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Effect of Soiling on Performance of Solar Panels

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Abstract: The output power supplied by the solar panel is mainly depends on the amount of sun radiation which is reaches on surface of the solar cells. There are many factors which determines the output or optimum yield in a photovoltaic module. The main contributing parameter which directly affect the performance of solar cells is environment. We study and evaluate key contributions for understanding the performance and loss of power due to soiling on PV panels. The characteristics of solar cells (Voltage and current) are studied with respect to shading due to accumulation of dirt and dust i.e soiling. There is two categories of shading due to accumulation of dust and dirt namely, one is soft shading such as air pollution, second is hard shading such as accumulated dust and dirt on the panels. We found that the shading affects of first type that is soft shading, the current provided by the PV module is reduces, but the voltage from the panel remains the same. In second type i.e hard shading, the performance of the solar panel is depends on whether some solar cells are shaded or all the solar cells of the PV panel are shaded. If some of the solar cells are shaded, then as long as the unshaded solar cells receive solar radiation, there will be some output available but in reduces manner. The study also suggests some cleaning process that can be applied for increasing the output of solar cells.

Keywords: Solar Panel, Solar Radiation, accumulation of dust, solar panel efficiency, soiling and its effect.

I. INTRODUCTION

Solar radiation received from the sun can be directly converted in to electrical energy by using PV technology. Solar panels are consist of small solar cells which made up of semiconducting material such as silicon can be used to absorb the solar radiation from the sun and converting it in to the electrical energy. Now a days, solar energy has been able to attract the world's attention and is in use for providing the energy. solar energy is the most dependent and widely used non- conventional energy source. The effect of dirt and dust i.e soiling on solar panels is very important factor which is normally neglected, given its unpredictable nature, and which may seriously affect the output of the panels.

Actually, the amount of energy generated is directly proportional to the amount of solar energy impact on the solar cells therefore, directly affect the energy generated by the whole system. Soiling is causes the performance losses and poses problem for Photovoltaic and CPV power plants which is installed especially in dusty site, such as in arid regions. Studies on the soiling and it's effects on solar panels is started in 1944 and since then large number of contributions have been made in studying the soiling effect, and research on the topic is increasing. Normally dirt from atmospheric air including dust, rain, air pollution and other particles accumulate on solar cells which affects their electrical performance, reduce the output of the plant because the current generated is reduced, which can be approx. 10% lower than normal current from completely clean panel. In some specific condition this value of current can be reach to a loss of 15%, when the panel is almost horizontal. Current loss in concentrator panels is more serious than in non-concentrator panel.



Fig 1: Cleaned Solar Panels



Fig 2: Un-Cleaned Solar Panels

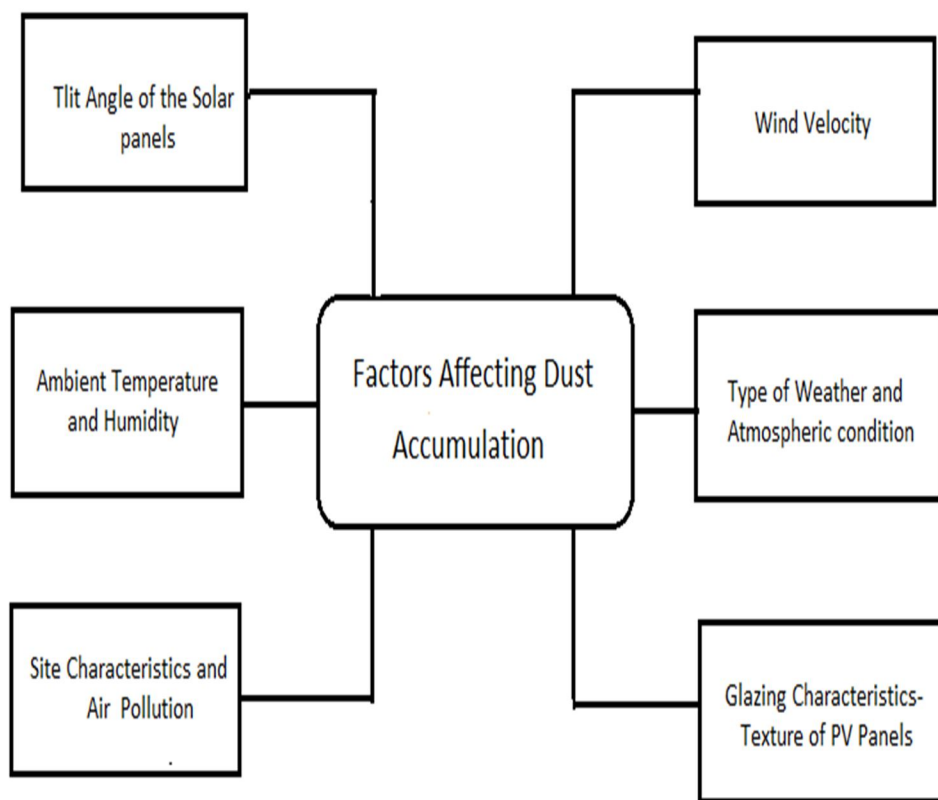


Fig.3-Factors Affecting Dust Accumulation

The characteristics of a solar panel can be studied by power–voltage or current–voltage curves. The figure 4 shows the power–voltage curve of solar panel for various conditions of solar radiation and temperature of solar cells. AS shown in figure 4 ,the panel output power from the panel is mainly depend on solar radiation and temperature of solar cells. Lower the amount of radiation, lesser will be power generated, and higher the temperature, the amount of power generated will be lesser. As shown in figure 4 for every curve of the solar panel, there is a point on the curve on which the power delivered is maximum.This point on the curve is known as maximum power point(MPP). There are two main factors on which the amount of power generated depend is solar radiation and temperature of the solar cells. There are some other factors as well which influences the output is

- 1) Type of weather and atmospheric condition.
- 2) Tilt angel of solar panel.
- 3) Ambient Temperature and Humidity.
- 4) Air pollution and Site chracteristics.

Due to increasing amount of energy demanded ,there is very much need of non conventional energy to fulfill the modern energy demand. There is increase in the demand of the solar panel system because they generate electricity without affecting the environment. The present capacity of solar power in India reached up to 25.21GW as of 31 December 2018. Which is achieved 4 years ahead of schedule. Which consist both on grid and off grid power. As we know that India is located with in the both the hemisphere due to which it receive ample amount of sun radiation from the sun. The Indian Meteorological Department (IMD) runs and monitored radiation stations which measure the solar radiation from the sun. In India mostly the weather is clear sunny in many areas about 280-300 days there is dry weather .The average intensity of solar radiation in india is 200 MW/km square .In India the highest radiation is received in Rajasthan and northern Gujarat.

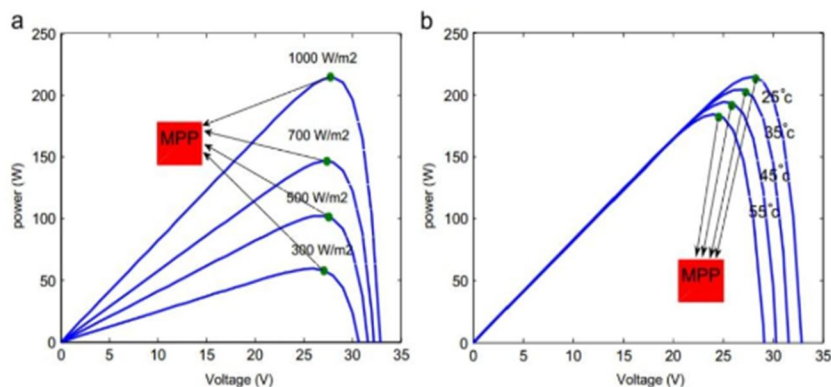


Fig4:Power Voltage Curve of Solar Panel

II. CAUSES OF DUST ACCUMULATION

There are two main parameters that effect on which the accumulation of the dust on solar panel is, the property of dust and the local environmental conditions. Dust is mainly consisting of size and shape of dust particle, weight of the dust particle. For example in industrial area the dust is acidic, which causes corrosion on the solar panel surface. The environment of local area also has adverse effect on the performance of PV module such as built environment, types of vegetation, and weather condition of the site. Also, the type of surface is also responsible factor for soiling. If surface of panel is rough, sticky than more amount of dust will be there on the surface of the panel. The panel position and direction of wind is also a major contributing factor for soiling. Normally the panels is placed in India is in south facing direction. The accumulation of dust is more if the panels are in horizontal direction. Type of wind is also very important factor if wind is strong than it can clear the surface of the panel and if the wind is not so strong than there be more soiling on the panels. However the speed and direction of the wind is not constant and it will also depend on the seasonal condition such as summer or monsoon. The wind pressure also contributes for soiling. There is another factor that affect the soiling is type of clay at the site. India there is different types of soil in different regions of the country, figure 5 shows the different types of soil and there effect on soiling.

III. EFFECT OF SOILING

The soiling is effect is more serious in the region, where most of the days of year are dry. Particularly in India there is about 280-300 days when there is no rain so there is more amount of energy loss. Performance of a PV module is depends on the ability of the panel glass surface to transmit solar irradiance the collection surface. The rate of decrease in the output of the PV module is mainly depend on the rate of dust deposition. The output can reduce upto 10% -15% if there is no rain for significant time duration. If there is slight rain of 1mm can reduce the power loss up to the 5%. The dust particle covers the surface of the panel as shown in fig 6. When the solar radiation from sun is incident on the dust particles it gets reflected and thereby reducing the total amount of solar radiation that will impact on the cells and results in influencing the total amount of energy generated. Dust on the surface of the panel not only reduces the incoming radiation from the sun on the PV module but it will also change the angle of incidence of solar radiation.

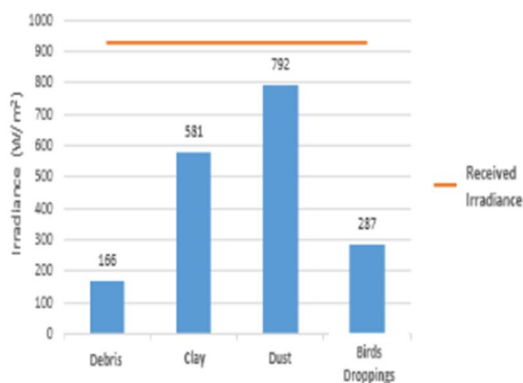


Fig.5 Effect of different kinds of soil on the solar Radiation

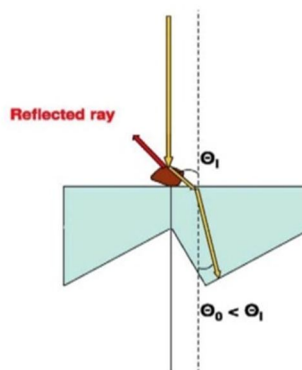


Fig.6-Effect of dirt particle on the surface of PV Panel

IV. EXPERIMENT PERFORMED

A small test is carried out on the site by using two panels of 200 watts. One panel is cleaned on the daily basis and other is not cleaned. The following observations are obtained during the peak hours From the table it is clear that the power loss is increasing as the accumulation of dust, dirt and soil are takes place on the surface of the solar panel cleaner. The average power loss during 6 days is found to be 5.88%.

Day	Time	cleaned panel		soiled panel		Power P1	Power P2	Difference in power
		V1 volt	I1 Amps	V2 volt	I2 Amps	Watt	Watt	Watt
1	12	24.58	7.68	24.58	7.67	188.774	188.528	0.2458
1	1	25.56	7.56	25.51	7.54	193.233	192.345	0.8882
1	2	25.5	7.34	25.42	7.32	187.17	186.074	1.0956
2	12	24.78	7.32	24.66	7.25	181.389	178.785	2.6046
2	1	26.5	6.98	26.35	6.9	184.97	181.815	3.155
2	2	25.78	7.14	25.64	7.11	184.069	182.300	1.7688
3	12	24.56	7.68	24.43	7.62	188.620	186.156	2.4642
3	1	25.8	7.34	25.65	7.26	189.372	186.219	3.153
3	2	25.75	7.43	25.56	7.36	191.322	187.866	3.4565
4	12	24.96	7.54	24.56	7.35	188.198	180.516	7.6824
4	1	25.68	7.12	25.26	6.89	182.841	174.041	8.7984
4	2	25.6	7.35	25.25	7.19	188.16	181.547	6.6125
5	12	24.78	7.78	24.12	7.78	192.788	187.653	5.1348
5	1	25.66	7.5	25.02	7.36	192.45	184.147	8.3028
5	2	25.56	7.56	24.86	7.23	193.233	179.737	13.496
6	12	24.54	7.87	23.68	7.57	193.129	179.257	13.872
6	1	25.27	7.54	24.47	7.34	190.535	179.609	10.926
6	2	25.2	7.57	24.37	7.32	190.764	178.388	12.3756

V. METHOD FOR CLEANING THE PANELS

Generally there is no attention is given towards the cleaning of photovoltaic surface. This lack of attention can stem from the idea that the amount of rainfall in the region is sufficient to clean the PV surface. There are numbers methods for cleaning the surface of solar panel. The method which is presently used is cleaning the surface with water manually. This method is same as cleaning of windows of house is done. There are some alternate methods recently developed such as automatic solar panel cleaning robots which can be used for cleaning the panels.



VI. CONCLUSION

soiling is one of the major factor that contributes for the power loss along with the solar radiation and high temperature. We cannot avoid the loss occurs due to this effect but can be controlled by regular cleaning. By test performed the average power loss is found to be 5.88%. This effect is more if there is no rain for significant duration. Local environment is also contribute for accumulation of dirt and dust.

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