

Experimental Study to Evaluate the Performance of Flat Plate Solar Collector with Natural Circulation

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Abstract

In this research, a practical study was carried out on a flat plate solar collector covered by transparent layer faced toward the south and tilted 30° from horizon. The collector is low cost and simple design with 170 liters volume capacity. The collector works according to the natural circulation phenomenon where the flow occurs due to the differences in water density. The practical data were collected for Baghdad (33.3° N, 44.3° E) during the period 15 Sep – 31 Dec 2007. The performance of solar collector had evaluated for various conditions and water demands. The obtained data show confident results. It is noticed that the maximum temperature of the water on 15 Dec could reach (43°C) where the inlet temperature was (18°C). Based on that, the using of mentioned collector is reliable and applicable to supply domestic hot water in conjugation with auxiliary heater.

Keywords: Solar Collector, Natural Circulation, Hot Water, Renewable Energy

1. Introduction

The solar energy is an inexhaustible source of energy can be exploited to solve the energy problems in the world especially with the rapid decline of the index of global oil reserves and the increasing of energy demand for traditional industries. In Iraq, interest is appeared to invest the solar energy, where there is about (3600 hours) of solar radiation annually (Bishir & Ibrahim 1984). Hence many studies were carried out in research centres and universities. These researches have been focused on electricity generation, desalination of water, distillation and air-conditioning. Solar water heaters are the simplest of solar energy applications and the most widespread at the present time.

This research is focused on the using of solar collectors to supply domestic hot water. Solar collectors are usually designed to rise the water temperature up to (100°C) using means of simple technology and inexpensive by the benefit of both direct and diffuse radiation without the needing of track system or maintenance mechanism (Duffe & Beckman 1997). That simple solar collector is made of black absorber plate to absorb maximum radiation and transform it into heat to the circulated fluid then used for domestic application or stored. Some of the gained heat could be lost out to the atmosphere. Therefore, a good insulator is needed from the bottom and sides of the collector. The glass covering is required to ensure greenhouse effect.

2. Review

Several studies have been done by Iraqi researchers within the last years. (Nihad 1989) had presented a computational program to analyze the thermal performance of a solar heater designed to satisfy Iraqi ambient conditions. The collected data and the mathematical model are converted to a simple program. Numerical and experimental study had done by (Wisam 2004) to simulate the behaviour of solar receiver of prismatic shape and triangular Section. The testes were done using 190 liters heater. The performance of solar collector had evaluated for various conditions and water demands. The results show that the maximum temperature of the water on 15 Feb could reach (44°C) where the inlet temperature was (16°C). An experimental test by (Amer A. 2005) was illustrated to study a portable type of solar heater in Baghdad. The rectangular PVC solar collector has the dimensions 58 cm x 87 cm and tilted 30° with the horizon. The study showed the possibility of using such type with the demand of an auxiliary electrical heater.

3. Experimental Work

A flat plate solar collector was used in this study and covered by transparent layer faced toward the south and tilted 30° from horizon. Some modifications were done on this device in order to satisfy desire requirements and conditions. Figure (1) shows a schematic diagram for the mentioned device, while figure (2) shows the actual view. The collector consisting from the main following parts:

The Core: This part of the solar collector is consisting of ten riser tubes made from aluminium, each has 1.5 cm ID and 2 cm OD, a header tube of 2.5 cm ID and 3 cm OD collects them. The tubes are welded by an absorber aluminium plate with 115 mm apart for each couple of tubes. Silver wires were used for welding due to the high thermal conductivity, low melting temperature and keep the absorber plate from any contact damage. The absorber surface coating by a matte black paint has absorbency of 0.96 and emissivity of 0.81 (Khalifa & Mehdi 1999).

Insulated Case: The case is used to contain the absorbed plate and tubes and keep the heat gained by insulating from back and edges by 5 cm of rock wool. The headers are insulated also to decrease heat loss.