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Performance Analysis of Solar Pv Panels Using The Developed Automated Cleaning System

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***ABSTRACT*:** *Solar energy is tremendous available as a most important energy source. The solar cells are used for many applications, including street lights to generate luminescent night. The accumulation of dust particles, deposits left by birds or the fallen leaves, on the surface of photo-voltaic PV panel will reflect the incident light falling on the panel, preventing a portion of the radiation from being used. This problem could reduce the ability of cells to allow free entrance of photons and absorb solar energy, which greatly affects its efficiency, reducing the lifetime of its storage power after a few months from its instillation, leading to a permanent or long-term failure, especially in the desert areas. Other factors such as panel orientation or panel surface material can contribute to the deposition of the impurities. Here in this work it find out the effect of cleaning of solar panel on the efficiency of the solar plate. It calculates the efficiency of solar panel before cleaning and after cleaning, it also calculate the effect of different parameters responsible during the cleaning of solar panel. The parameters responsible for cleaning are feed speed, roller speed, feed depth, no. of pass of roller. Through experiment it is found that the value of efficiency for all isolation is maximum in case of solar panel without dust. From the graph it is found that as the rotation speed of the roller increases the efficiency of the solar system decreases. From the experimental analysis it is also found that the value of efficiency is maximum for feed velocity 0.1 m/s where as it is minimum for feed velocity 0.3 m/s.*
KEYWORDS: *solar panel, solar efficiency, cleaning device, thermal insolation*

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I INTRODUCTION

Solar panels having the ability to absorb the sunlight as a source of energy to generate electricity or heat. And it is designed in such a way such that maximum output has to be obtained whether it is used to generate electricity or any other purpose. A photovoltaic (PV) module is a packaged; connect assembly of typically 6x10 photovoltaic solar cells. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 365 Watts (W). The efficiency of a module determines the area of a module given the same rated output – an 8% efficient 230 W module will have twice the area of a 16% efficient 230 W module. There are a few commercially available solar modules that exceed efficiency of 22% and reportedly also exceeding 24%. A single solar module can produce only a limited amount of power; most installations contain multiple modules. A photovoltaic system typically includes an array of photovoltaic modules, an inverter, a battery pack for storage, interconnection wiring, and optionally a solar tracking mechanism. The most common application of solar panels is solar water heating systems.

II SOLAR PANEL CLEANING SOLUTION

There are some different solution for cleaning it and one of the solution belongs to this are Fill a bucket with warm water and with a cleaning solution. Green cleaning supplies do a great job on glass and solar panels. Here's is a simple non-toxic recipe for glass cleaner: 1/4 cup vinegar, 1/2 teaspoon liquid non-abrasive soap or detergent, and 2 cups of water in a spray bottle. There is some tools and accessories which in turn cleans the

panels With the HiFlo Window Washing Systems, the cleaning of solar panels becomes quick, easy, and effective. Without using ladders or cranes and even without walking on the roof, the modules can be cleaned in no time.

The cleaning results are immediately visible and the solar output already risen considerably during the cleaning itself. Even if some manufacturers claim that solar stations are self-cleaning the opposite is true! Dirt, dust, oil, etc. from clouds and the atmosphere are absorbed by the rain and deposited onto the panels. It is true that rain removes part of the existing dirt, but it also deposits new dirt on the surface. Kutaiba Sabah et.al in the experiments which is previously done, dust accumulation for the solar panels being investigated for a long period of time that is approximately for one year. The experiments have been done in different countries which have climate conditions of the dusty weather. Those countries are Iraq, Egypt and UAE. Anglani et.al Mirror cleaning for concentrated solar thermal (CST) systems is an important aspect of operation and maintenance (O&M), which affects solar field efficiency. The cleaning process involves soil removal by erosion, resulting from droplet impingement on the surface. Zhou et.al the self-cleaning technology for solar cell array can promote efficiency of electricity produced and protect the solar cell. The methods of dust-removal, such as natural means, mechanical means, self-cleaning nano-film, and electrostatic means are presented.

III EXPERIMENTAL SETUP

3.1 Control

For controlling the robot an Arduino mega 2560 microcontroller board was used. This board is based on the Atmel ATmega2560 microcontroller. With 54 digital input/output pins and 16 analogue ones, the board has enough flexibility for this project.

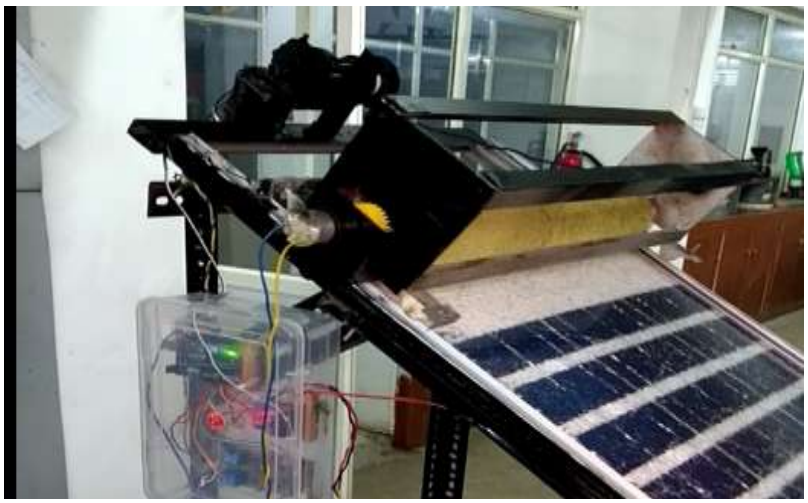

Fig.1 showing the control motor of the feed roller

Additionally, the board has 6 interrupt pins (pins 2,3,18,19,20). These are especially important for the operation of the encoders counting the motors rotation. Everytime a pulse arrives from the motors encoder, an interrupt will is triggered, consequently pausing other tasks so each pulse gets registered by the microcontroller.

3.2 Design Specification of the experimental Setup

Here in this analysis to develop the complete experimental setup, here first we have developed the solid model of complete setup in NX to virtually visualized complete setup. With the help of different solid model, it is easy to find out the position of different components in actual setup. Different solid model used for detecting the actual model is shown in the below figures. The dimension of the solar panel is shown in the below table

Table.1 Showing the Geometric specification of solar panel

Parameter	Value
Length of the panel	1.3 m
Width of the panel	0.5 m
Thickness of the panel	15 mm
Capacity of the panel	24 V

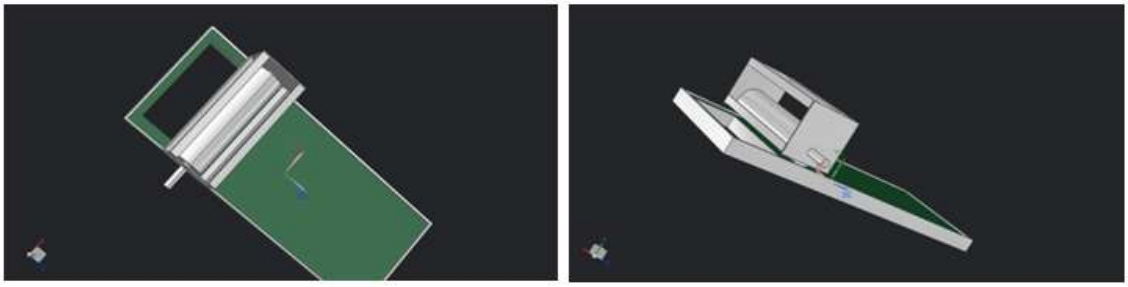

Fig.2 view of the solid model of the complete setup

Fig.3 setup used for the Experimental analysis

IV METHODOLOGY AND OBSERVATION

The performance of the solar system depends on the solar ray trap by the solar cell as the radiations trap by the solar cells on the solar panel is maximum the performance of the solar system is also maximum. Due to the dust on the surface of the solar panel the radiation falling on the system and trapping by the solar cell reduces which decreases the performance of the solar system. Here in this work we are finding the effect of cleaning of solar panel on the performance of the solar system. There are many parameters which are responsible for cleaning of the system. There in this work we are finding the effect of rotation of cleaning roller on the cleaning of solar panel. Finding the effect of number of pass of the feed roller on the surface finish of the solar panel, also calculating the effect of feeding speed on the cleaning of the solar panels.here in this work it also analyzed the effect of solar insolation on the performance of the solar system. To find the effect of solar insolation here we have considered 10 different solar isolation that is 20, 40, 60, 80, 100, 120, 140, 160, 180, 200 W/m^2. With the help of voltmeter and ammeter we measure the value of voltage and current, find the value of power and calculate the efficiency of the solar system. The complete setup for the experimental analysis were shown in the below fig.

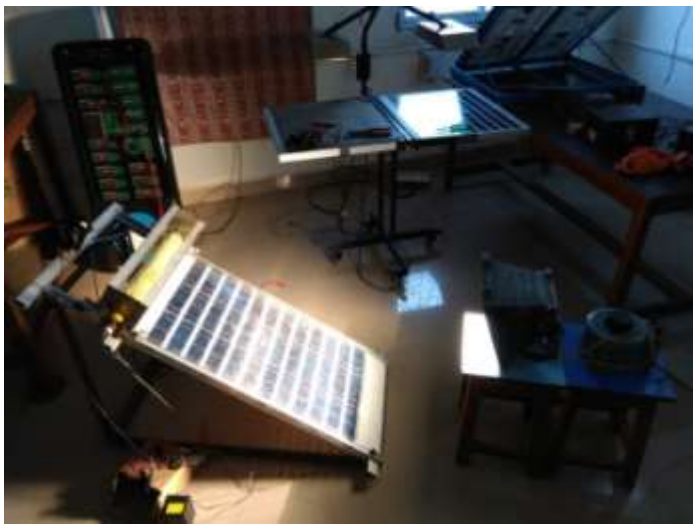

Fig.4 complete setup for the experimental analysis

The efficiency of the solar system is calculated on the basis of formula mention in the below section

$$\eta_{max} = \frac{P_{max}}{E \times Area\ of\ collector} \quad (1)$$

Where η_{max} is the maximum efficiency of the solar system, P_{max} is the maximum power generated by the solar panels, E is the incident radiation or insolation.

4.1 Before Cleaning

The value of voltage, current, power and efficiency of the solar panel for solar panel having dust on the surface is mention on the below table. During the analysis the rotation of the roller is 10 RPM and the velocity of the feed is near about 0.1 m/s.

Table.2 Value of different parameters for different insolation before cleaning

S.No.	Insolation W/m^2	Voltage (volt)	Current (A)	Power (W)	Efficiency (%)
1	20	11.86	0.05	0.593	7.16
2	40	13.89	0.01	1.389	8.38
3	60	15.01	0.2	3.002	12.08
4	80	15.30	0.25	3.825	11.54
5	100	15.95	0.25	3.987	10.63
6	120	16.22	0.3	4.866	10.4
7	140	16.64	0.35	5.824	9.63
8	160	16.90	0.35	5.915	9.2
9	180	17.14	0.4	6.856	8.92
10	200	17.32	0.45	7.794	8.78

4.2 After cleaning

After analyzing the solar panel with dust roller was start to clean the solar panel. The cleaning of solar panel with the help of roller mechanism is shown in the below fig.

Table.3 Value of different parameters for different insolation after cleaning

S.No.	Insolation W/m^2	Voltage (volt)	Current (A)	Power (W)	Efficiency (%)
1	20	11.86	0.05	0.593	10.25
2	40	13.89	0.01	1.389	11.32
3	60	15.01	0.2	3.002	14.59
4	80	15.30	0.25	3.825	15.24
5	100	15.95	0.25	3.987	17.12
6	120	16.22	0.3	4.866	13.53
7	140	16.64	0.35	5.824	11.89
8	160	16.90	0.35	5.915	11.41
9	180	17.14	0.4	6.856	10.44
10	200	17.32	0.45	7.794	9.27

After experimentally observing the efficiency of the solar panel with dust and without dust, here we compare the efficiency of the solar panel. The comparison graph of the solar panel is shown in the below fig. With the help of above graph it is found that the value of efficiency for all isolation is maximum in case of solar panel without dust. So it is conclude that as the dust were clean from the surface of the solar panel the efficiency of the solar system increases.

4.3 Effect of Rotation of feed roller

Here in this section the effect of different rotation speed of cleaning roller were analyzed. During the analysis the feed velocity of the roller remain constant that is 0.1 m/s. for analyzing the effect of different roller speed here we have considered the three different rotation of the roller that is 10, 20 and 30 RPM. For analyzing the effect of roller speed at different isolation, 10 isolation values were also considered.

Table.4Value of different parameters at different rotation

Insolation (W/2)	Power at 10 RPM	Power at 20 RPM	Power at 30 RPM	Efficiency (%) at 10 RPM	Efficiency (%) at 20 RPM	Efficiency (%) at 30 RPM
20	1.48	1.87	1.35	18.043	17.86	17.64
40	2.05	2.58	2.98	16.304	16.03	15.88
60	3.21	3.42	3.93	15.84	15.42	15.16
80	3.98	4.15	4.89	14.78	14.27	13.96
100	4.63	4.92	5.86	14.16	13.87	13.55

120	5.73	5.43	6.85	13.65	13.02	12.84
140	6.87	6.96	7.81	12.52	12.17	11.86
160	7.43	7.84	8.79	11.8	11.4	10.95
180	8.23	8.57	9.8	10.02	9.89	9.66
200	9.67	9.92	10.74	9.94	9.78	9.44

From the above graph it is found that as the rotation speed of the roller increases the efficiency of the solar system decreases. It is also observed that the efficiency of the solar system also decreases with the increase in solar isolation.

4.4 Effect of feed roller speed

Here in this section the effect of feed speed of cleaning roller on the cleaning of solar panel where analyzed in order to analyzed the effect of feed speed here we considered three different feed speed that is 0.1, 0.2 and 0.3 m/s. the efficiency at 0.1 m/s were already analyzed in the above section. For velocity 0.2 and 0.3 m/s were analyzed here in this section. The speed of the roller was controlled with the help of controlling system shown in the below fig.

The value of efficiency of the solar panels for different feed velocity of the cleaning roller where mention in the below table. The cleaning roller having velocity 0.1 m/s is shown in the below fig.

Fig.5 roller having 0.1 m/s speed

Table.5 showing the value of different parameters for roller speed 0.1 m/s

S.No.	Insolation (W/m2)	Power (W)	Efficiency (%)
1	20	0.878	12.14
2	40	1.58	11.8
3	60	2.24	10.43
4	80	2.87	9.94
5	100	3.25	9.48
6	120	3.64	8.89
7	140	4.28	8.56
8	160	5.02	7.93
9	180	5.79	7.54
10	200	6.48	7.13

Table.6showing the value of different parameters for roller speed 0.2 m/s

S.No.	Insolation (W/m2)	Power (W)	Efficiency (%)
1	20	0.925	11.42
2	40	1.84	10.91
3	60	2.79	9.53
4	80	3.24	9.16
5	100	3.91	8.68
6	120	4.22	8.36
7	140	4.87	8.08
8	160	5.72	7.73
9	180	6.23	7.58
10	200	7.06	7.08

Table.7showing the value of different parameters for roller speed 0.3 m/s

S.No.	Insolation (W/m2)	Power (W)	Efficiency (%)
1	20	0.865	11.23
2	40	1.23	10.837
3	60	2.14	9.38
4	80	2.89	9.14
5	100	3.11	8.421
6	120	3.87	8.23
7	140	4.25	8.013
8	160	4.98	7.639
9	180	5.88	7.324
10	200	6.76	7.053

After calculating the efficiency of solar panel at different velocity of feed roller, comparison of efficiency were carried out in the below table and graph.

Table.8showing the comparison of Efficiency

S.No	Insulation (W/m2)	Efficiency (%) at 0.1 m/s	Efficiency (%) at 0.2 m/s	Efficiency (%) at 0.3 m/s
1	20	12.14	11.42	11.23
2	40	11.8	10.91	10.837
3	60	10.43	9.53	9.38
4	80	9.94	9.16	9.14
5	100	9.48	8.68	8.421
6	120	8.89	8.36	8.23
7	140	8.56	8.08	8.013
8	160	7.93	7.73	7.639
9	180	7.54	7.58	7.324
10	200	7.13	7.08	7.053

V RESULT

Here it compares different input parameters on the basis of different performance parameters. The comparison of different parameters where shown in the below fig.

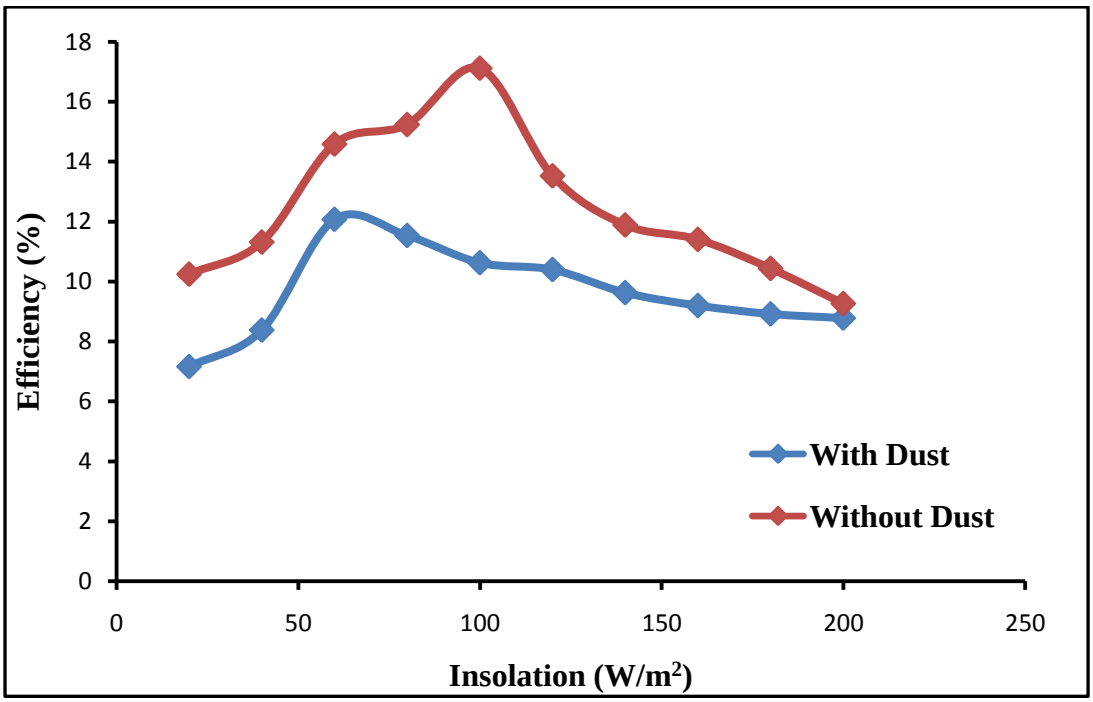

Fig.6 showing the comparison of efficiency

Comparison Graph of the Efficiency of different rotation speed is shown in the below fig.

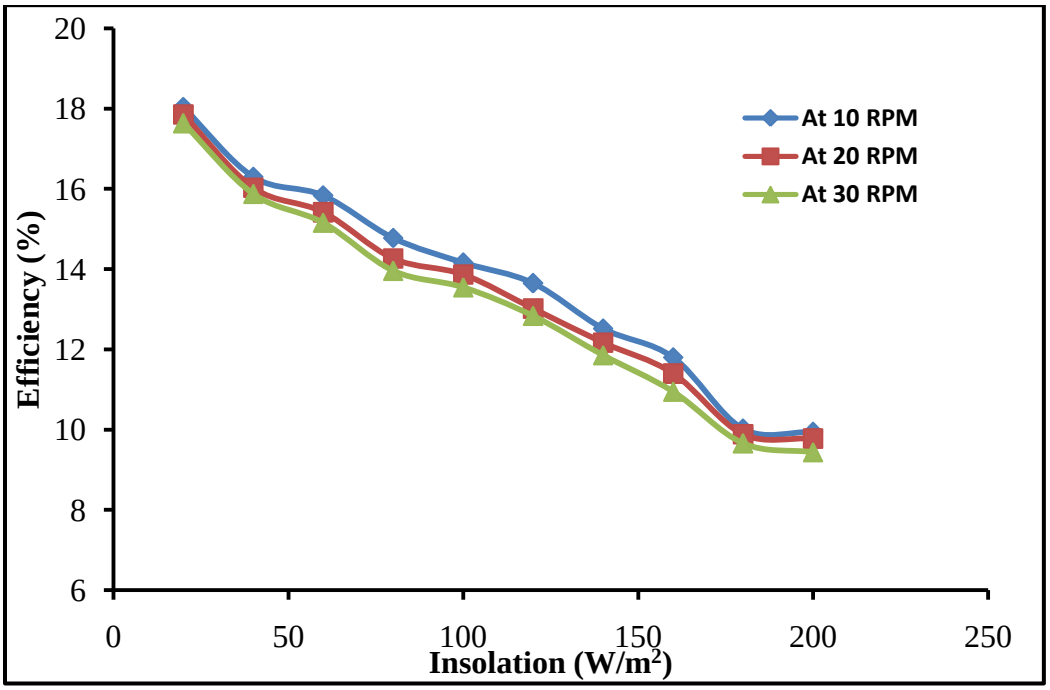

Fig.7 comparison of efficiency for different Isolation

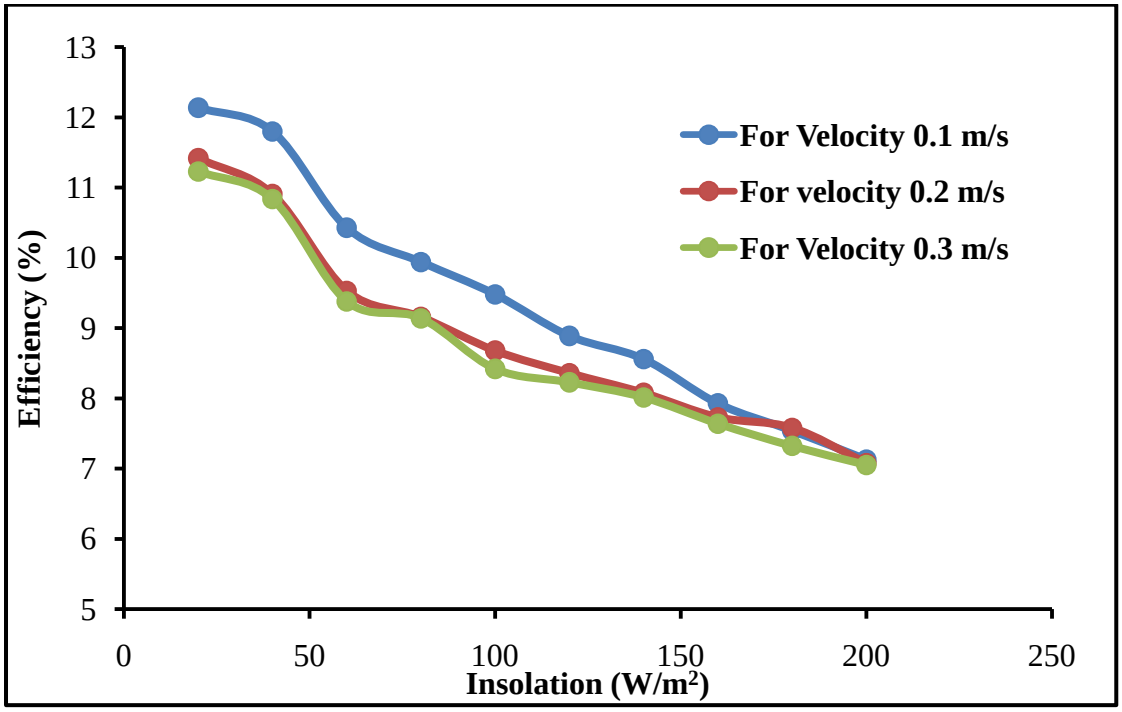

Fig.8 comparison of efficiency for different velocity of feed roller mechanism

From the above analysis it is found that the value of efficiency is maximum for feed velocity 0.1 m/s where as it is minimum for feed velocity 0.3 m/s. so it is concluded that as the velocity of feed roller increases the surface cleaning of the solar panel reduces due to this the radiation falling on the solar panel where less trap by the solar cell which is responsible for reducing the efficiency of the solar system.

VI CONCLUSION

From the above experimental analysis following conclusion were drawn

- It is found that the value of efficiency for all isolation is maximum in case of solar panel without dust.

- So it is conclude that as the dust were clean from the surface of the solar panel the efficiency of the solar system increases.
- From the graph it is found that as the rotation speed of the roller increases the efficiency of the solar system decreases.
- It is also observed that the efficiency of the solar system also decreases with the increase in solar isolation.
- From the analysis it is found that the value of efficiency is maximum for feed velocity 0.1 m/s where as it is minimum for feed velocity 0.3 m/s.
- So it is concluded that as the velocity of feed roller increases the surface cleaning of the solar panel reduces due to this the radiation falling on the solar panel where less trap by the solar cell which is responsible for reducing the efficiency of the solar system.

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