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Experimental Study on the Effect of Dust Deposition on Solar Photovoltaic Panel in Jaipur (Rajasthan)

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Abstract: ***In this paper we are going to discuss the effect of dust deposition on the solar photovoltaic panel. The dust deposition on solar photovoltaic panel has significant effect on the performance, efficiency of the panel and power production. With the passage of time the density of dust on the panel increases. And this reduces the short circuit current (Isc) and open circuit voltage (Voc) .To show the effect of dust deposition we perform the experiment in artificial sun (using halogen lamp). From the data we obtained in our study, we are able to conclude that there is a reduction in power production up to 31.1% and efficiency of the solar photovoltaic panel system is reduced to 5% from 7.2% and reduction of short circuit current can be seen up to 27.24%.***

Keyword: Dust, Solar photovoltaic panel, photovoltaic effect, halogen lamp, experimental set up

1. Introduction

To convert solar energy into electricity, solar photovoltaic panel is used. The photovoltaic effect of solar radiation is responsible for this conversion. In this, direct current is produced because the exposure of solar radiation to the solar panel is continuous. In recent years due to technological advancement, the use of solar photovoltaic panel is increased. The efficiency of this system is quite low and these are costly as well to manufacture and install. So for the proper working and to get the maximum power for the utilization, the proper maintenance is required. In this paper we have studied about the significant effect of the dust on the performance of the solar photovoltaic module. The dust deposition is a natural process because the use of panel is in the outdoor condition. The dust deposition reduces the amount of radiation which is falling on the panel and creates shadow effect. The radiation which is responsible for the power production and generation of power is reduced. So as the amount of radiation decreases by dust deposition, the power generation reduce.These attenuation depends upon the size of dust particle and density of the dust deposited as well.

2. Experimental setup and electrical Specification

Specification Of Solar Module	Rating
V_{oc} (open circuit voltage)	21.90V
I_{sc} (short circuit current)	2.45Amps
Rated current	2.30Amps
Rated voltage	17.40Volts
Maximum power point(MPP)	40 Watt
Temperature of module	25^oC
Area	$0.2m^2$
Halogen lamp	900Watt
Material of p-v panel	Polycrystalline

3. Experimental Working

In our study, to show the effect of dust accumulation on a solar photovoltaic module, we have done our experiment by keeping solar radiation constant. To keep the radiation constant which is falling on the p-v module, we use halogen lamp of 150watt each and total panel of halogen lamp contains six lamps. The total electrical power was 900 watts. The purpose of keeping the radiation constant is that if the radiation is varying then the effect of dust deposition on the panel will be not be determined very well. Throughout the experiment the radiation was $301.6w/m^2$ and it is measured by the solar flux meter. The potentiometer is used to vary the load (resistive) across the panel terminal. Voltage and current measured by the voltmeter and ammeter respectively, on the various load condition to plot the I-V characteristic and P-V characteristics and point out the power. There were reductions in power generation. The dust deposition on the panel collected to measure the density of various days. As the density of dust on the panel increases, dust deposition on the panel creates attenuation to the radiation falling on the panel and this attenuation increases with increment in the density of dust. This attenuation reduces the amount of the radiation which is mandatory for the working of the solar photovoltaic panel. The experimental work was conducted for 20 days to find out the data and to conclude its effect. The tilt angle of the photovoltaic panel with the horizontal was 0^o, it was placed on the flat surface for the 20 days. On the flat surface or at 0^o tilt angle the dust deposition is maximum and at 90^o the dust accumulation is minimum. The size of fine sand is 0.10-0.25mm which is the major part of this location in the soil.

a) Power control unit- all the equipment is installed in it this is one of the main part of experiment consist of voltmeter, ammeter, resistance temperature detector, potentiometer.
b) Solar panel.

c) Dust sample collector.
d) Weighing machine to measure weight of dust.
e) Halogen lamps.
f) Voltage controller to vary the intensity of the halogen lamp.

For day 1 when panel is clean

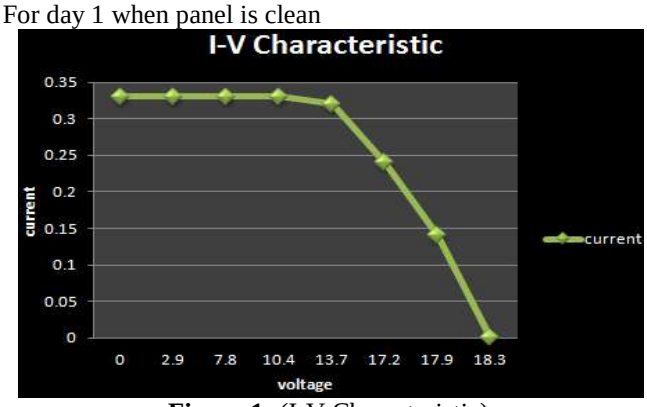

Figure 1: (I-V Characteristic)

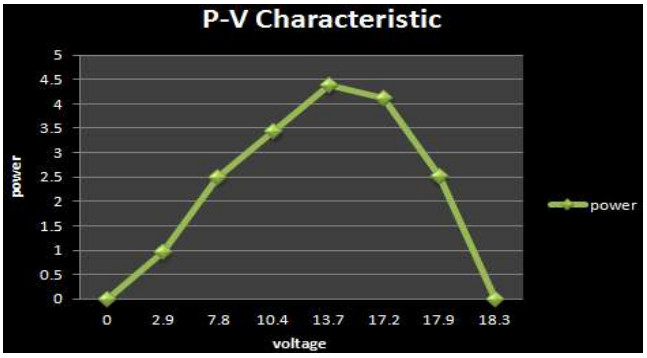

Figure 2: (P-V Characteristics)

For day 5 when some dust deposited and its density is 10g/m^2

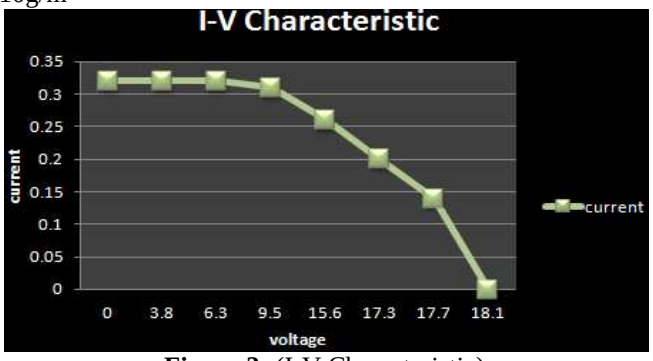

Figure 3: (I-V Characteristic)

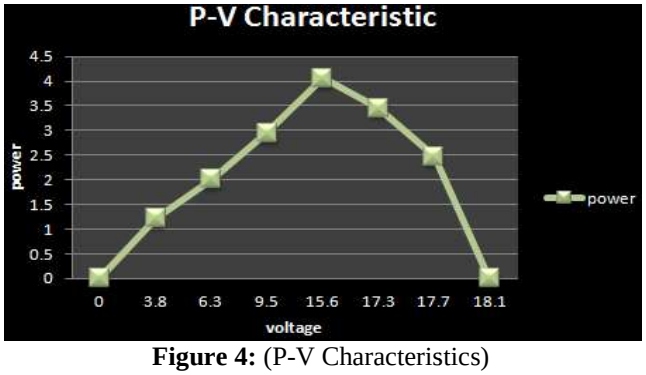

Figure 4: (P-V Characteristics)

For day 10 when the density of dust deposition is 20g/m^2

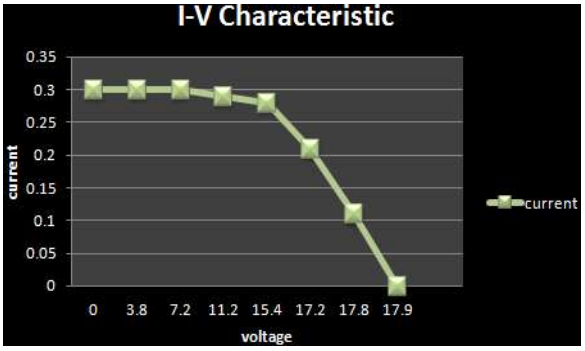

Figure 5: (I-V Characteristic)

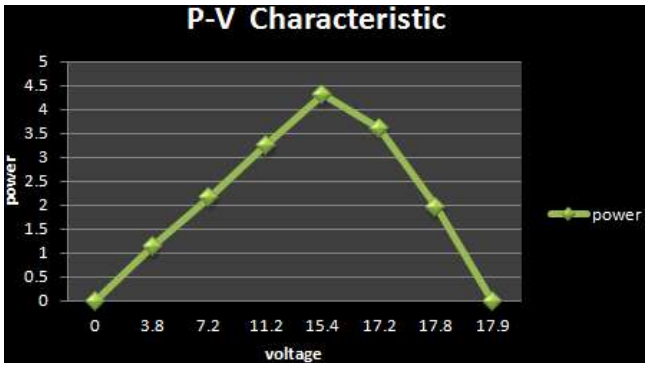

Figure 6: (P-V Characteristics)

For the day 15 the density of dust 50g/m^2

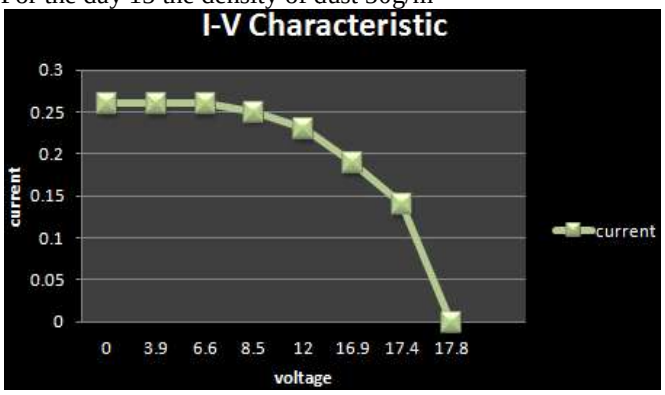

Figure 7: (I-V Characteristic)

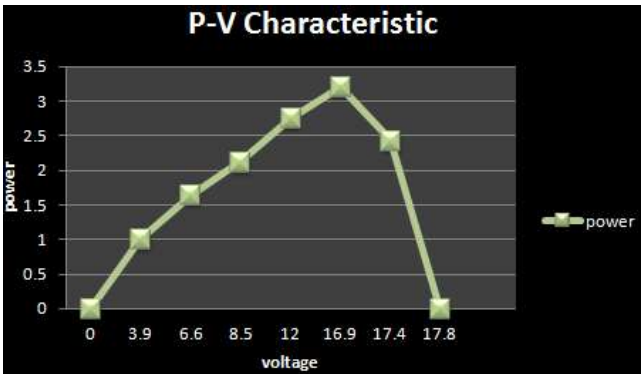

Figure 8: (P-V Characteristics)

For the day 20 the dust density 70g/m^2

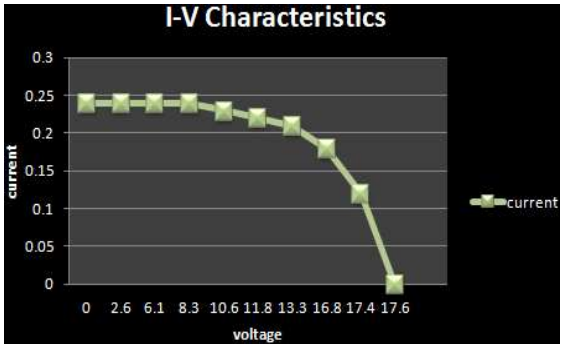

Figure 9: (I-V Characteristic)

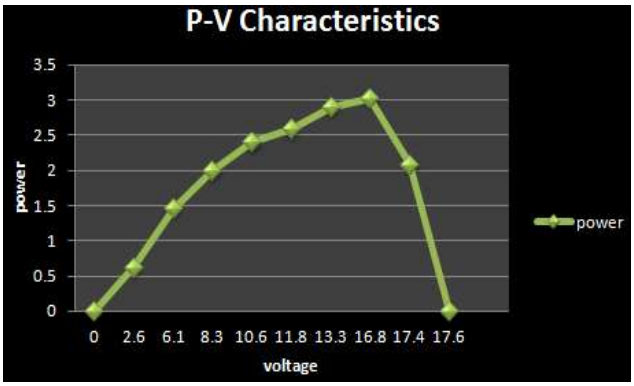

Figure 10: (P-V Characteristics)

Percentage reduction in short-circuit current

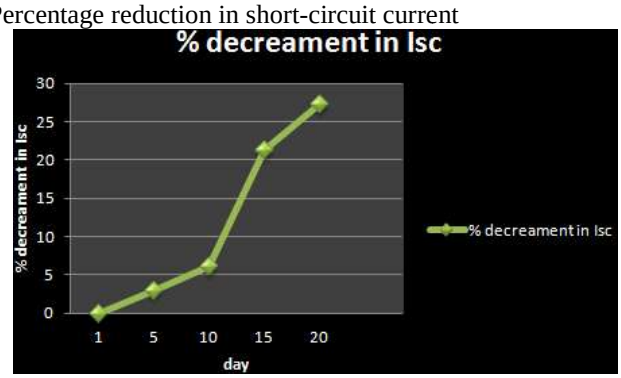

Figure 11: (I-Day Characteristic)

Percentage reduction in power generation

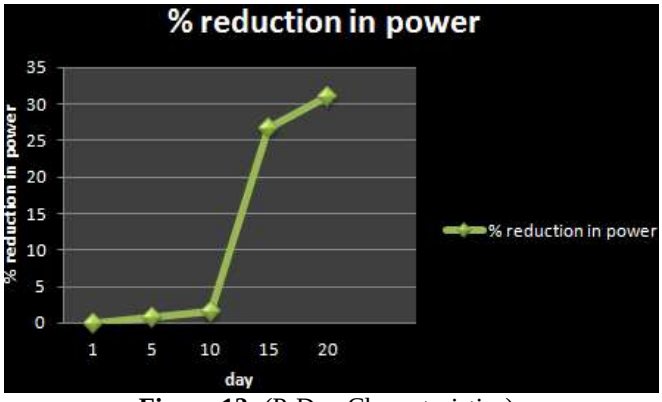

Figure 12: (P-Day Characteristics)

4. Result and Conclusion

The readings we found for the I-V (current- voltage) and P-V (power-voltage) characteristics of clean panel at day 1 and that obtained data compared with the I-V and P-V characteristics of data obtained for the day 5 ,day 10, day15 and day 20 respectively. The densities for different days were different. And it was found that reduction in power, short circuit current and open circuit voltage. And as the density of dust increases over the solar p-v panel then power reduced to 31.1 %.

5. Future Scope

So it is proposed that proper maintenance is important. Cleaning of panel in proper time interval is necessary. For the small level photovoltaic panel usage it can be cleaned manually and after some time. But for the large solar photovoltaic power plant where the area of photovoltaic panel is large and dust accumulation is large, manual cleaning is not possible there we can use some automatic mechanism having motor and wiper system which can be run once in a day (generally in the morning or when it is require to clean the panel) to clean the panel. After running that system panel will be cleaned and start producing desired power. Or some dirt repellent coating can be used on the transparent glass cover so that it can repel the dust particle naturally and density of dust will not increase in that case. Panel inclination angle also have dirt repellent property because the dust particle whose weight increased will not be able to stay on the panel and simultaneous wind can remove the dust as well.

6. Acknowledgement

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Author Profile

Shobhit Kumar received the B. Tech degree in electrical engineering and M. Tech degree in energy engineering from Suresh Gyan Vihar University, jaipur, india, in 2013 and 2014 respectively. During 2013-14 the experimental work has been done in the solar lab provided by college to study the effect of dust deposition on solar photo-voltaic panel.