Journal of Computer and Engineering Technology 5 (1)

ISSN: 2600-8971

Using Concentrating Solar Dish to Heat Water

Afreen Emad Sa'ad Aldeen, Mechanical Engineering, Al-Mustansiriyah University, Iraq, engafreen@yahoo.com

***Abstract*—** *The high intensity of solar radiation in Iraq encourages the researchers to apply many ideas to get benefit of that sort of renewable energy. Thus, this work focuses on the adaptation of solar energy to heat the water using a concentrating parabolic dish. The experimental model consists of a 150 cm dish covered by alu-foils to reflect the solar radiation upon the receiver. Two different shapes of receivers have been used, a cylindrical one with dimensions of (10 cm x 15 cm), and another of helical coil (250 cm length) inside square vessel of (30 cm x 30 cm). Two cases have selected for comparison: case (A), where the distilled water used as a working fluid, while in case (B) salt water used as a working fluid. The results show that the using of solar dish with helical coil receiver gives higher temperature than that of cylindrical receiver. Furthermore, the maximum temperature has been gained from case (B). However, the work gives as a good indication of using the described system in providing suitable hot water for domestic requirements in Iraq.*

Keywords-Concentrating Dish, Solar Radiation, Hot Water, Steam Generation, Renewable Energy**.**

I. Introduction

Solar energy is the most available, clean, and inexpensive source of energy among the other renewable sources of energy. The high gain of solar radiation in Iraq (about 7 kWh/m^2.day) with the long sunny periods (3700 h/year) encouraged the researchers to develop many solar systems (Patrick & Khalidah, 2010). The methods of using solar energy to produce hot water is either by flat plate solar collector or concentrating central receiver system. The concentrating collector consists of a parabolic dish with a central receiver. The development of concentrating solar systems has started around the 70's, and during the last years it is well implemented to demonstrated steam power plants in many countries around the world (Barth et al., 2002; Chavez et al.,1990; Kolb, 1990; Smith et al., 1991; Pacheco, 1992).

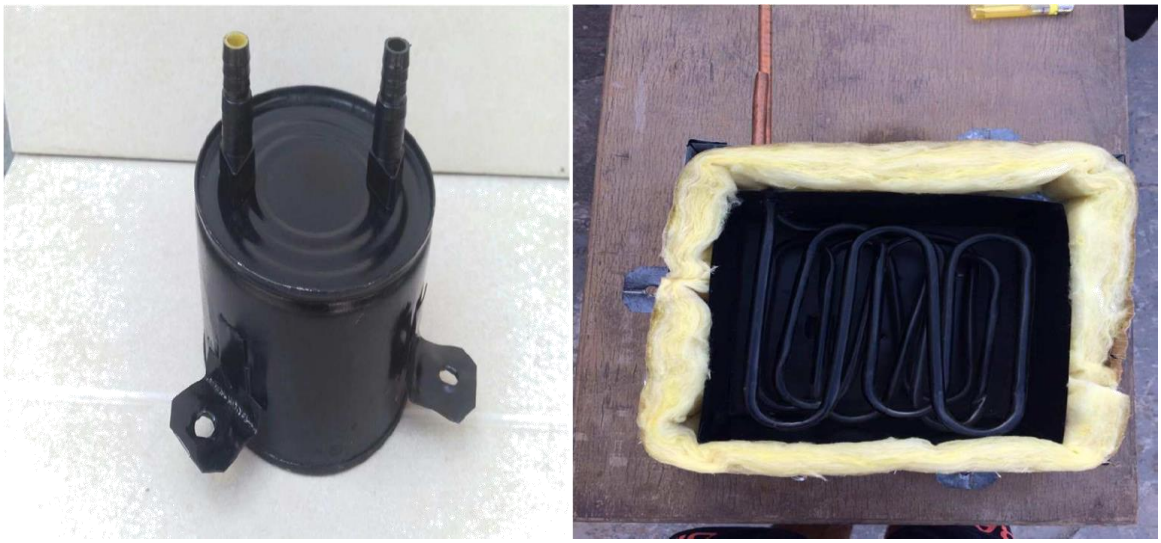
II. Procedure of the Present Work

This work focuses on the adaptation of solar energy to heat the water using a concentrating parabolic dish. The model consists of a 150 cm dish covered by alu-foils to reflect the solar radiation upon the receiver. Two different shapes of receivers have been used. In type (I), a simple cylindrical tank with dimensions of (10 cm x 15 cm) has used. While, in type (II), a helical coil of (250 cm) length inside square vessel of (30 cm x 30 cm) has used, as shown in Figure (1). The features and the dimensions of the collector are selected to get the highest solar gain (Pacheco et al., 1994; Andujar, Rosa, & Geyer, 1991; Bradshaw & Meeker, 1990). The parabolic dish was made from steel and covered by aluminum foils to reflect the radiation upon the receiver. It has a diameter of 150 cm and fixed on the ground by a concrete foundation. The distance from the focal point to the vertex line is 90 cm. The receiver in type (I) was a cylinder tank fabricated from aluminum. It was 10 cm in diameter and 15 cm length. It was supported by a steel structure to the dish at height of 115 cm, and painted in a black color to enhance the absorption.

(a) Using cylindrical receiver **(b) Using helical coil receiver**

Figure (1) Actual Photos of Parabolic Solar Dish Collector

The tank has inlet and outlet tubes to circulate the water, as shown in Figure (2a). The receiver in type (II) is a square vessel of (30 cm x 30 cm), with a helical coil inside of 250cm length, with inlet and outlet tubes to circulate the water, as shown in Figure (2b). An external tank (5 liters capacity) and water pump (2400 rpm,10 L/min) were used in order of circulating the water inside the system, as shown in Figure (3).



a) Cylinder receiver **(b) Helical coil receiver**

Figure (2) Receivers Used in the Study

Figure (3) External Tank and Water Pump

III. Results and Discussions

The measurement of water temperature has been collected during the daytime in the period 20 Feb - 10 Mar 2017, where many considerations have taken including the presence of coldness, wind and rain that effects negatively on the target of the research, so the corresponding readings were displaced from the analysis(Bradshaw & Meeker, 1990; Chavez et al., 1995; Tyner, Sutherland & Gould, 1995). Two cases have selected for comparison: case (A), where the distilled water has used as a working fluid, while in case (B) salt water has used as a working fluid.

A. Cylindrical Receiver

In case (A), where distilled water was the working fluid, the water temperature reaches to 90 ^{o}C, as shown in figure (4). In case (B), where salt water was the working fluid, the water temperature reaches to 92 ^{o}C, as shown in Figure (5).

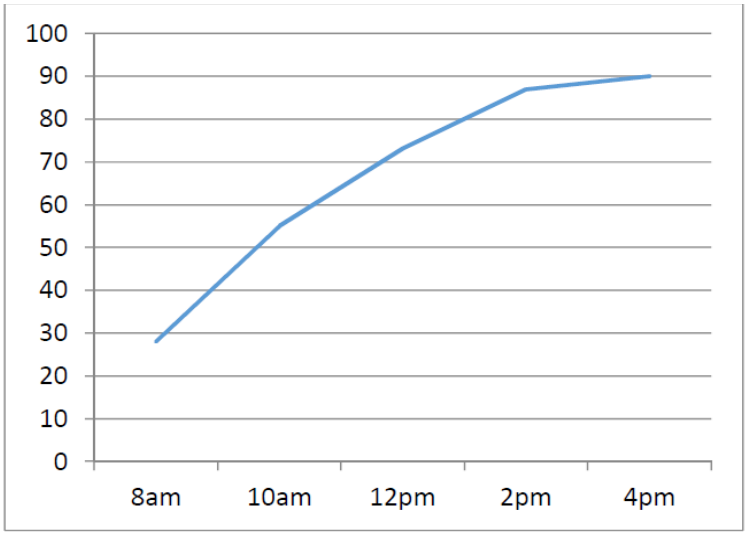


Figure (4) Distilled Water as a Working Fluid for Cylindrical Receiver

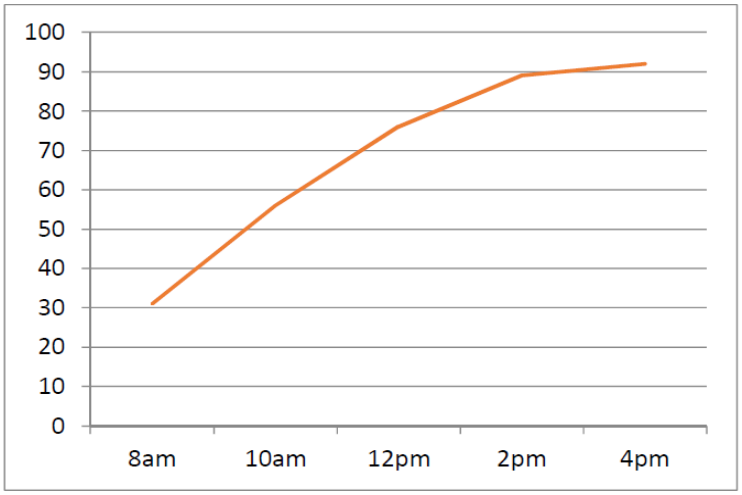


Figure (5) Salt water as a working fluid for cylindrical receiver

B. Helical Coil Receiver

In case (A), where distilled water was the working fluid, the water temperature reaches to 93 ºC, as shown in Figure (6). In case (B), where salt water was the working fluid, the water temperature reaches to 97 ºC, as shown in Figure (7).

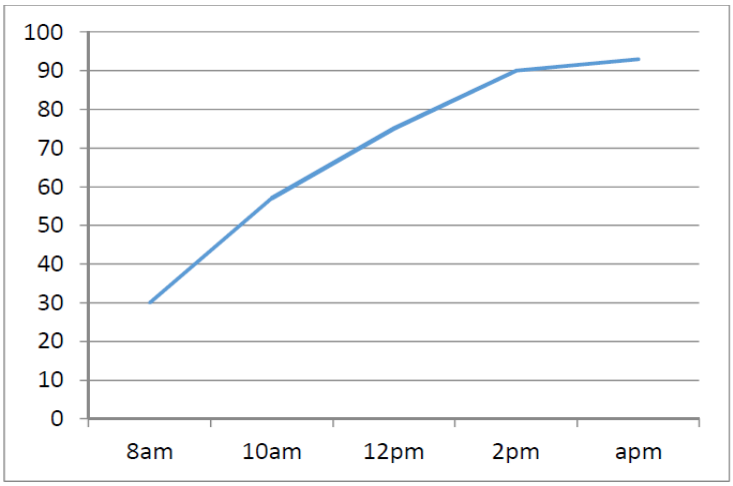


Figure (6) Distilled Water as a Working Fluid for Helical Coil Receiver

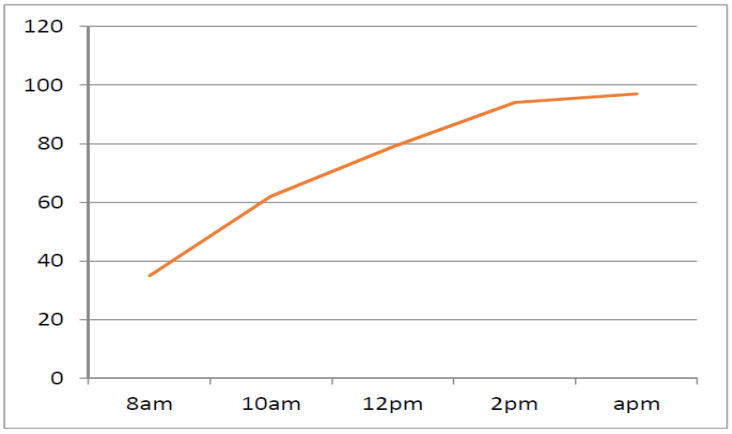


Figure (7) Salt Water as a Working Fluid for Helical Coil Receiver

IV. Conclusion

It is concluded from the study, the following points:

1. It is possible to produce hot water or even steam for power generation using solar concentration dish.
2. The using of solar dish with helical coil receiver gives higher temperature than that of cylindrical receiver, where the projected area of helical coil receiver more than the projected area of cylindrical receiver.
3. The salt water as a working fluid could store heat more than the distilled water.

References

Patrick, D., & Khalidah, J. (2010). Iraq Has an Opportunity to Become a Solar Leader. *Winter*, pp. 7-9.

Barth, D. L., Pacheco, J. E., Kolb, W. J., & Rush, E. E. (2002). Development of a High Temperature, Long-Shafted, Molten-Salt Pump for Power Tower Applications. *ASME J.Sol. Energy Eng*., 124(2), pp. 170–175.

Chavez, J. M. R., Rush, E. E., Matthews, C. W., Stomp, J. M., Imboden, J., & Dunkin, S. (1990). An Overview of Advanced Central Receiver Concepts. *Sandia National Laboratories report, Albuquerque, NM*, pp. 11.

Kolb, G. J. (1990). Reliability Analysis of a Salt-in-Tube Central Receiver Power Plant. *Sandia National Laboratories report Albuquerque, NM*, pp. 19.

Smith, D. C., Rush, E. E., Matthews, C. W., Chavez, J. M., Bator, P. A., & Barberton, O. H. (1991). Report on the Test of the Molten-Salt Pump and Valve Loops. *Sandia National Laboratories report, Albuquerque, NM*, pp. 60.

Pacheco, J. E. (1992). Flow Stability in Molten-Salt Tube Receivers. *Sandia National Laboratories report, Albuquerque, NM*, pp. 6.

Pacheco, J. E. R., Ralph, M. E., & Chavez, J. M. (1994). Investigation of Cold Filling Receiver Panels and Piping in Molten Nitrate-Salt Central- Receiver Solar Power Plants. *Sandia National Laboratories report, Albuquerque, NM*, pp. 9.

Andujar, J. M., Rosa, F., & Geyer, M. (1991). CESA-1 Thermal Storage System Evaluation. *Sol. Energy*, 46(5), pp. 305–312.

Bradshaw, R. W., & Meeker, D. E. (1990). High-Temperature Stability of Ternary Nitrate Molten Salts for Solar Thermal Energy Systems. *Sol. Energy Mater*.,21(1), pp. 51–60.

Chavez, J. M., Reilly, H. E., Kolb, G. J., Gould, B., Zavoico, A., & Sutherland,P. (1995). The Solar Two Power Tower Project, A 10 MWePower Plant, pp. 469–475.

Tyner, C. E., Sutherland, J. P., & Gould, W. R. J. (1995). Solar Two, A Molten Salt Power Tower Demonstration. *Sandia National Laborator report, Albuquerque, NM*, pp. 20