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Effect of dust on the operation of photovoltaic solar panels installed in the Hodna region - Experimental study

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Abstract

In this work, an experimental study of the effect of dust on the operation of photovoltaic solar panels was conducted in the Hodna region. For this, a monocrystalline type of solar panel was tested with a power of 100W. A quantity of dust was scattered for the first tests during the month of March 2022, then the voltage and current were measured. The second tests were conducted under outdoor M'sila conditions for two months. The results obtained show that the accumulation of dust on the surface of the panels reduces the passage of solar radiation on the one hand, and leads to a rise in the temperature of the panels on the other hand, which reduces the energy produced by the photovoltaic system. Therefore, periodic cleaning of photovoltaic solar panels is necessary.

Keywords: Photovoltaic, Solar energy, Voltage, Current, Dust, Temperature.

1. Introduction

The problems of unstable oil and gas prices and environmental pollution, especially carbon dioxide emissions, are pushing countries to turn to renewable energies because they are inexhaustible and environmentally friendly. Solar thermal and photovoltaic energies are important in the energy strategies of countries, especially in the long term because the lifespan of solar devices is estimated at 25 years in the production of electricity, and it is an alternative in the face of growing needs in energy and one of the best. Photovoltaic energy is a direct conversion of solar radiation into electrical energy through photovoltaic solar panels, but with climate change this conversion is affected by several parameters such as dust and environmental temperature [1,2].

However, due to PV system exposure to outside and meteorological conditions, the formation of dust on the PV panels degrades the performance during its expected period of operation. After solar radiation and temperature, dust is considered the third most significant factor that can affect the solar PV module performance. Dust from agricultural activity, pollen, air pollution particles, sea salt, construction and other anthropogenic and natural sources accumulates on the panels, this has a cascading effect on performance, from the reduction of sunlight to causing reduced energy absorption by solar cells [3-14].

This work is based on an experimental study of the effect of dust on the operation of solar panels installed in M'sila, in order to assess the effect of this factor on the electrical parameters of the panels for the Hodna region.

2. Experimentation

In order to study the effect of dust on the operation of photovoltaic solar panels, a series of experimental tests were carried out under the external and meteorological conditions of M'sila, in the laboratory of physics and chemistry of materials, Mohamed Boudiaf University, M’sila, Algeria. A comparative study of photovoltaic solar panels cleaned and without cleaning was undertaken.

Set Two monocrystalline solar panels were tested during the days of March 27 and May 11 2022, the first is cleaned with water only, and the second without cleaning. They are oriented towards the south with an angle of 35°, which is equal to the latitude of the wilaya of M'sila. We installed two identical solar panels of the monocrystalline type (figure 1), with a power of 100 W of the SFM-100 model (solar panels available in the laboratory).

Fig 1. The two solar panels tested (with and without cleaning)

2.1 Measuring devices

Weather parameters are measured using a Vantage Pro2 brand weather station, Davis Laboratories. The currents and voltages of the panels are measured by a FLUKE 600V CAT type multimeter. The mass of dust on the solar panels was measured by a KERN-type electric

balance. To measure the current, the multimeter was connected in series with a resistor. We conducted two series of tests to find out the effect of dust on the operation of photovoltaic solar panels.

2.2 First tests (March Tests)

For the March 2022 tests, the dust was scattered on the solar panel by us.

2.2.1 Meteorological parameters

The day of March 27, 2022 was characterized by sunny weather, with light gusts of wind and a few cloudy periods, as the following curves show (Figure 2):

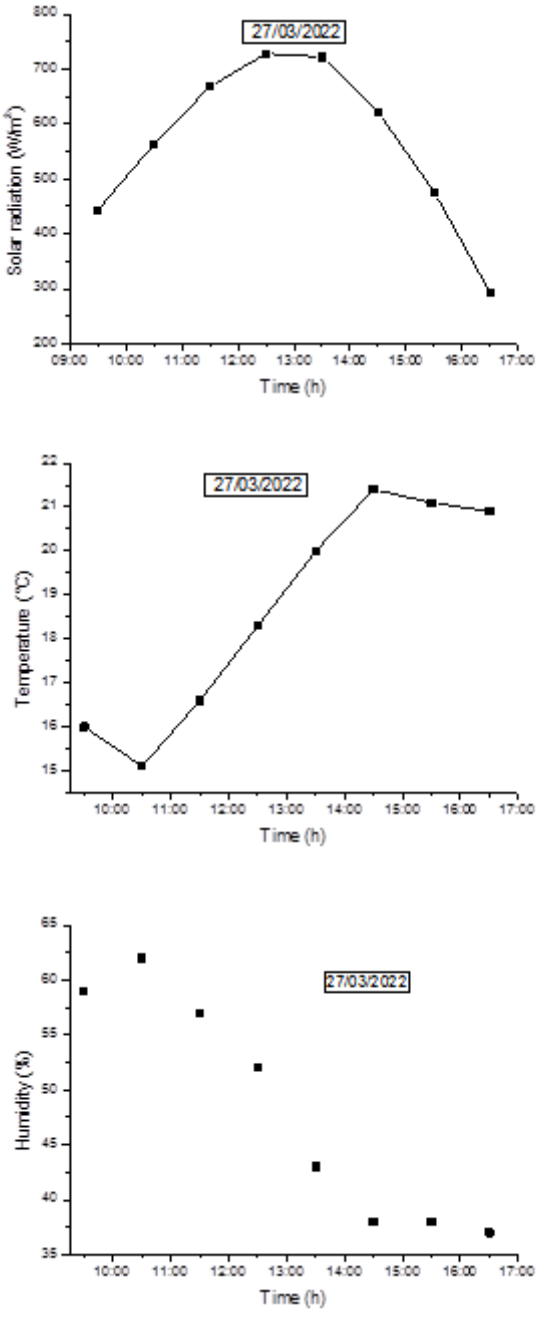


Fig 2. Temporal variations of meteorological parameters (Day of 27/03/2022)

2.2.2 Current and voltage measured values of the panels

The measured values of the current and the voltage of the panels were recorded every hour, from 9:30 to 16:30. The obtained results are shown in figure 3.

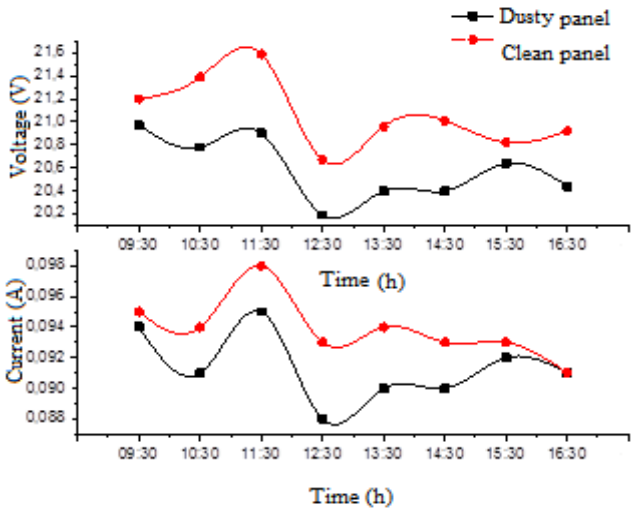


Fig 3. Temporal variations of current and voltage for the month of March

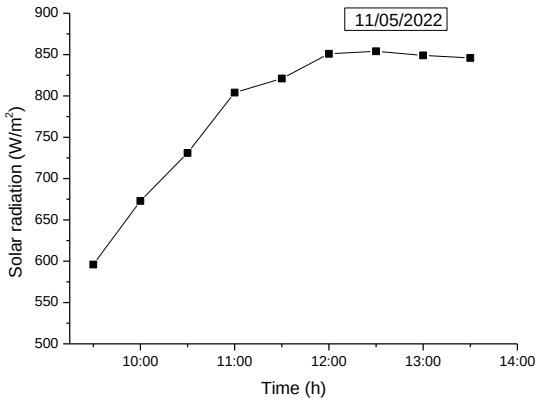
The curves in figure 2 which represent the daily variations of current and voltage illustrate that the clean panel takes on higher values than those of the dusty panel. This indicates that dust deposition has a significant effect on the operation of photovoltaic panels.

2.3 Second tests (May Tests)

The May tests were conducted under real external conditions for two months without cleaning for the first panel, and the second was cleaned before taking each measurement.

2.3.1 Meteorological parameters

May 11, 2022 was characterized by sunny weather with a clear sky with some clouds, as shown in Figure 4.



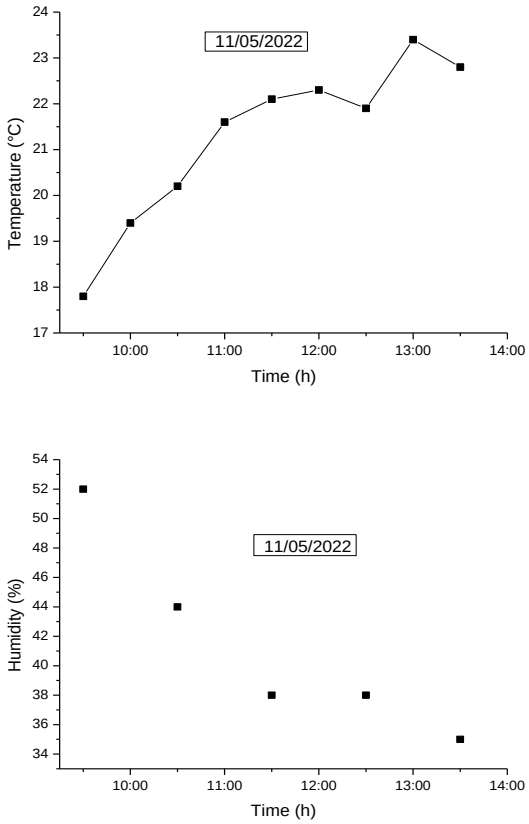


Fig 4. Temporal variations of meteorological parameters (Day of 11/05/2022)

2.3.2 Current and voltage measured values of the panels

The measured values of the current and the voltage of the panels were recorded every hour, from 9:30 to 13:30 for the day of May 11. The results are shown in figure 5.

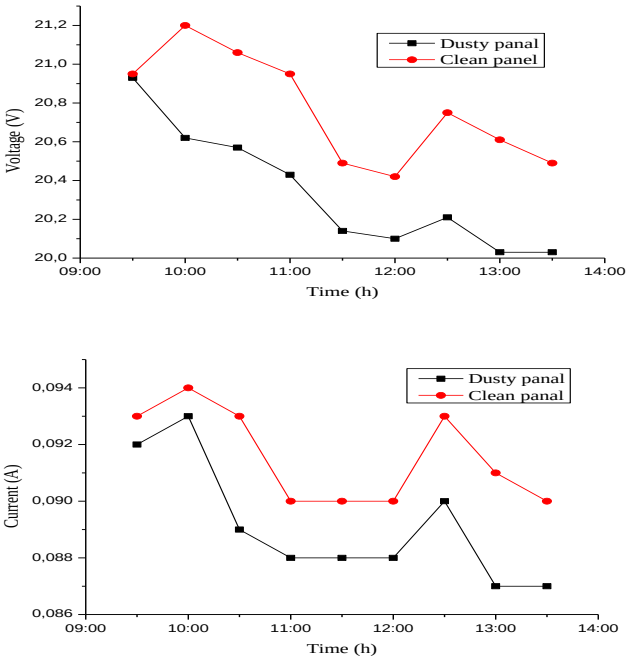


Fig 5. Temporal variations of current and voltage for the month of May

The curves in figure 5 show that the difference between the values of the voltage and the current of the cleaned solar panel and those of the dusty panel is higher during the morning, then it is gradually reduced until noon. Where, almost all the curves are coincident. This can be explained by the large amount of solar radiation falling on the panels at noon, when the rays are perpendicular to the solar panels. In the afternoon, the gap begins to gradually increase again. It can also be concluded that if the thickness of the dust layer is low and not opaque to the solar ray, the effect thereof is negligible.

2.4 Effect of dust on solar panel temperature

The temperature of the solar panels was measured every hour from 9:30 to 15:30. The results obtained are presented in Table 1.

Table 1. Temporal variations of solar panel temperatures (with and without cleaning)

Time	09 May 2022		10 May 2022	
	Clean panal temperature (°C)	Dusty panal temperature (°C)	Clean panal temperature (°C)	Dusty panal temperature (°C)
09 :30	27,8	28	32	33,1
10 :30	29,4	30,5	41,9	44,3
11 :30	41,8	44,5	54,2	55,7
12 :30	43,9	45,9	54,7	55,7
13 :30	48,9	49,8	55	55,7
14 :30	52	53,9	56	56,1
15 :30	44	44,5	49	49,9

We note that the solar panel temperature without cleaning is higher than that of the clean panel, which proves that the layer of dust prevents the natural cooling of the panels.

3. Conclusion

After analysing the results obtained in this experimental work, where great interest was shown in the effect of dust on the operating characteristics of solar panels. It can be concluded that the deposit of dust on the solar panels is an impediment to the proper functioning of the latter, in particular, if the quantity of dust is high, the percentage of solar rays passing through decreases and its temperature increases, which is reflected in a negative effect on the electrical properties of solar panels and their low efficiency. It is necessary to periodically clean the photovoltaic

panels in order to maintain them and their performance. Also, solar panels generate less energy when exposed to high temperatures compared to when they are in a cooler climate. Solar photovoltaic systems can often generate more electricity on a day with cool wind and hazy sunshine than when the sun is shining and the temperature is high.

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