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Experimental Investigation of Solar Thermal Collector on the Open Parabolic Trough

Kadhim K. Idan Al-Chlaihawi, Khaled Al-Farhany and Ahmed Thabit Al- Rubaye
Department of Mechanical Engineering, University of Al-Qadisiyah, 58001 Al-Qadisiyah, Iraq

Abstract: Experimental study of solar heat transfer in a Parabolic Trough Solar Collector (PTSC) recording to the Iraq weather conditions in Ad Diwaniyah city (32°N, 45°E). Different parameters used included varying the flow rate, focal length to test their effects on the performance of the collector. Three rates of water flow were used (2, 2.5 and 3 L/min). Results showed that; the performance of the collector increases when the mass flow rate increases. Furthermore, when the flow rate increased from 2-3 L/min, the useful heat gain and efficiency of the collector increased by 29 and 28%, respectively. It also, can be seen the performance of the collector decreases as the focal length increase. Two different methods have been used to increase the energy obtained from the solar collector. The first method by using of secondary reflectors and the second method by using of fins. Two configurations of secondary reflectors were used named as flat reflector and curved reflector. By using the first method, the efficiency of the collector increasing from 34.7-40.8% while it increasing from 35.5-38.44% when the second method used.

Key words: PTSC, solar collector, parabolic trough, collector thermal efficiency, secondary reflectors, energy obtained

INTRODUCTION

The planet is exposed to environmental pollution due to the emission of carbon dioxide and other gases that led to global warming, increase the temperature of the atmosphere, the fall of acid rain, melting of snow and the erosion of arable land and the lack of rain from other areas, leading to desertification. Furthermore, our world is facing an ongoing economic crisis due to high-energy prices and increasing of demands because they are associated with fossil or conventional fuels (oil, gas and coal). For that, solar energy is one of the most important sources of renewable and clean energy which the world depends heavily in recent years on it for treating the energy problem. These renewable and sustainable energies are available in all parts of the world and they are clean and non-polluting energies. Recently, it has great importance and attention by the scientists because of the development of technologies that produced (Pearson *et al*., 2012).

Thermal energy can be produced from the sun by using solar thermal concentrators. As a result of multiple purposes, solar thermal concentrators can be divided into three types: low concentration concentrates, medium concentrates concentration and high concentration concentrates (O'Neill *et al*. 2002). High concentration solar concentrators used convex lenses or mirrors to focus the sun and produce high temperatures. Flat reflective surfaces cannot produce temperatures above 250•C while lenses and convex mirrors have been developed to produce temperatures greater than 1000•C. It used to evaporate water and operate steam boilers to generate electricity (Karp and Ford, 2010; Karp *et al*., 2010).

The most important design used to focus the sunrays is the parabolic trough Fig. 1 where convex mirror surfaces are used to reflect sunlight on glass surfaces containing tubes filled with special fluids that fill the entire size of the parabolic trough (Salomoni *et al*., 2010).

Now a days the most prevalent solar system for electricity production or steam generation for industrial processes is the parabolic trough technology. Thus, in

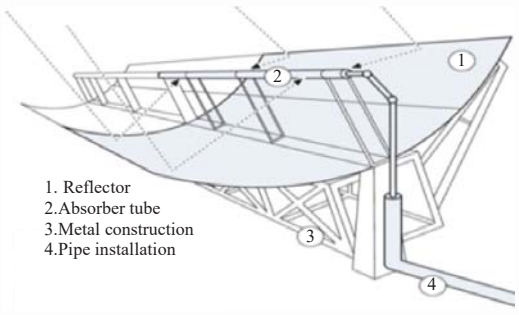

Fig. 1: Parabolic trough solar thermal collector

Corresponding Author: Kadhim K. Idan Al-Chlaihawi, Department of Mechanical Engineering, University of Al-Qadisiyah, 58001 Al-Qadisiyah, Iraq