

Solar Panel Cleaning Mechanism for Better Efficiency

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ABSTRACT

Solar energy is tremendous available as a most important energy source. The solar cells are used for many applications, including street lights to generate luminescent night. The accumulation of dust particles, deposits left by birds or the fallen leaves, on the surface of photo-voltaic PV panel will reflect the incident light falling on the panel, preventing a portion of the radiation from being used. This problem could reduce the ability of cells to allow free entrance of photons and absorb solar energy, which greatly affects its efficiency, reducing the lifetime of its storage power after a few months from its instillation, leading to a permanent or long-term failure, especially in the desert areas. Other factors such as panel orientation or panel surface material can contribute to the deposition of the impurities. Here in this work it find out the effect of cleaning of solar panel on the efficiency of the solar plate. It calculates the efficiency of solar panel before cleaning and after cleaning, it also calculate the effect of different parameters responsible during the cleaning of solar panel. The parameters responsible for cleaning are feed speed, roller speed, feed depth, no. of pass of roller. Through experiment it is found that the value of efficiency for all isolation is maximum in case of solar panel without dust.

KEYWORDS: solar panel, solar efficiency, cleaning device, wet cleaning, dry cleaning.

INTRODUCTION

Global warming is considered one of the greatest challenges that humanity has had faced on Earth[1]. A rise in temperature of 2 °C can cause so many complex, intertwined and irreversible problems such as water scarcity and stress, increasing sea levels, leading permanent flooding of almost all coastal regions on the Earth, extinction of various animal

species, increase in the heat extremes and heat waves that would lead to inhabitability in many regions. A key solution for this grand challenge is reducing, if not eliminating, the harmful effects of human activities such as the burning of fossil fuels for energy needs in transportation, manufacturing, buildings, heating, and cooling. Energy has been one of the fundamental requirements of life, surpassed only by water and food. Energy obtained via burning fossil fuels releases significant amounts of CO₂, SO_x, and more hazardous chemicals into our atmosphere, which is not only harmful to the living creatures exposed to them but are also the main cause for global warming. Energy generation using clean sources and improvement of energy efficiencies are considered as the key mitigation strategies to overcome the global warming challenge. Renewable energy sources, particularly, solar energy have huge potentials to be converted into a useful form of energy in a much cleaner way than fossil fuels.

Solar panels having the ability to absorb the sunlight as a source of energy to generate electricity or heat. And it is designed in such a way such that maximum output has to be obtained whether it is used to generate electricity or any other purpose. The direct conversion of solar energy into electrical energy is performed by means of photovoltaic (PV) generators. A PV cell is a semiconductor p-n junction photodiode that can generate electrical power when exposed to light.

Generally, the term photovoltaic effect refers to the generation of a potential difference at the junction of two different materials in response to visible or other electromagnetic radiation.

FACTORS EFFECTING THE EFFICIENCY

A. Effect of Humidity with Dust

Kazem et al studied the effect of relative humidity on the performance of the Photovoltaic (PV). Three types of PV (Polycrystalline, Monocrystalline and Amorphous Silicon) were tested in this investigation. PV system connected to measurements humidity, current and voltage. The results showed that the output current, voltage, and power increase with low relative humidity. The efficiency of the PV is high when the humidity low[2]. Hence low relative humidity enhances the performance of PV systems.

B. Effect of Temperature with Dust

The effect of operating temperature on the performance of amorphous Silicon (a-Si) solar cell modules under practical operating conditions was investigated by Astawa in 2007. The power production drop dramatically from autumn to winter period and the performance of solar cell modules also down about 65% of their initial performance in the same period[2].

In 2009 Erel used thermoelectric cooler to compare between the performance of solar cell before and after cooling. The result indicated that the decrease in solar cell temperature about 15 °C causes a gradual increase roughly to 0.01 volt for each (4Cm×4Cm) solar cell.

The investigations found that PV output power affected by ambient temperature. The more clean and cool PV the high power generated and more efficiency.

EFFECT OF DUST ACCUMULATION ON PV MODULE

Generally solar power plants located on a very arid region that has frequent dust storms and dusty conditions. Deposits of dust on the surface of PV module blocks the solar irradiation from reaching cells through the glass cover. The density of deposited dust, its composition and particle distribution, can have an impact on the power output and current voltage and characteristics of PV modules. During the course of the study, it was observed that there is atmospheric dust that scatters the solar radiation, in addition to dust deposits on PV surface, which also blocks PV module from direct solar radiation. The study concluded that long period of PV module exposure to real outdoor conditions gradually decreases power output if no cleaning is performed to remove the dust.

What is Dust?

Dust is defined as the minute solid particles less than 500 µm in diameter. Minute pollens such as bacteria and fungi, and microfibers separated from clothes, carpets and fabrics are also known as dust when settled on surfaces. Dust deposition is a function of various environmental and weather conditions.

NEED FOR CLEANING

The efficiency of the solar system is calculated on the basis of formula mention in the below section [3]

$$\eta_{max} = P_{max} / E \times \text{Area of collector}$$

Where η_{max} is the maximum efficiency of the solar system, P_{max} is the maximum power generated by the solar panels, E is the incident radiation or insolation.

Before Cleaning

The value of isolation and efficiency of the solar panel having dust on the surface is mention on the Table 1 and the same values for the solar panel after cleaning are shown in Table 2.

Table 1.

Sl. No.	Insolation W/m2	Efficiency (%)
1	20	7.16
2	40	8.38
3	60	12.08
4	80	11.54
5	100	10.63
6	120	10.4
7	140	9.63
8	160	9.2
9	180	8.92
10	200	8.78

Table 2.

Sl.No.	Insolation W/m2	Efficiency (%)
1	20	10.25
2	40	11..32
3	60	14.59
4	80	15.24
5	100	17.12
6	120	13.53
7	140	11.89
8	160	11.41
9	180	10.44
10	200	9.27

From the Fig.1, it can be observed that, the solar panel with regular dust roller cleaning with the help of roller mechanism (Fig.2) can increase the annual energy production by up to 15%.

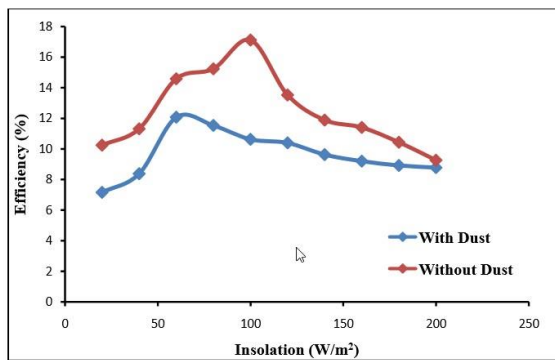
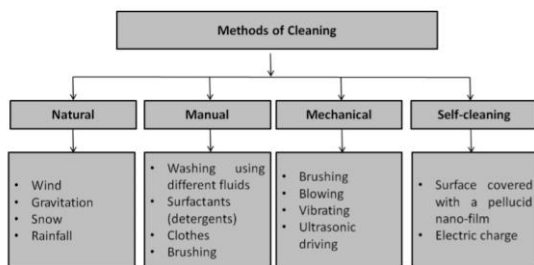


Fig. 1. showing the comparison of efficiency

METHODS OF CLEANING



Natural Cleaning

Rainfall is considered to be the most efficient natural cleaning agent for eliminating particles from PV surfaces, as it naturally re-establishes the performance of the modules.

However, light rainfalls may not clean the panels and could make performance worse nature can be the most effective and least costly cleaning agent for dust problems. The natural cleaning effect of rain and snow has been observed by the authors in numerous studies in different parts of the world. Generally, the rain washes away dust and soiling restoring collector performance to nearly original capacities[4].

Manual Cleaning

The most commonly used method of manual cleaning for PV panels in small-scale installations uses tap or distilled water (frequently mixed with detergent) and a soft wiping cloth.

For large-scale PV plants, high-pressure water jets and brushes are commonly used. Manual cleaning is similar to the method used to clean windows of buildings. Special brushes are used to prevent scratching the surfaces. In addition, some brushes are connected directly to a water supply to wash and scrub at the same time[5].(Fig.3)

PROPOSED METHOD OF CLEANING

Among many methods of cleaning the wet cleaning said to be more efficient and economic as shown in Fig.3. In general, dry cleaning is less effective than wet cleaning. The first reason is that water or other chemicals involved in wet cleaning serve as a medium through which dust layers containing salt or similar chemical deposits can be dissolved. The fluid also serves as a medium through which these particles can be transported away from the PV module surface. But the drawback of the wet cleaning is heavy wastage of the water which makes it difficult to use in places where availability of water is the big obstacle.



Fig.2 showing dry cleaning using rollers



Fig.3 showing Wet cleaning

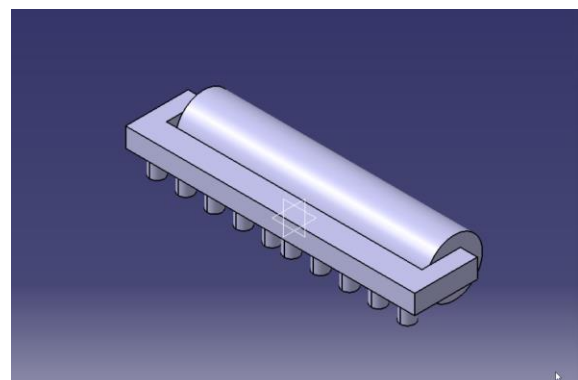


Fig.4 showing combined model of the dry and wet cleaning.

This paper proposes combined method, i.e., dry cleaning and wet cleaning method to clean the panels more efficiently irrespective of the place or season and is shown in the Fig.4. By combining both the

methods the drawbacks of the wet and dry cleaning will be compensated to get the more efficiency and increase in the lifespan of the solar panel.

CONCLUSIONS

In this proposal the use of the filter to recycle the used cleaning water, as the water without the dust particles increases the lifespan and recycling helps to meet the need of water. To be precise in dry cleaning microfibres are used, which are light in weight and absorbs the water efficiently. To increase the productivity it can be made automated and working hours can be set only after the sunset. This automation can avoid plant disruptions -crews deploy at night to avoid energy producing hours.

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