MOHAMMED FOWZI MOHAMMED. STUDY TO ENHANCE THERMAL PERFORMANCE OF THE RISERS IN FLAT PLATE SOLAR WATER COLLECTORS. UNIVERSITY OF TECHNOLOGY. Mechanical Engineering Department . PH.D . Supervisors : Dr. Jafar M. Hassan and Dr. Qussai J. Abdul-Ghafour . 2015. 216P.

Abstract

The present work is a numerical and experimental study of thermal performance of modified flat plate solar water collectors. Numerical simulations have been done by solving the governing equations (Continuity, Momentum and Energy) equations in the laminar regime in three dimensions by using the FLUENT software version (14.5).

The effect of flow on temperature distribution of flat plate water collectors by inserting (twist strip with twist ratio (3), helical spring surrounding the solid shaft) inside riser pipes is numerically simulated and compared with solar collector without inserting device inside its riser pipes at flow rates of (100 and 150)ℓ/h . Also, the numerical simulation was to study the effect of variable combining and dividing header (convergent-divergent) with different diameters and compared with uniform header pipes at a flow rate of (100) ℓ/h. The experimental study included three flat plate solar collectors used in a closed loop system at a flow rates of (60,100 and 150) ℓ/h through the study of three main models tested. The models included, the effect of series and parallel connections on the thermal performance, the enhancement of thermal performance by inserting a strip with different twist ratio, compared the thermal performance of three flat plate solar collectors by inserted twist strip with twist ratio (3) inside risers pipes for one solar collector and inserted helical spring surrounding the solid shaft inside riser's pipes for the second collector. While the third collector was without inserted devices. This study is divided into two categories: first, the testing process without load withdrawal. Second, the testing process with

discontinuous load condition. The numerical simulation results show that the flat plate water, solar collectors with the inserted, twist strip and helical spring that's surround the solid shaft were higher enhancement of heat transfer than without inserted devices. Also, the velocity distribution inside riser pipes in case of uniform header diameter was found better than variable headers diameters for the same boundary conditions. The experimental results show that the collector's efficiency in series connection is higher than the parallel connection within flow rate level less than (100) ℓ/hr. Moreover, the collector efficiency in parallel connection of (I-Configurations) is more than the (Z- Configurations) with increasing the water flow rate. The maximum daily efficiency of parallel (I-Configurations) and (Z- Configurations) are (55%) and (51%) respectively at a water flow rate (150) ℓ/ hr. It was also noted that the thermal stratification of storage tank in case of series connection is higher than that of parallel connection. The experimental results show that, the highest heat transfer rate occurs at a twisted ratio (3).Consequently, for the same twisted ratio the daily efficiencies for the solar collector at different flow rates used (60,100 and 150) ℓ /hr, were (48.5 %, 56.5% and 62.6%) respectively. The daily efficiencies, were (6.8%-14%) higher than of without inserted devices and is about (2.5%-6.9%) higher than with a twisted strip insert inside riser pipes for the same weather conditions. Good agreement is obtained when experimental results are compared with the numerical simulation and previous works.

Keywords: flat plate. Solar collectors. Thermal performance