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# Effect Of Dust On The Performance Of Solar PV Panel

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**Abstract:** Research and development in photovoltaic (PV) systems has usually been concentrated in studies on radiation availability,efficient operating strategies ,design ans sizing of these systems. On the other hand, the influence of dust on the performance of PV systems has not been given much attention. In this work, electrical performances of Photo-voltaic panels are studied experimentally for the effect of deposited dust particles. The experimental data are used for the calculation of the energy efficiency and power output of the PV systems. It was concluded that dust significantly reduces the efficiency of solar photo voltaic panel.
**Key words:** Dust ,performance of Solar PV panel, Effect of Dust.

## Introduction

Now a days, energy-related aspects are becoming extremely important. They involve, for instance, a rational use of resources, the environmental impact related to the pollutants emission and the consumption of non-renewable resources. For these reasons there is an increasing worldwide interest in sustainable energy production and energy saving. Among the technologies that could play a role in the generation of sustainable and widespread energy, interesting solutions are represented by photovoltaic (PV) cells, wind generators, biomass plants and fuel cells. In particular, photovoltaic systems can be considered one of the most widespread solution with significant margins of improvement while ensuring the generation of energy with low environmental impact.

The research activity and development in PV field has usually been focused on solar radiation analysis, efficient operating strategies, design and sizing of these systems. Previous papers analyze the PV module in terms of panel modeling and I-V characteristic. However, in these works, critical aspects and external conditions that could involve the PV system are not taken into account. Solar cell efficiency is an important input parameter in PV-powered product design. Often, only limited space is available for the solar cells to be integrated. Cell efficiency can even become a criterion of principal system feasibility. As a basic parameter, cell efficiency serves as an input in calculating the optimal system configuration, e.g., as a cost related trade-off between the storage unit and its lifetime, PV size and its efficiency, and finally the demand side (with correlated consumption profiles). Although these calculations are well known for autonomous PV systems, e.g. (Castaner and Silvestre, 2002)[1], device integrated PV systems, especially when used indoors, become more complex to model. Power measurements of PV modules in test laboratories and industry are usually performed with solar simulators. Dust is the lesser acknowledged factor that significantly influences the performance of the PV installations[2]. Few studies analyzed this effect and the consequent efficiency degradation. Current research on

PV system performance and the effects of the deposition of dust is limited due to the fact that powder is a complex phenomenon that is influenced by different environmental and weather conditions[3]. A brief schematic representation of the factors that determines the settling of dust on the PV panels is shown in setup of experiment. A detailed analysis of the influence of dust on the PV modules performance is proposed in this paper. Based on all these information the effects of the dust on the PV panels electrical performances have been highlighted. During the study of the performance of solar pv panel with and without, then the following factors considered:

1. Solar Radiation v/s Time characteristics.

2. Ambient Temperature v/s Time characteristics.

3. Panel efficiency v/s Time analysis with dust.

4. Panel efficiency v/s Time analysis without dust.

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## Experimental Methodology

The experiment is conducted by using the two 36w solar panel mounted on a stand. The electrical parameters like voltage & current have been measured to study the effect of environmental dust effect[4,5]. The net effect of dust on the power reduction was evaluated & analyzed. The effect of dust can be quantified by comparing the efficiency of panel exposed to dust & without dust. In this work, the system of measurements is consists of a silicon solar panel of area $0.404m^2$, a dc voltmeter for measurement of generating voltage, a dc ammeter for measurement of producing current, and also a suitable load resistance. The experimental study was done in the Central region of India. The latitude and longitude of the location are 23°25 N and 77°42 E[6,7]. The ambient temperature fluctuates in the range of 5 to 48 ºC during a year in Bhopal. The solar photovoltaic panel was tested and the parameters like $V_{oc}$, $I_{sc}$, solar irradiance, and ambient temperature etc. needed for the evaluation of the systems were measured at interval of one hour between 9.00 and 18.00. The ambient temperature and the incident solar radiation intensity was measured using thermometer and portable Solar Power meter respectively[8].

**Fig.1 - Experiment Setup**

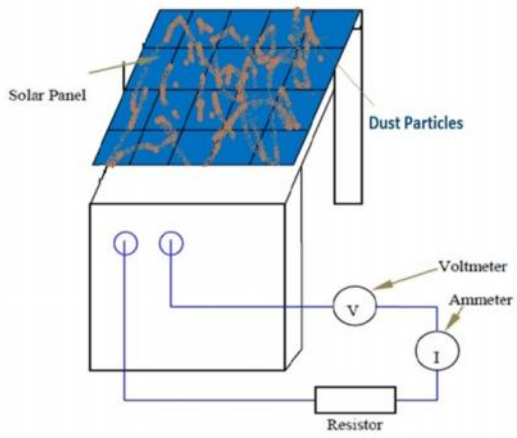


**Fig.2 - Block Diagram**

**Table I: Specification of the PV module**

| | |
|---|---|
| Model | Tata BP 184459 |
| Maximum power | 36W |
| Open circuit voltage | 18V |
| Short circuit current | 2A |
| Number of cells | 36 |
| Dimensions | 950×425×35 mm |
| Weight | 6 kg |
| Fill factor | 0.85 |

Power output (watt) $P_o=V_{sc}*I_{sc}*FF$

We calculate the solar panel efficiency (%) by the following formula:[9]

$$\eta = \frac{V_{oc}*I_{sc}*FF}{A*I}\times 100$$

Where,

$V_{oc}$ -Voltage of electricity produced (volts)
$I_{sc}$ – Electrical current produced by the solar PV panel (Ampere)
FF- fill factor
A- Area of solar panel (cross-section of panel)
I- Intensity of Solar Radiation ($W/m^2$)

$$\% \text{ reduction in power} = \frac{P_{without\ dust} - P_{with\ dust}}{P_{without\ dust}}\times 100$$

$$\% \text{ reduction in efficiency} = \frac{\eta_{without\ dust} - \eta_{with\ dust}}{\eta_{without\ dust}}\times 100$$

## Results and Discussion

The data obtained for Solar Radiation v/s Time characteristics, Ambient Temperature v/s Time characteristics, Panel efficiency v/s Time analysis with and without dust curve for the silicon solar panel under investigation shown in fig.3,4,5,6 respectively. In the summer, the sun appears higher in the sky, which increases the duration of sunlight seen in a day, and in the winter it appears lower, which decreases the length of sunlight in a day. The sun is highest in the sky on the summer solstice. The min and max temperature was found to be 29.6 to 36.8℃. The maximum and minimum solar radiation intensity was found to vary between 985 & 210 $W/m^2$.

To be more exact, it is 23.45º higher than on the equinox, or at 40 - 23.45 = 16.55º to the south of vertical so it got the max solar radiation on the panel. The performance of a solar panel is necessary to describe the electrical parameters of the cell. The $V_{oc}$, $I_{sc}$, fill factor, η estimate. From the previous study we saw that by making solar PVs pointing dynamically toward the sun we maximize the amount of radiation received, and we can increase output power upto maximum limit.

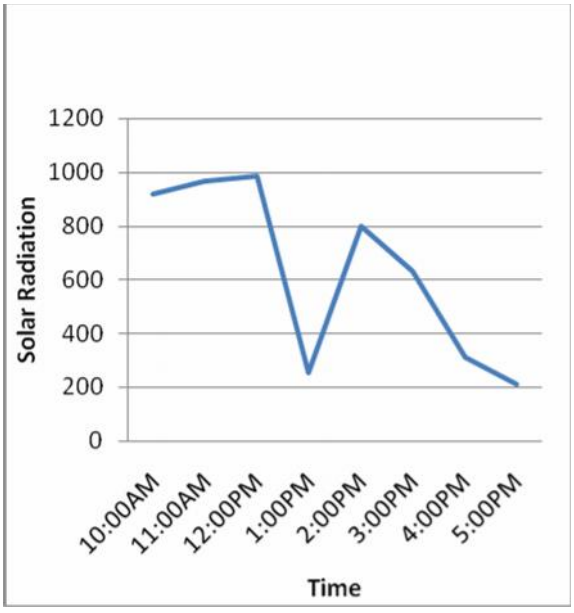


**Fig3- Solar Radiation v/s Time characteristics**

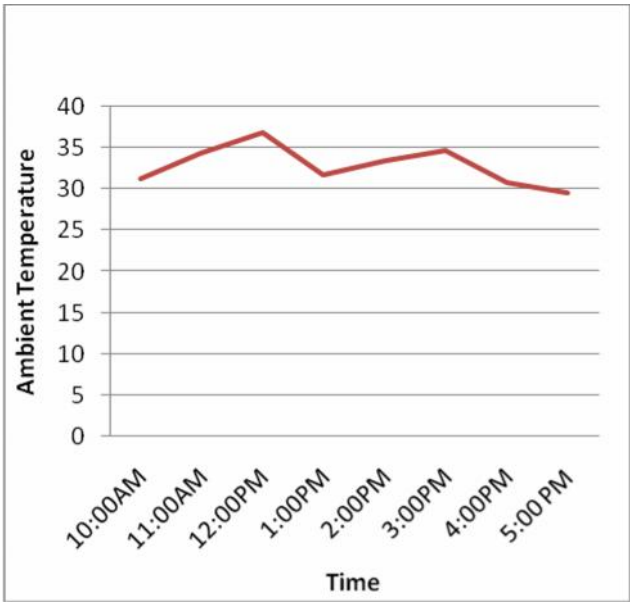


**Fig4- Ambient Temperature v/s Time characteristics**

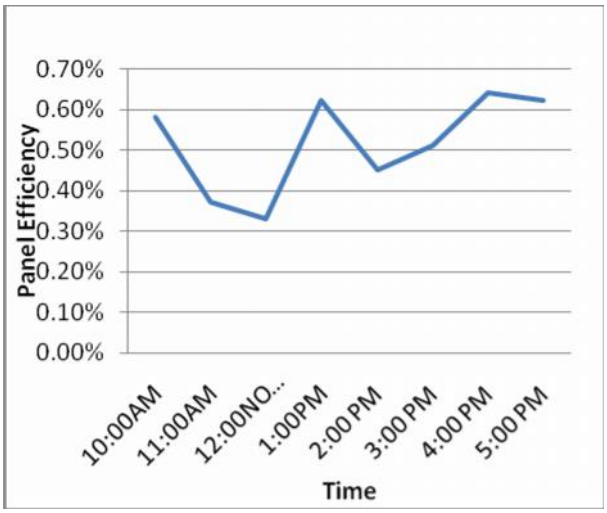


**Fig5- Panel efficiency v/s Time Characteristics With dust**

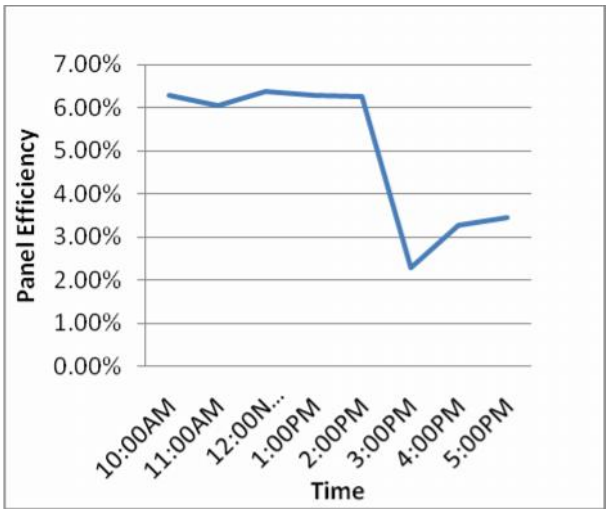


**Fig6- Panel efficiency v/s time characteristics without dust**

## Conclusion

In this paper, the performance of solar photovoltaic panel subjected to environmental dust was experimentally studied. The effect of dust on the power reduction and efficient reduction of PV module was quantified. From the graph we can see that we get the maximum efficiency 6.38%, minimum 2.29% without dust & maximum efficiency 0.64%, minimum 0.33% with dust. The result shows that dust considerably reduces the power production by 92.11% and efficiency as 89%.

The electrical parameter of solar panel are sensitive to the dust density so it is very essential to provide auto cleaning mechanism to remove the dust particles from the surface of the panel in order to ensure high performance.

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