thus, the increase in efficiency will also result in increase in saving by increasing the solar units generated.

III. CONCLUSION

The increase in energy consumption leads to the high electricity demand but the depleting nonrenewable resource resulted in increase in renewable sources. The increase in use of solar energy demands effective

conversion of sunlight into electrical energy employing any of this method will ensure the effective conversion. Using these methods will also ensure saving. Every method has their own advantages and disadvantages but the increase in efficiency is assured.

IV. REFERENCES

[1] Castaner, L.,Silvestre, S.: Modeling Photovoltaic Systems Using PSpice. John Wiley and sons, West Sussex (2002).

[2] M. Catelani, L. Ciani, L. Cristaldi, M. Faifer, M. Lazzaroni, M. Rossi, "Characterization of photovoltaic panels: the effect of dust" c 2012 IEEE.

[3] Shaharin A. Sulaiman, Haizatul, H. Hussain, Nik Siti H. Nik Leh, and Mohd S. I. Razati, "Effect of dust on the performance of PV panels" World academy of science, engineering and technology 58 2011 PP 589.

[4] Islam M D, Alili A A, Kubo I and Ohadi M 2010 Measurement of solar energy (direct beam radiation) in Abu Dhabi, UAE J. Renewable Energy 35.

[5] Effect Of Dust On The Performance Of Solar PV Panel Dayal Singh Rajput1, K. Sudhakar2 1,2Department of Energy, MANIT, Bhopal, India.

[6] Aravind G, Gautham Vasan*, Gowtham Kumar T.S.B, Naresh Balaji R G. Saravana Ilango National Institute of Technology - Tiruchirapalli Tiruchirapalli – 620015.

[7] K.A. Moharrama, 1, M.S. Abd- Elhadyb, H.A. Kandila, 2, H. El-Sherifa 3, Enhancing the performance of photovoltaic panels by water cooling.