A New Solar Energy Converting System with Vertical Photovoltaic Panels

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Abstract— **A major problem of solar panels is the soiling of the surface caused by environmental factors (dust, snow). Cleaning (periodic maintenance) using different cleaning techniques is expensive and sometimes are limited by the fragility of the solar panels systems. There was an intense research concerning the cleaning methods of the solar panels, such as mechanic, ultrasonic and electrostatic methods, but they jeopardize the integrity of the solar panels. In order to remove the active substrate of the solar cells from the cleaning system, a new design of the solar panel has been developed. The new system proposed in this paper uses two vertical solar panels sided mounted along a forty five geometrical degrees mirror prism. The light coming from the sun is reflected horizontally, perpendicular, due to the prism to the photovoltaic panels.**

Keywords- cleaning system; solar; vertical panels.

I. INTRODUCTION

A major problem in the solar panels system energy generation is the soiling of the panel's surface exposed to the sun caused by environmental factors (dust, snow smog). Cleaning methods and periodic maintenance are expensive and reduce the efficiency of the solar panel if they are not done in time.

There was an important research done focusing on the cleaning technologies of the solar panels, such as mechanic, ultrasonic and electrostatic methods, but they jeopardize the integrity of the solar panels.

An important issue concerning the solar panels systems energy efficiency is the decreasing of the transparency of the glass surface due to the soiling particles from the close environment such as dust, snow, smog, etc. The technologies used for the solar panels cleaning are expensive and can damage the integrity of the solar system. The improvement of the energy efficiency of solar photovoltaic systems requires new cleaning methods such as ultrasonic and electrostatic, but they also can jeopardize the integrity of the photovoltaic cells. Over time, solar panels will get covered with pollen, dust, grime, dirt, and even bird droppings.

In time, the surface of the solar panels is covered with particles from the atmosphere that fore decreasing their energy efficiency. The solar panels are used usually in the deserted or remote areas, along the highways where the presence of the dust particles or smog have a major effect on the good functioning of the solar systems. The natural auto-cleaning of the solar panels due usually to the rain and wind is ineffective and uncontrollable. The dust deposition is a major problem in the desert areas where the frequency of the rain is reduced.

The electrostatic methods of cleaning and purification of the air have been used for decades for dust or another particles removal from gases. Recently, the electrostatic methods have been used for surface cleaning, which make them suitable for solar panels cleaning as well, due their simplicity and maintenance free proprieties.

The particularities of the high efficiency areas for solar systems with high concentration of dust particles, isolated remote villages or polluted zones, where solar radiation is high enough to have an economically efficient energy production, require low-maintenance solar panels and innovative technologies of cleaning or dust/smog protection.

One of the methods of cleaning the solar panels are the electrostatic methods. Dust particles are generally smaller than 50 um in diameter, consisting of particles of different physical properties, chemical compositions and electrical proprieties. From the electric point of view they have the proprieties of insulated materials.

Figure 1 presents a free electric screen or curtain without the dielectric film proposed by Mizunder and all. The electrodes are connected to a high voltage power supply by using either a single-phase or a three-phase AC drive wave forms. Single-phase excitation produces a stationary wave between the electrodes, [1], [2], [3].

The dust particles are electrostatic charged on one polarity of the voltage of the electrodes. When the polarity is changes the charged particles of dust are repelled from the surface of the solar cells. More effective have been proved to be the three-phase high voltage wave-forms that produce a moving electrostatic wave, [3], [4].

The three-phase high voltage wave system is more effective because it moves along the surface of the solar panel, inducing a longitudinal electrostatic force that removes the dust particles [4].

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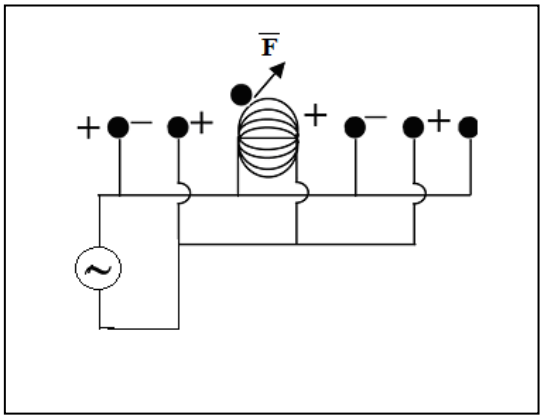

Figure 1. Single-phase electrostatic dust removal system (Masuda,1971).

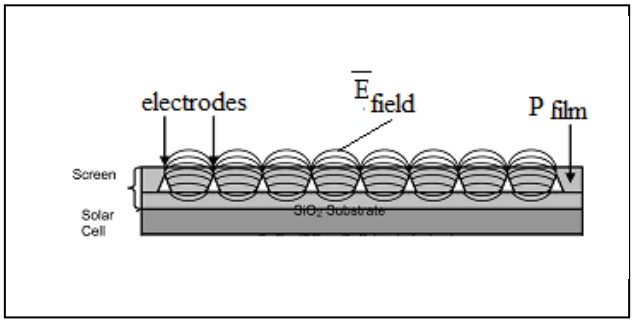

Figure 2. A transparent electrostatic screen over a solar panel.

The insulated particles from the surface of the solar panel are charged by the electric field E_{field}. Due to the fact that the electric field between the multiple electrodes is variable, changing its polarity periodically, an electrostatic force acts on the dust particles. As a result a displacement force on the particles is generated leading to their moving on the surface of the panel to the margins of it, (Figure 2). The highest is the voltage that is used the best efficiency of dust removal is obtain. The problem is that using a very high voltage can damage the solar panel by accidental electrostatic discharges to the semi-conductor substrate.

Another technology, which is very effective on the dust/particles (organic or inorganic) removal from surfaces, is the ultrasonic technology. The ultrasonic cleaning wave acts on the dirty films attached to the surface due to a long exposure to the atmospheric pollutant factors. Due to the fact the ultrasonic waves can induce cavitations in the dirt layer it is able to remove hard adhesive substrates very difficult to be remove using classical cleaning methods, and also can clean hard-to-reach and inaccessible surfaces. The cleaning effect of the ultrasonic waves is used today in very different areas of activity when the classical cleaning methods are ineffective and expensive. As a disadvantage, the cavitations processes can affect also the sensitive electronic surfaces or layers leading to their destruction. As an example, a classical ultrasonic cleaning system is shown in Figure 3, [5].

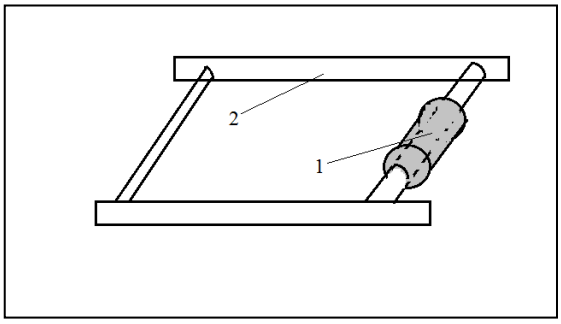

Figure 3. Ultrasonic cleaning device.

The ultrasonic cleaning device presented in Figure 3 uses two ultrasonic piezoelectric generators (1) and two long plates (2). In the area determinate by the piezoelectric oscillators and the plates a "grid" of ultrasonic waves are formed, all the unwanted materials attached to the surface to be cleaned being removed. The ultrasonic cleaning system can also damage the solar panel.

II. EXPERIMENTAL

In order to avoid the solar panel damaging by the cleaning process, on consider a new geometry of the solar panel system. The new geometry uses two vertical photovoltaic panels (solar garden lamps type), placed parallel faced one to each other. Between them a 45° surfaces mirror prism is placed as is shown in Figure 4.

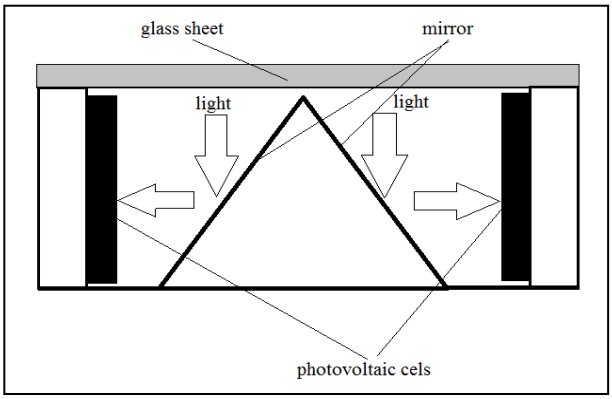

Figure 4. The vertical photovoltaic system schematic

In Figure 5 is presented the photovoltaic system that has been used for experimental set up.

The new system proposed in this paper uses two vertical solar panels, commercial available, posed along a 45° (geometrical degrees) mirror prism one of each side of the prism. The light coming from a light source fixed above the prism is reflected horizontally, perpendicular, due to the prism mirror sides, direct to the photovoltaic panels.

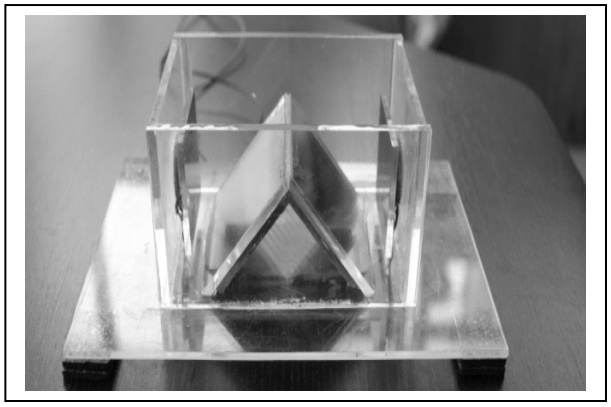

Figure 5. The vertical photovoltaic panels system

The electrical schematic of the vertical solar system is presented in Figure 6.

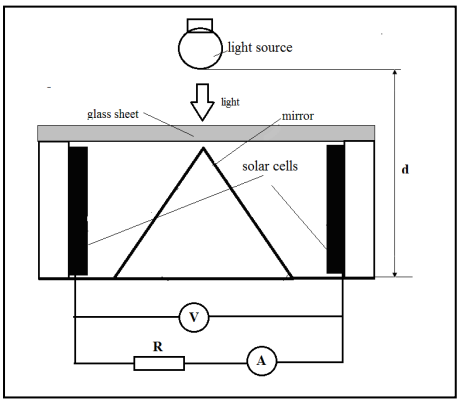

Figure 6. The vertical photovoltaic panels system. R= 330Ω.

The vertical solar system performances (voltage, current) have been measured as is shown in Figure 6 for different distances **d** of the light source (a 75W bulb). The data have been compared with classical horizontal solar system performances, in the same experimental conditions and for the same distances from the light source. The experimental data for the voltage at the outlet of the solar panel for both experimental set up are presented in Figure 7.

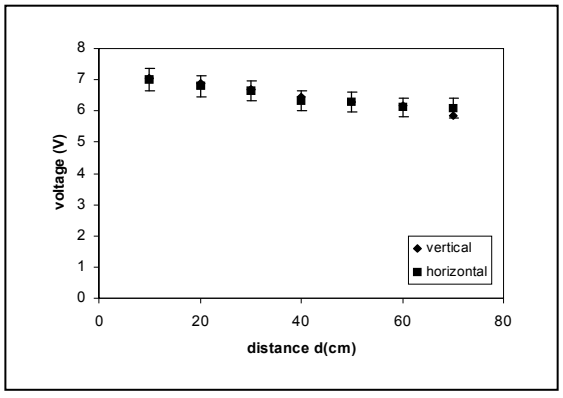

Figure 7. The voltage evolution for different distances.

In Figure 8 are presented the experimental data for the current at the outlet of the solar panel for both experimental set up.

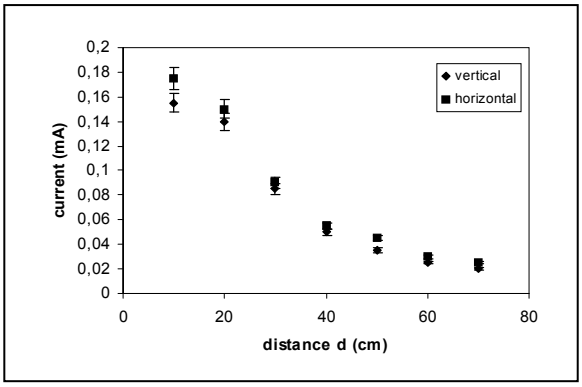

Figure 8. The current evolution for different distances.

The Figures 7 and 8 show insignificant differences between the classical solar system with horizontal positioned panels and the new system with vertical solar panels in terms of output voltage and current (power). On can affirm that the two solar systems are similar from the point of view of energetic performances.

III. CONCLUSIONS

The system does not affect the efficiency of the photovoltaic panels. There is no decrease in the power produced by mounting the panels vertically. The upper part of the system covered with glass allows automatic cleaning by electrostatic or ultrasonic methods without jeopardizing the integrity of the photovoltaic panels. The mirror system does not imply important additional costs as concerns the constructional solution. It can be used as a hybrid system, produces thermal energy by cooling the glass enclosure.

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