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Improvement of Solar Energy by Mirror Reflection Technique

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Abstract: ***The main objective of this proposal (project) is to ameliorate the solar energy by considering the mirror reflection approach. Simple arrangements of the system can be seen widely throughout the industries such as (IT cells, manufacturing cells) etc with/without mirror or in contrast, keeping the solar panel flat/tilted. Our experimental analysis divulged that when we consider mirror reflectors, we will receive additional power (due to more focus of sunlight onto the PV module). As a result, the number of solar panels needed to produce a certain amount of power can be reduced. Therefore, we can generate more solar energy by using mirror reflection because the output power using plane mirror reflector is higher and these reflectors are very cheap and easily available in the market. The paper also aims to show the culmination obtained by implementing different types of arrangements (use of mirror, without use of mirror), to check whether there will be drastic improvement or measure in energy production which has to be carried out. The measurement of voltage, current and power of the photovoltaic solar panel using mirror reflector, without mirror reflector were taken into the account.***
Keywords: Solar Panels, Mirrors, Received Power, Reflector, Solar Power, Photovoltaic Solar Panel.

I. INTRODUCTION

Extracting useable electricity from the sun was made possible by the discovery of the photoelectric mechanism and subsequent development of the solar cell – a semi-conductive material that converts visible light into a direct current. A series of solar cells, electrically connected, a DC voltage is generated which can be physically used on a load. Solar panels are being used increasingly as efficiencies reach higher levels, and especially popular in remote areas where placement of electricity lines is not economically feasible. This alternate power source is achieving popularity rapidly since the realisation of fossil fuel depletion. Solar power is being heavily researched and many new technologies are introduced at rapid rate. We know that India is a developing country with acute power crises. Hence, solar energy can be considered as a great source for tackling this problem. But, main problem is that many areas in India are not economically stable enough to use large solar panels or solar trackers to get more electricity for everyday needs as they are expensive and not easy to install. This is applicable everywhere in the country from rural areas, small villages to industries. The challenges are faced on how to increase the efficiency of solar panel. This is possible can be achieved by various ways and arrangements. In this paper we have discussed various techniques by which we can increase the efficiency of a solar panel by mirror reflection technique. Conclusion is made by comparing all the different arrangement and selecting the best possible one by taking into consideration all the various aspects related to it.

A. Why Solar Energy Instead of Conventional Power Source?

1) *Reduction in dependability on Fossil Fuels:* We know that in today's world the fossil fuel stipulation is increasing day by day. We know that India has halfway energy setbacks. From previous year (2018) due to sanctions on Iran, the oil which we (India) used to snap up from Iran was at low cost. But from May (2019) the further deals are dismissed and now India has a deal with Saudi Arabia at 1.2x the cost compared to Iran. So, by planting solar modules can relax the fluctuations and can provide consistency. On the other hand, this can also cut the percentage of India's intermediate power setbacks.
2) *Environmental Advantages:* Oxides of carbon (monoxide, dioxide), nitrogen are common emissions seen in the vehicles and should be avoided at any cost. Climate change and global warming is main concern and it should be kept as minimum as possible. The solar power source is achieving tremendous increase in demand despite the higher cost than compared to other power sources. It is necessary to obtain as much solar energy as possible. Due to insufficient and irregular supply of electrical energy, solar is far better as a source for small scale industries and rural areas.
3) Solar energy costs have now reached a few Rs. per Kwh and may drop further with the introduction of new technologies day by day. In the past years till present, solar energy has increased in efficiency and its prices have reduced to a great extent.

II. METHODOLOGY

The sunlight hitting on the surface of the solar panel can be concentrated additionally by using flat shaped reflectors (mirrors). Here, parabolic shaped reflectors can also be used but since the manufacturing cost of these reflectors are higher than that of flat reflectors, this alternative approach was ruled out. This type of mirror only works at a certain spot to focus the sunlight onto a smaller area in a certain direction which may lead to rise in the temperature of the solar panel and requiring a separate cooling

system. Therefore, the concept will utilize two mirrors which will be at fixed angles and each of them would reflect additional sunlight onto the solar panel. As illustrated in Fig. 1, the arrangement will be in the following manner.

Although the geographical location of India stands to its benefit for generating solar energy the reason being India a tropical country which receives solar radiation almost throughout the year, two separate tracking mechanisms (for mirror) to track the sun would increase the cost of the whole system. Therefore, using fixed directed mirrors was more convenient both in terms of economy and complexity of design and arrangement.

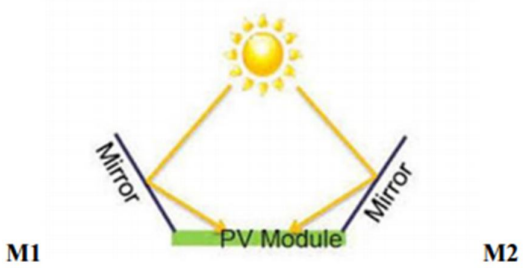


Fig. 1 Design of the Concept

During the action plan, it was decided that readings of solar panel for finding out the efficiency will be taken in two ways: With the use of mirror reflectors. (using two plane mirrors) by varying it at different angles and Without the use of mirror reflectors and keeping the panel inclined at a specific angle. Readings of both the arrangements were taken during beginning of summer from February – March. All the readings were taken between 8:00 am – 5 :00 pm with the help of multimeter.

A. Proposed Model

An alternative technique to increase the efficiency of solar panel is introduced. This design is self-made and tested. Power, voltage and current of the solar cell is recorded at different times and with each different arrangement and is compared with each other. According to the results simple plane mirror is found to be the best option for reflector material. Since it is cost effective and easily available in the market unlike tailored-made reflectors which is comparatively expensive. In compensation with the durability and performance, the conventional mirrors are identified as the ideal option.

We went for static version of arrangements where few cases were considered and initially tried flat and inclined solar panel arrangements also. The mirrors were kept both in parallel and perpendicular direction of sun path. We observed that when the mirrors were kept parallel to the direction of the sun path, the changes in the output are more than the changes in the arrangement where the mirrors were kept perpendicular to the direction of sun path. In case of parallel there is no obstruction between the sun light and mirrors whereas in the arrangement of perpendicular there is obstruction and the output of the that arrangements are better in the parallel arrangement. Finally, we tried the arrangements where we only used conventional solar panel and two mirrors and observed the outputs which were more efficient.

III. OBSERVATION AND RESULT

For the experiment we used a solar panel which has the following features:

Model No: KRISMA Solar Panel KS 010 (33cm x 30cm)

Max Power (P_{MAX}) = 10 W

Voltage at Max Power (V_{MP}) = 17.50 V

Current at Max Power (I_{MP}) = 0.58 A

Open Circuit Voltage (V_{OC}) = 21.50 V

Shot Circuit Current (I_{SC}) = 0.63 A

Tolerance = +/- 3%

Two plain reflecting mirrors used as the reflectors having dimensions – 42cm x 35 cm. Steel frame used for fixing the mirror at specific angle made by arc welding of steel bar whose dimensions are very similar to the plain mirrors. Their job is to provide a stable setup to the mirror which helps to achieve the arrangements. A regular multi - meter which is used to measure the parameters like potential difference - voltage, current and power. These three parameters are mainly required to calculate the output of the solar panel.

A. Observation

TABLE 01

RECEIVED DATA FOR SOLAR PANEL USING MIRROR AS REFLECTOR FOR VOLTAGE COMPARISON AT DIFFERENT ANGLES

Sr.No.	TIME	ANGLES				
		30°	45°	60°	75°	90°
1	8:00	20.8	20.9	20.8	20.9	20.8
2	9:00	21	21	21	20.9	20.8
3	10:00	21	21	21.1	21	20.9
4	11:00	20.7	20.7	21.1	20.7	20.4
5	12:00	20.3	20.3	20.5	20.4	20.1
6	13:00	20	20.1	20.2	20	20
7	14:00	20.3	20.4	20.7	20.5	20.1
8	15:00	20.4	20.4	20.8	20.4	20
9	16:00	19.8	19.9	20.7	20	19.9
10	17:00	18.3	18.4	18.9	18.5	18.2
AVG.		**20.26V**	**20.31V**	**20.58V**	**20.33V**	**20.12V**

Table shows variation of voltage of a solar panel using reflector (mirror) at different angles and These values are compared. The readings were taken from 8:00 AM to 5:00 PM. The solar panel received a maximum of 20.58V when the mirror was kept at 60°. The data was taken by using multimeter in March 2019 in the same weather and temperature. Observed readings were taken when the arrangement was kept parallel to the path of sun.

TABLE 02

RECEIVED DATA FOR SOLAR PANEL USING MIRROR AS REFLECTOR FOR CURRENT COMPARISON AT DIFFERENT ANGLES

Sr.No.	TIME	ANGLES				
		30°	45°	60°	75°	90°
1	8:00	0.39	0.42	0.39	0.41	0.40
2	9:00	0.52	0.53	0.52	0.51	0.5
3	10:00	0.6	0.62	0.61	0.62	0.59
4	11:00	0.6	0.61	0.63	0.62	0.65
5	12:00	0.49	0.52	0.53	0.5	0.54
6	13:00	0.51	0.53	0.54	0.52	0.5
7	14:00	0.53	0.5	0.55	0.49	0.47
8	15:00	0.51	0.5	0.58	0.49	0.44
9	16:00	0.44	0.46	0.46	0.45	0.42

10	17:00	0.31	0.33	0.33	0.36	0.33
AVG.		**0.490A**	**0.502A**	**0.514A**	**0.497A**	**0.484A**

TABLE 03

RECEIVED DATA WHEN THE PANEL WAS KEPT FLAT, INCLINED AND BY USING TWO MIRRORS (Their Comparison)

Sr. No.	TIME	WITHOUT MIRROR (Solar Panel kept flat)		WITHOUT MIRROR (Solar Panel Inclined)		WITH 2 MIRRORS (60° Arrangement)	
		FLAT		INCLINED (45°)		60°	
		VOLATGE	CURRENT	VOLTAGE	CURRENT	VOLTAGE	CURRENT
1	08:00	20.3	0.34	20.6	0.36	20.8	0.39
2	09:00	20.5	0.45	20.7	0.48	21	0.52
3	10:00	20.6	0.55	20.8	0.59	21.1	0.61
4	11:00	20.7	0.61	20.9	0.65	21.1	0.63
5	12:00	20.0	0.46	20.3	0.51	20.5	0.53
6	13:00	19.6	0.49	19.9	0.50	20.2	0.54
7	14:00	20.4	0.50	20.7	0.51	20.7	0.55
8	15:00	20.5	0.51	20.7	0.55	20.8	0.58
9	16:00	20.2	0.36	20.5	0.38	20.7	0.46
10	17:00	18.3	0.24	18.3	0.26	18.9	0.33
AVG.		**20.11V**	**0.451A**	**20.34V**	**0.479A**	**20.58V**	**0.514A**

The following table shows the value of the voltage and current readings observed at different time during the day when the readings were taken for different arrangements of solar panel. Here, we can see that we get the most efficient value when the solar panel was arranged with two mirrors and we get the reading of 20.58V which is higher than compared to other two arrangements.

B. Analysis

TABLE 04

ANALYSIS FOR THREE DIFFERENT ARRANGEMENT SETUPS

Sr.NO.	**SETUP Arrangement**	**EQUIPMENT**	**OUTPUT (V and A)**	**POWER OUTPUT (Watt)**
1.	Flat Solar Panel	Solar Panel and Welded Base	**20.11V** and **0.451A**	**9.04**
2.	Inclined Solar Panel	Solar Panel and Welded Stand	**20.34V** and **0.479A**	**9.74**
3.	Flat Solar Panel with two Reflecting Mirrors	Solar Panel + 2x Reflecting Mirrors and Welded Stand	**20.58V** and **0.514A**	**10.57**

The difference between the setup (arrangements) in terms of the output values are **significant** i.e., change in the values of output voltage, current and power.

From the table above, we can see that the setup arrangement no. 03 is most efficient as compared to the setup arrangement 01 and 02. If we compare the values of all the three setups, a significant percentage increase is seen as we modify our arrangement.

If we compare setup no. 01 and 03, it is observed that there is **0.47V** increase in the value of voltage, **0.063A** increase in the value of current and **1.53W** increase in the value of power. It shows that there is **2.34%**, **13.97%** and **16.92%** increase in the value of voltage, current and power respectively.

If setup no. 02 and 03 are compared, it is observed that there is **0.24V** increase in the value of voltage, **0.035A** increase in the value of current and **0.83W** increase in the value of power. Therefore it shows that there is **1.18%**, **7.31%** and **8.52%** increase in the value of voltage, current and power respectively.

Hence, we come to know that the arrangement no. 3 gives the best percentage increase value as compared to the other two arrangements in terms of voltage, current and power.

C. Result

From the above observation tables, we can see that the experimental values of the solar panel with various arrangements (without mirror (flat and inclined) and with double mirror) are shown. When the values of these arrangements are compared, it is observed that the value when two mirrors are implemented (Setup no. 03) gives good output and efficiency when the mirrors are kept at **60°.** A **16.92%** power increase is obtained when this value is compared with flat solar panel arrangement and **8.52%** increase in the power is obtained when this value is compared with inclined solar panel arrangement.

D. Snapshots of Project



IV. CONCLUSION

Solar energy has very high future and scope ahead and it is proving as an efficient energy source in present and in the future. However, the prime cost of this technology is still higher. One simple way to drive down the cost of PV electricity is to combine reflectors with solar panel in order to extract more light. The analysis and experimental observations data both show that the mirror system plays a vital role and has higher power output compared to without mirror system.

As it was observed earlier from the result that the experimental values of the solar panel with various arrangements where current and voltage data both show that the mirror system has higher power output compared to without mirror system. When two mirrors were implemented as in Setup no. 03 where the mirrors were kept at **60°** gives better output in terms of power, voltage and current**.** Therefore, we conclude that the arrangement designed i.e. setup no. 03 (Solar Panel with reflecting mirror) produces more output than existing arrangements which we have considered (flat solar panel arrangement and inclined solar panel arrangement). The objective of the experiment and design which was to widen the window in of maximum power output has been achieved.

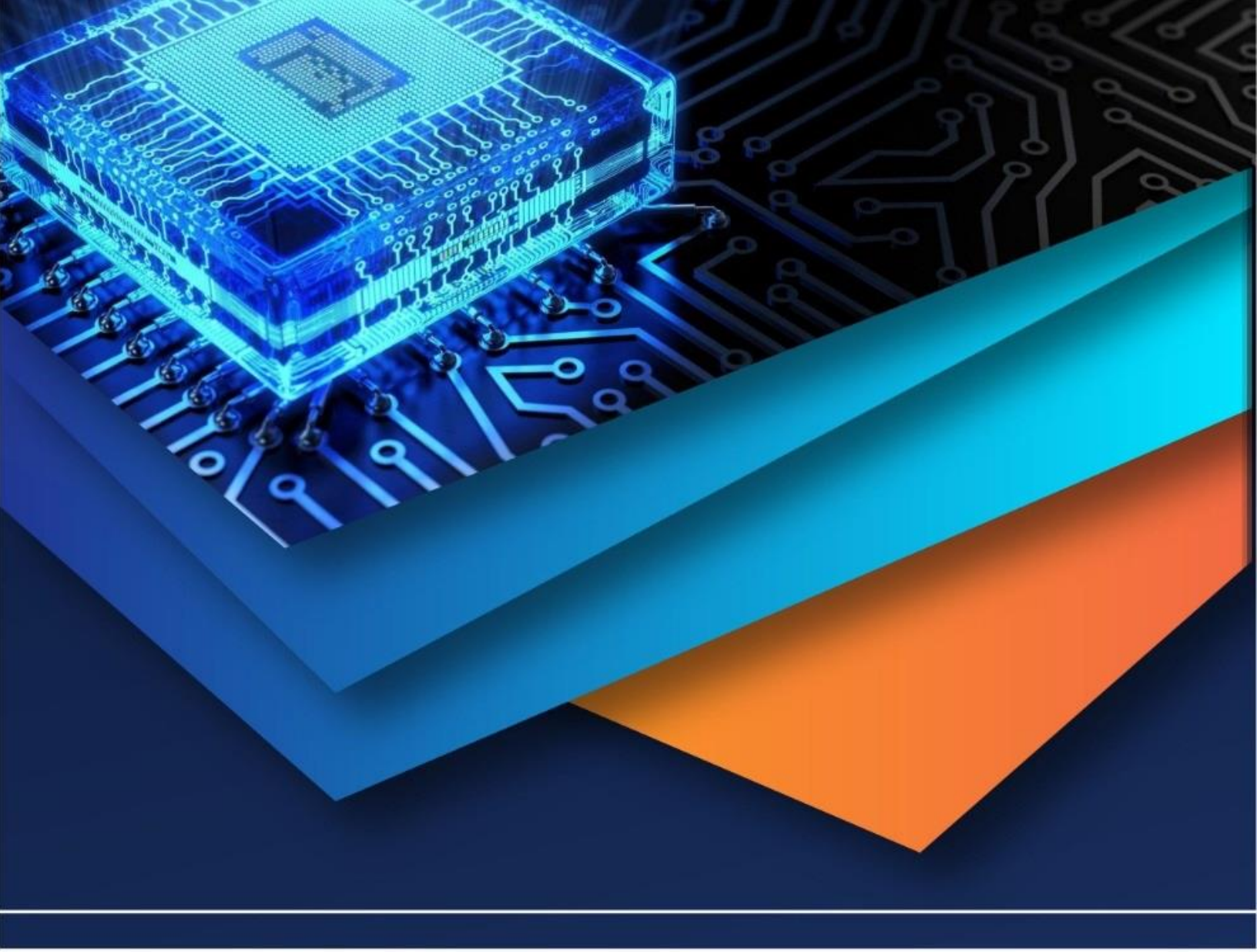
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