

Self-Cleaning Solar Panels to Avoid the Effects of Accumulated Dust on Solar Panels Transmittance

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Abstract: *In previous experiments, dust accumulation for the solar panels has been investigated for a long period of time which is approximately one year [1]. The experiments have been done in different countries which have climate conditions of the dusty weather. Those countries are Iraq, Egypt and UAE. The solar panels were never cleaned, firstly for one month, secondly for two months and so on. The results were there was a decreasing in the transmittance of the solar panels, which is emphasize the effect of accumulated dust, even though the changing in the tilt angel which is in conjunction with the dust deposition on the panels. A well designed auto cleaning system to clean the solar panels will be added to the panels to keep the transmittance of the solar planes fixed approximately and to reduce the cost- of periodic cleaning.*

Keywords: Self-cleaning, Solar Panel, Transmittance, Dust Affects.

1. Introduction

Most of the applications nowadays like heating water, agriculture and industrial applications use the solar panels as an electrical power source instead of relying on the generators or the ordinary sources for electricity. The most important part of these systems is the solar panel where the solar energy is converted to heat for water heating or converted to electricity for the others. There are many types of the solar panels. The first one is the standard silicon single crystal module fabrication crystal to ingot to wafer to module. Second, the flat plate panel is the most widely used in the world. Third, thin film module - spray-on successive non-crystalline films.

For those countries that have a bad weather conditions like the middle-east countries, also the countries of the north of Africa, which have a dusty climate and covered by the desert belt, the accumulation of dust on the solar panels will lead to the reduction of the panels' transmittance [1]. Solar desalination plants in some of the middle-east countries like the solar desalination plant of Abu Dhabi suffers from the deposition of dust [2] on its solar plates. With the time, the accumulated dust will affect the transmittance of the solar plates. Hegazy [1] found that the effect of the accumulated dust will be reduced with the increasing of tilt angle, since the tilt angle will affect the exposure time to the sunlight also. But the best way to eliminate the effect of the accumulated dust on the solar panels is to clean the panels.

Cleaning the solar panels is also a problem. The normal way to clean the solar panels is washing them. But still also need time to spend or paying money to a cleaning agency. Actually, the cleaning should be frequently from time to time, and that is mean spending more and more money for cleaning. Our research is to construct a new method of self-cleaning. A solar panel supported with auto-cleaning robot [3]. A two linked-track vehicle supported by brushes was proposed [3]. The structure of the robot will be designed to meet the specification of the flat plate panel. The robot will

be consisting of brushes driven by DC-motors. The movement of the brushes will be controlled by a microcontroller. The DC-motors will produce a rotational motion. The rotational motion of the DC-motors will be converted to a linear motion by using a belt where the brushes will be fixed on the belt. The sufficient electrical power which is needed to drive the DC-motors will be supplied from the solar plate itself.

This research is a combination of two ideas. The first one is the idea of the reduction of the effects of accumulated dust on the flat solar plate. Hegazy [1] studied the effects of accumulated dust on the flat solar plate with different tilt angles. Hegazy conclude that for moderately dusty places, weekly cleaning of solar panels is strictly recommended as part of the maintenance routine. Nevertheless, equipment should be cleaned immediately after a dust storm to retain nominal operating efficiency. In similar investigations, Garg [4] has measured the normal transmittance of direct radiation through glass and found that over a period of 30 days, the transmittance decreased from 90% to 30% for a horizontal mounting.

Similar measurements were made in Kuwait by Sayigh et al. [5], who observed 64%, 48%, 38%, 30% and 17% reduction in the transmittance of the glass plates after 38 days of exposure to the environment with tilt angles of 0°, 15°, 30°, 45° and 60°, respectively.

All those studies show that the dust accumulation affect the on the transmittance of the solar collector and there should be a cleaning schedule for the solar panels.

The second one is using an auto-cleaning robot to reduce the accumulated dust. R.D. Schraft and U. Brauning have designed an automated cleaning robot to clean the facades of the buildings [6]. Their robot was designed to clean the flat windows of the buildings. This robot automatically cleans the outside of windows on a facade with vertical jambs and horizontal bars. According to the above statements this

research will solve the problem of the dust accumulation to reduce the effect of dust by designing an automatic cleaning robot based on the idea of facades robot cleaner.

2. The Aim of the Research

In this research, the effects of accumulated dust have been studied by the working team so as to analyze the maximum non cleaning time for the flat solar plate. Also, investigate and design an auto cleaning robot to work as the auto cleaner which is fixed on the flat solar panel. The design of the auto cleaning robot will have flexibility in order fix on different sizes of flat solar panels.

3. Methodology

- a) Collecting and studying more extra details regarding the effects of accumulated dust on the flat solar panels.
- b) Designing the basic prototype of the auto cleaning robot.
- c) Choosing the proper microcontroller to control the auto cleaning robot.
- d) Designing the microcontroller's algorithm such that the microcontroller can control the robot in the right direction.
- e) Execute the algorithm in the real time to investigate and debug the common errors.

4. Components of Auto - Cleaning Robot

In this section we illustrated the components that used to build the auto cleaner robot:

1- Brushes driven by DC-motor



Brush



DC- Motor

2- Microcontroller use to control the Brushes movement



Microcontroller

3- Conveyor Belt use to convert the rotational motion of DC-motor to linear motion



Conveyor Belt

4- Sensors use to give Information to Microcontroller



Sensor

5. Conclusion

Actually, there are many benefits from such a project. First, economical benefit, where there is no more money will be paid to a cleaning agency. Second, it is time saving, where there is no time will be spent to clean those solar panels. Besides that, frequently cleaning will ensure that the solar panel works with a good transmittance. Finally, safety and health of workers in sites. Since robots are capable of working in hazardous environments, more dangerous operations are being handled by robots. Thus the safety and health of workers is ensured, thereby reducing expenditures on health and medicines.

References

- [1] Hegazy, A.A., Effect of dust accumulation on solar transmittance through glass covers of plate-type collectors. *Renewable Energy*, 2001. 22(4): p. 525-540.
- [2] El-Nashar, A.M., Seasonal effect of dust deposition on a field of evacuated tube collectors on the performance of a solar desalination plant. *Desalination*, 2009. 239(1-3): p. 66-81.
- [3] Houxiang Zhang; Wei Wang; Rong Liu; Jianwei Zhang; Guanghua Zong; , "Locomotion Realization of an Autonomous Climbing Robot for Elliptic Half-shell Cleaning," *Industrial Electronics and Applications*, 2007. ICIEA 2007. 2nd IEEE Conference on , vol., no., pp.1220-1225, 23-25 May 2007.
- [4] Garg HP. Effect of dirt on transparent covers in flat plate solar energy collectors. *Sol Energy* 1974; 15(4):299-302.
- [5] Sayigh A, Al-Jandal S, Ahmed H. Dust effect on solar flat surfaces devices in Kuwait. In: *Proceedings of the workshop on the physics of non-conventional energy sources and materials science for energy*. Triest, Italy: ICTP; 1985. p. 353-67.
- [6] R. D. Schraft, U. Brauning, T. Orłowski, M. Hornemann, Automated cleaning of windows on standard facades, *Automation in Construction*, Volume 9, Issues 5-6, September 2000, Pages 489-501, ISSN 0926-5805, DOI: 10.1016/S0926-5805(00)00060-1.

Author Profile



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