Ain Shams University

Faculty of Engineering

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Study of the Heat Transfer Characteristics for a Heat Pipe Solar Collector

A ThesisSubmitted in Partial Fulfillment of the Requirements for the Degree ofMaster of Science in Mechanical Engineering

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ETHICS STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Master of Science 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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ACKNOLEDGMENT

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ABSTRACT

The purpose of this work is to study experimentally the performance of a heat pipe solar collector under the climatic conditions of Cairo, Egypt. A solar collector consists of four heat pipes with evacuated glass tubes has been designed and installed in an outdoor water heating system. The collector performance is studied during a summer day (5 August 2014) from 8:00 am to 3:00 pm with the collector facing south. The collector tilt angle was 30°, the cooling water flow rate was 0.2 lit/min, and the heat pipe evaporation to adiabatic length ratio (L_e/L_a) was 13.5. It was found that the average heat pipe maximum temperature was 66°C, the maximum useful rate of heat gain was 146 W, and the maximum efficiency reaches 68% at 1:00 pm. The collector overall heat transfer coefficient was found to be about 30 W/m^2K, and the optical efficiency was 64.15%. Also the effect of varying the collector tilt angle, the cooling water flow rate, and the evaporation to adiabatic length ratio on the collector performance are studied during different days in the summer season. The results showed that the performance of the collector is the best for the 30° inclination rather than the 45° and 60° inclinations. The optimum water flow rate was found to be 0.2 lit/min, and it was found that increasing the flow rate leads to the decrease of the efficiency.

Finally, the results showed that the collector has the best performance when the (L_e/L_a) is 13.5 and as the length ratio is decreased (by increasing the adiabatic length) the collector efficiency decreases.

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