MONITORING THE DUST LEVEL OF OPTICAL SURFACE OF SOLAR PANELS AND AUTOMATIC CLEANING DEVICE

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Annotation: The period of use of solar panels is on average 20-25 years. Therefore, during this period, it is important to constantly monitor these solar panels, especially to analyze the amount of dust particles collected on their surfaces. This article provides information on monitoring the dust level of the optical surface of the solar panel and the automatic cleaning device in time.

Key words: Solar panel, dust, monitoring, automatic device, current, voltage, power.

The global energy requirements have increased significantly in the past several decades and are predicted to rise more than 50% by 2030. Present world energy requirements are met mostly from the conventional sources of energy like coal, gas and oil, which are being exploited in an unregulated manner resulting in exhausting world reserves of fossil fuels in the near future. With increasing cost of electricity and concern for the environmental impact of fossil fuels, implementation of renewable energy sources like solar power are rising. [1].

The main method for harnessing solar power is with arrays made up of photovoltaic (PV) cells. Electricity generated using solar photovoltaic (SPV) technology can only be economical if the PV modules operates reliably for 20– 25 years under field conditions. The main limiting factors which reduce extensive use of PV applications include the high initial investment cost and the relatively low conversion efficiency of PV cells due to heating of PV panels. [2,3,4].

The influence of dust particles on the surface of solar panels and temperature on its energetic parameters

Module temperature is always higher than the ambient temperature. Higher temperature of the module is because of the glass cover over it, which traps the infrared radiation. [5]. Overall, power output and efficiency of the PV cells decrease with the increase in its operating temperature as shown in Figure 1.

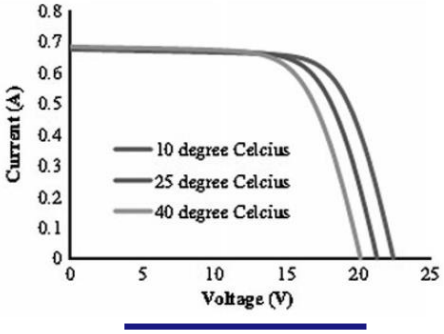

Figure 1. Effect of temperature on the I–V curve of the PV module

A linear increase in solar radiation causes a linear increase in module power. Figure 2 shows the dependence of solar radiation on the module volt-ampere characteristic. The results of several decades of research conducted in different regions of the world have shown that the dust particles collected on the optical surface of the solar panel have a significant negative impact on the efficiency of the module.

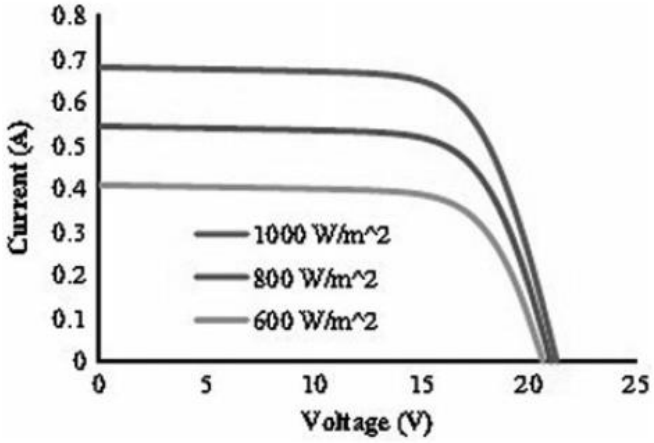

Figure 2. Effect of Solar irradiance on the I–V curve of the PV module

As a result, most of the radiation coming from the sun is trapped by the dust particles collected on this surface, and as a result, it leads to a decrease in efficiency. The accumulation of dust particles in different regions of the world requires different time. It depends on the angle and direction of installation of the solar panel, the direction of the wind, and the nature of the dust. In addition to the above natural factors, even production technology plays a role [6, 7, 8]. Table 1 shows the efficiency indicators of different types of photovoltaic technologies.

Table 1. Solar photovoltaic technologies

Number	PV technology	Efficiency (%)
1	Carbon nanotubes (CNT)	3-4
2	Amorphous silicon	5-7
3	Poly crystalline silicon	8-12
4	Mono crystalline silicon	15-18
5	Other thin film (CdTe, CIS, etc.)	16-20
6	Triple junction under concentrated Sun	Up to 37.4

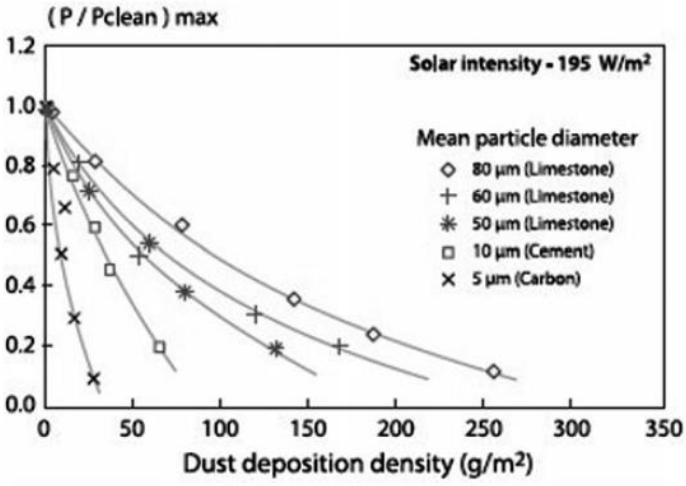

Figure 3. Short circuit current for various particle sizes as a function of dust deposition density

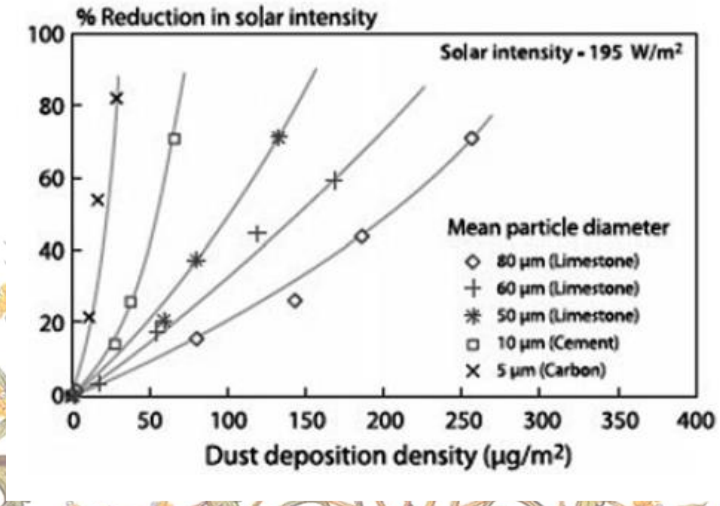

Figure 4. Power output for various particle sizes as a function of dust deposition density

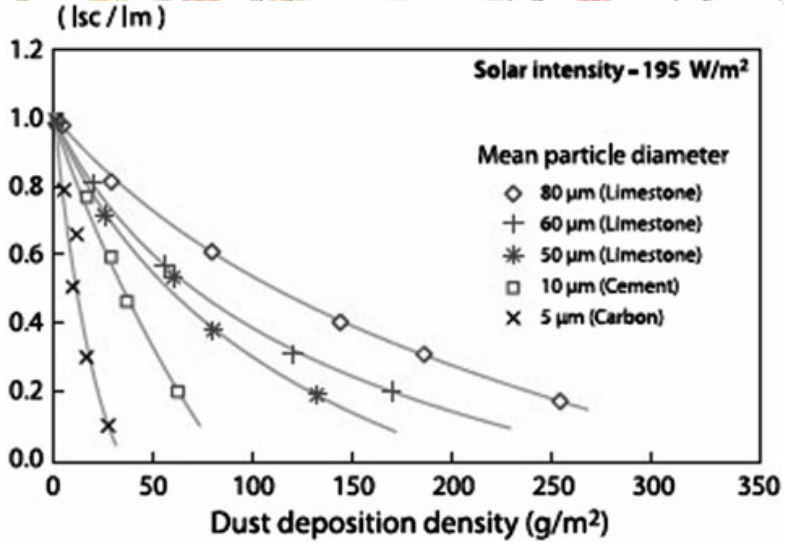

Figure 5. Reduction in solar intensity for various particle sizes as a function of dust deposition density

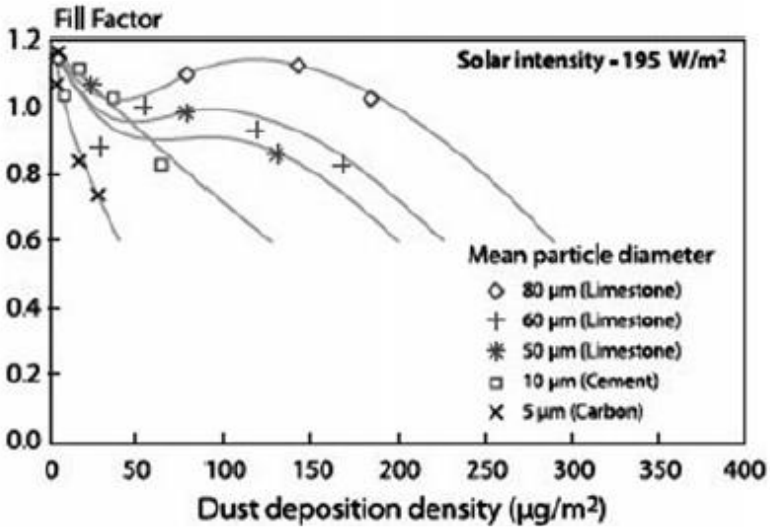

Figure 6. Reduction in fill factor for various particle sizes as a function of dust deposition density.

It can be concluded from the pictures 3, 4, 5, 6 above that different dust particles have different effects on the efficiency of the solar panel. It is clear from the graphs that the particles that have the highest negative impact are the smaller ones [8].

Methods of cleaning the optical surfaces of solar panels from dust particles

Solar panels are now being cleaned by natural methods, automatic methods, and manual methods. The natural cleaning method means implementation with the help of rain, with the help of wind energy and at the expense of melting snow. Dust particles on the surface of the solar panel are washed away by rainwater. Dust particles fly off the solar panel during wind. One of the next main cleaning methods is the automatic cleaning method. These consist of devices consisting of various cleaning brushes and automatic water spraying systems. Below are some automatic cleaning tools [9].

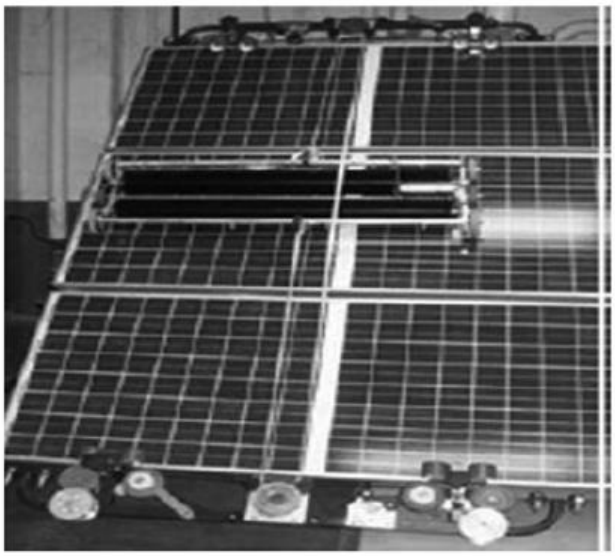

Figure 7. Real-time operation of PV cleaner

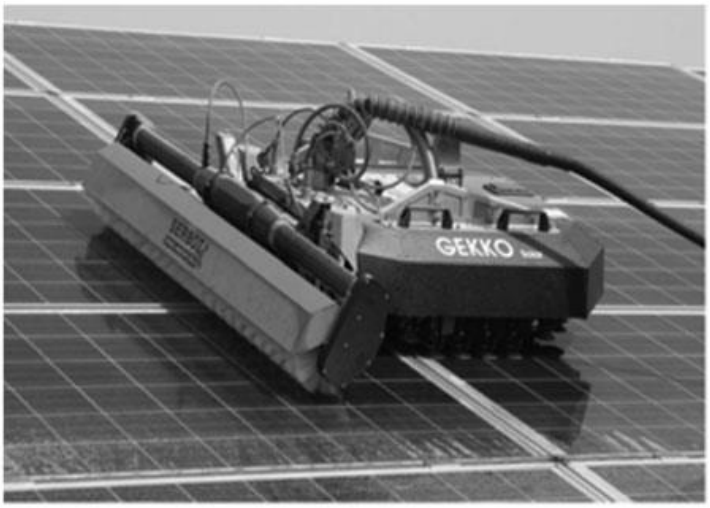

Figure 8. Cleaning of Solar PV module using Gekko Solar

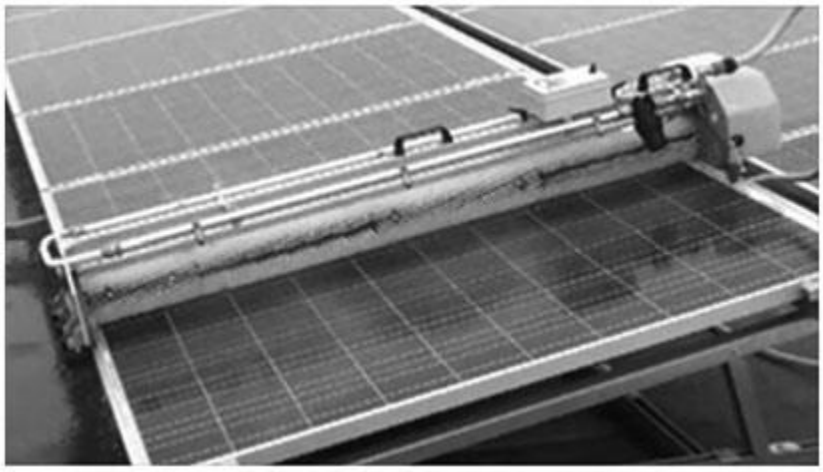

Figure 9. Wash panel cleaning over SPV (solar photovoltaic)

Figure 10. Greenbotics solar PV cleaning robot in action

Proposed device

This device belongs to the measurement technology, and can be used in particular to determine the degree of contamination of the optical glass protective surfaces of photovoltaic solar panels and to provide automatic self-cleaning.

The optical transparent glass used to protect the surface of photovoltaic cells mainly works in open areas, is exposed to various atmospheric influences (dust precipitation, volatile small waste, automobile and industrial exhaust gases, snow, etc.), falls on the surface of the solar panel. As a result, the efficiency of converting solar radiation into electrical energy decreases.

Thus, the proposed device increases the energy efficiency of converting solar energy into electricity by expanding the functionality that is, providing the monitoring function and switching mode when automatically cleaning the surface of photovoltaic cells in time, the efficiency of remote information acquisition, and the electricity for washing. increases the level of ease of operation with minimal consumption of energy and clean water. If necessary, you can use a wireless Wi-Fi communication line (radio channel) / or infrared range with appropriate optics (if direct vision can be provided) or cellular you can use a communication line (mobile phones), but this will increase the cost of the device. There are different designs for cleaning the surfaces of solar panels with pumps, hoses, sprayers (nozzles, carcher nozzles, etc.) and therefore they are not given in the description. Below is a schematic view of the device that monitors the dust level of the optical surface of solar panels and has an automatic cleaning function [10].

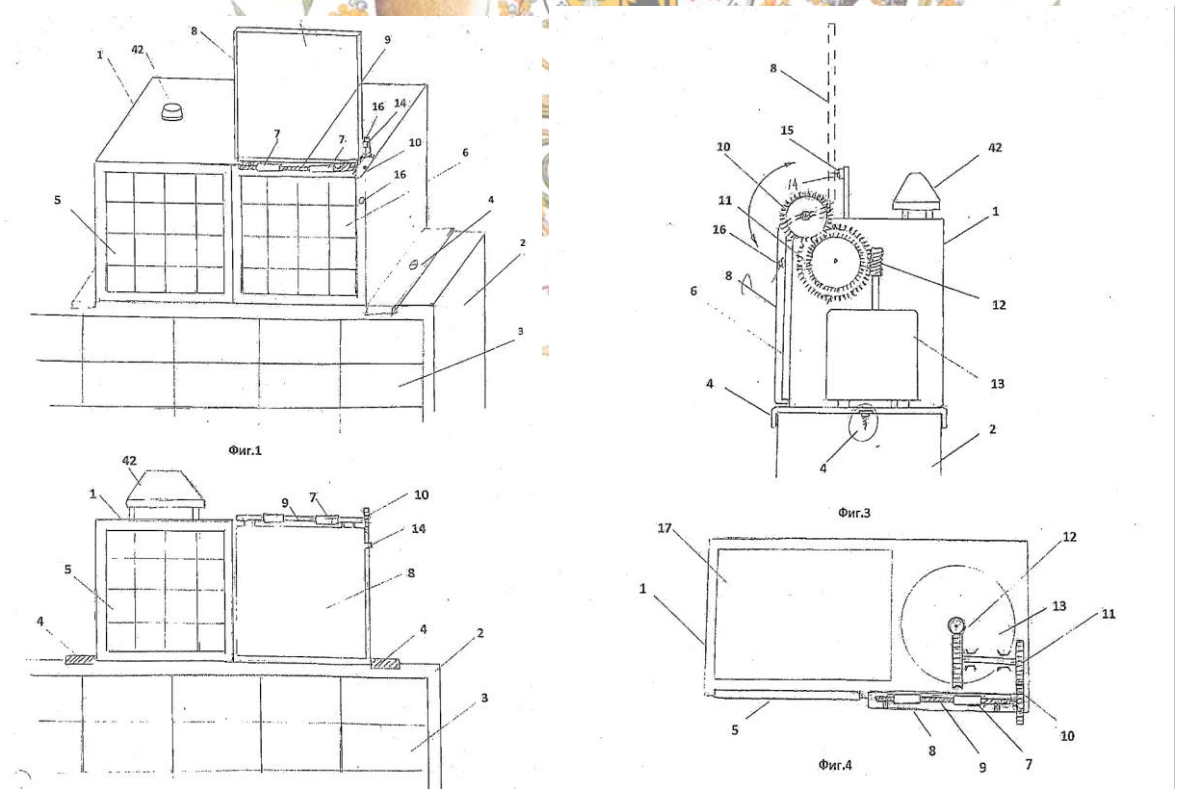

Figure 11. Schematic view of an automatic device that monitors and self-cleanses the level of contamination of the photoelectric battery optic surface.

Summary. The proposed device significantly increases the efficiency of the solar panel and keeps the necessary information informed by monitoring the pollution of the optical surface of the panel. It is advisable to use this device mainly in areas with a high level of dust.

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