AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
MECHANICAL POWER ENGINEERING DEPARTMENT

Experimental and Numerical Investigation of Various Cooling Techniques for Enhancing Solar Cells Efficiency

A thesis submitted in partial fulfillment of the requirements of the Doctor of Philosophy degree in Mechanical Power Engineering

Submitted by:

Abdelaziz Bayoumi Abdoh Ali Hussien

M.Sc. in Mechanical Engineering (Mechatronics), Ain Shams University, June 2014

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Cairo, 2017

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EXAMINERS COMMITTEE

The undersigned certify that they have examined and discussed openly the Ph.d. Thesis submitted by **Eng. Abdelaziz Bayoumi Abdoh Ali Hussien**, in partial fulfillment of requirements for the degree of Doctor of Philosophy, titled "**Experimental and Numerical Investigation of Various Cooling Techniques for Enhancing Solar Cells Efficiency**". We recommend to the Faculty of Engineering, Ain Shams University to accept the thesis and offering the student the Ph.d. Degree in Mechanical Engineering (Mechanical Power Engineering).

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Date: ___/ ___ / 2017

STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Doctor of Philosophy in Mechanical Power Engineering.

The work included in this thesis was carried out by the author at the Mechanical Power Engineering Department, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

No part of this thesis was submitted for a degree or a qualification at any other University or Institution.

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ABSTRACT

One of the important challenges in utilizing the photovoltaic (PV) system is the decrease in the energy conversion efficiency of PV cells during the working period. This is due to increase in the cells temperature above a certain amount. To enhance the output power of PV systems one way is cooling them during the operation period that can be achieved via heat absorption by a cooling medium, which can in turn be utilized in other applications.

This thesis investigates the output power of photovoltaic module. It includes two parts, the first is comparing two previous shapes of cooling fluid pipes (serpentine shape, parallel shape) with a new structure (serpentine-parallel shape) that was a combination between these two shapes. At the start water is used as the cooling fluid.

In the second part, two types of nano-fluids (TiO_2-water, Al_2O_3-water) as a cooling fluid are used to enhance the PV performance on the best shape of pipes. A comparison between theoretical (Comsol Multiphysics package) and experimental work results for fixed Photovoltaic/ Thermal (PV/T) hybrid system is presented.

An active cooling system is designed and conducted to cool the PV module at which an absorber system consists of copper plate and pipes that are attached in the backside of the PV module to allow water or the other two nano-fluids to flow underneath it.

In addition to the above an electrical analysis for the systems is conducted where I-V, and output power during working hours are presented. Beside that the thermal study for the fixed PV module and the piping system is presented which constitutes the outlet temperatures, the module temperatures, and overall heat transfer. As a result, a significant improvement in the electrical output power is recorded associated with the decrease in the module temperature.

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