

Optimizing Efficiency of Solar PV Module Through Auto Cleaning with Mirror Reflection System

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Abstract— Solar panels are installed on roof top hence facing a problem of dusting which reduce the efficiency of PV module about 30%. This automated system is implemented using 8051 microcontroller which controls the dc motor, connected to sliding brush. This mechanism does not require any sensor for cleaning the panels, for cleaning the PV modules, a mechanism consists of a sliding brushes has been developed. In this paper, performance enhancement of solar panel by direct reflection of light has been introduced through mirror. In terms of daily energy generation, the presented cleaning-cum mirror reflection scheme provides about 35% more energy output as compared to the module without mirror reflection and cleaning system.

Key words: PV Module, Mirror Reflection

I. INTRODUCTION

Richard Evans Day discovered that selenium produces electricity when exposed to light, back in 1867, but the efficiency was too small as 15%-20% in the commercially used PV panels.

According to the sun-earth geometry in India, sun's inclination angle with respect to the ground surface, i.e. the angle of incidence of the sun rays is 23.50 with the vertical, and this inclination is towards the south [1]. Thus, the solar panel in our case was also tilted 23.50 with the horizontal as shown in the figure 1 for receiving maximum solar energy the environmental conditions in which the solar PV modules are installed, like tropical climate around the equator, significant amount of dust gets deposited on PV modules. The regular cleaning of PV modules is required in tropical climate which adds to the cost of operation and maintenance of the PV system.

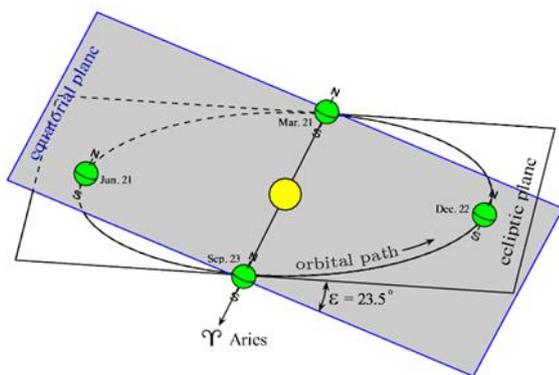


Fig. 1: Sun inclination with earth

It has been observed that the reduction in energy output from a PV panel with dust could be as much as 25%, when the modules are not cleaned for 30 days [2]. The paper explains the design procedures and the results obtained for the module which are dusty, cleaned and mirror reflected.

II. CLEANING AND MIRROR REFLECTION

The automated cleaning mechanism is implemented using brush, rod, dc motor & sliding wheel. The brush is fitted in the rod. The rod is fitted with the wheels at both the ends, which are fitted in the channel with dc motor and belt in which they rotate. The time of rotation of dc motor is fixed for 2 minute in every 24 hours through 8051 micro controller. In this way the cleaning mechanism works [3].

Mirror Reflecting System Reflection by mirrors is the simplest form of reflection, yet, it appears to be the most effective one. Even for the performance enhancement of solar panels, it plays a very important role. First of all, the field data obtained, show that the improvements of the output currents using plane mirror reflectors is even higher than that of sun tracking. And secondly, these reflectors are very cheap and are easily available in the market.

III. EXPERIMENTAL SET UP

Owing to the sun-earth geometry and the location of India, the solar panel was kept inclined at an angle of 23.50 with the horizontal. The length of the panel was aligned along the north-south direction. The mirrors were then attached at the two edges of the panel as shown in Fig. 2. The orientations of the mirrors were kept in accordance with the direction of the sun rays, so that the maximum possible amount of light was reflected on to the panel [4]. The electrical specifications of the panel were as follows in table 1.

Solar Panel Specifications	Values
Max power rating	3.0watt
Open-circuit voltage	V
Short-circuit current	A
Rated voltage	V
Rated current	0.34 A
Module Weight	1.15 kg
Module dimension	185*185*17 mm

Table 1: Solar Panel Specification

The mirrors were placed at an angle of approximately 120 degree with the panel's horizontal surface. The overall experimental setup is illustrated in Fig. 2. Two pieces of plane mirrors were used to reflect sun-light effectively at any time of the day. The size of each of the mirror reflectors used was 2.0cm x 1.0cm

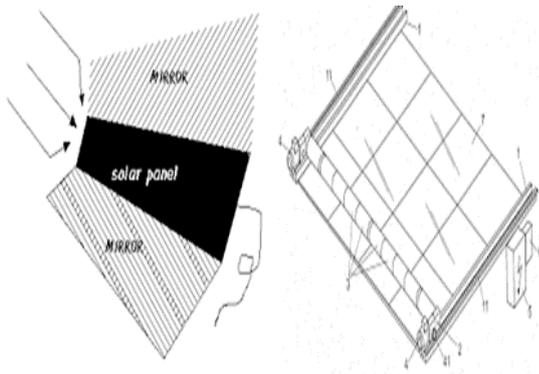


Fig. 2: Experiment set up

IV. RESULT

The experiments for this paper were carried out under bright and sunny weather at different time. The data, thus obtained, are summarized between solar panel based auto cleaning cum mirror pattern and conventional (flat top) pattern and illustrated below.

It can be seen from the table that the reading obtained by using plane mirror is much higher than the reading using conventional method, during the mid-day. Even during the remaining hours, the enhancement in output of the panel with mirror is quite close to that of sun tracking [5].

Date	10/08/2016			
Power in watt				
Time	Solar Panel based on Auto cleaning and mirror pattern	Power in Per Unit	Conventional	Power in Per Unit
10:00	8.161	0.340	5.209	0.289
10:30	10.030	0.418	6.325	0.351
11:00	10.766	0.449	7.209	0.401
11:30	11.997	0.500	7.966	0.443
12:00	12.293	0.512	8.338	0.463
12:30	12.417	0.517	8.672	0.482
1:00	11.858	0.494	8.323	0.462
3:00	7.442	0.310	4.275	0.237
3:30	7.009	0.292	3.851	0.214
4:00	4.871	0.203	2.227	0.124
4:30	3.861	0.161	1.369	0.076
5:00	3.034	0.126	0.652	0.036
5:30	1.671	0.070	0.213	0.012
6:00	0.851	0.035	0.114	0.006
Average Power	97.249	4.052	59.420	3.301

Table 2:

In case of an average sunny day, the percentage improvement with mirror is about 30% higher than that of conventional method during the mid-hours of the day.

V. CONCLUSION

The mentioned auto cleaning cum mirror reflection system is most suitable for today's industrial need. The difference is quite significant as we can see from Table 2 the difference in

number of units generated per day and cost of per kWhr. The results obtained from this study on the use of plane mirrors for the performance enhancement of solar panels have come out to be highly encouraging. And the plane mirrors used for this purpose are very cheap and easily available. This makes the use of solar energy more viable for the developing countries of the world, reducing the overall cost of producing energy by Solar Home System. Also, such system is cheap and easy to install.

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