International Journal of Early Childhood Special Education (INT-JECSE)
DOI:10.9756/INTJECSE/V14I5.845 ISSN: 1308-5581 Vol 14, Issue 05 2022

Design and Fabrication of Solar Water Heater

Rahul Thangaraj[1*], Gnanasekaran[2], Mathew Prabhakaran[3], Sriram[4]
[1,3,4]UG Student, department of Mechanical Enqineering, K.S Rangasamy College of Technology, Tiruchengodu - 637215, Tamil Nadu, India.*
[2]Associate professor, department of Mechanical Engineering, K.S Rangasamy college of Teechnology, Tiruchengode - 637215, Tamil Nadu, India.
Corresponding Author Email:trahul1103@gmail.com

Abstract
Collection, storage and utilization of solar energy by solar collector using reflector are cheapest and effective renewable energy technologies. This solar collector for water heating purposes uses a nonconventional source of energy which can be used for house hold applications. Solar air heaters performance can be improved by a variety of techniques. However, these techniques do not guarantee a compromise between the effectiveness and the cost of the solar heater. The cost of production will be comparatively low and high in capacity. The proposed design consists of a smooth curved helical flow channel with a reflector plate of triangular shape. The copper tube is used for transmitting water because of its high thermal conductive property. The reflector plates made of aluminium are used to focus the heat energy obtained from the sun rays to hit on the copper tubes which carries water in it.

Keywords :*Solar energy, solar collector plate, energy analysis, efficiency*

1. Introduction

A growing interest in renewable energy sources is being generated because of concerns related to environment and scarce conventional energy. Solar energy is an important alternate source of energy to replace energy resources. As a result of solar energy, the planet's energy demand can be fully met, which is currently being met by burning fossil fuels. It is possible to combat climate change and global warming caused by utilizing solar energy in an efficient and exhaustive manner. This energy can be applied directly to heat in one of its most straightforward applications. In addition to being used for water heating, solar radiation can also be used for central heating systems. By using solar panels, solar energy can be converted into heat in this instance. Since the beginning of the 20th century, solar water heating technology has advanced greatly. The most economical way to collect solar energy for water heating is to utilize a natural circulation. Solar energy is an energy source that has been producing energy for billions of years, and is therefore a renewable source of energy in contrast to non-renewable sources of energy. Solar energy technologies utilize the sunlight to heat houses and generate electricity. As a result of solar tank less water heater reviews, it is the most important source of energy for all living creatures. As a renewable energy source, it requires little maintenance, is easy to install, and does not emit pollutants. Solar power is one of the cleanest energy sources available today. In addition, solar energy has one limitation: its inability to be used at night. The amount of sunlight received on earth depends on a number of factors, including location, time of day, season, and weather.

2. Literature Review

An experimental study conducted by Jayant et al. was conducted at Nagpur Government Medical College, to examine the direct circulation systems. In the present study, we examined the efficiency of flat plate collectors in Nagpur region both theoretically and experimentally. The maximum and minimum temperature observed were approximately 70 degree Celsius and 18 degree Celsius respectively. To study these aspects, a test setup has been constructed and experiments have been conducted [4].

It has been noted that the performance of solar collectors is primarily determined by the material characteristics as reviewed by Mariandurai et al. Thermal performance is mainly determined by the material characteristics of solar thermal collectors. They require the selection of material based on its suitability for outdoor and adverse environments. The absorbing and reflecting properties of the material are also important. In order for a solar dryer, to operate effectively, the mechanism of heat transfer and the medium through which the heat is transferred are of utmost importance [5].

In this paper, khazem et al. presented a survey of the various types and applications of solar thermal collectors. In the first part of this paper, environmental problems associated with conventional energy sources are analyzed along with the benefits of renewable energy systems. A description of the methods utilized to evaluate the performance of the collectors is presented, along with an optical, thermal, and thermodynamic analysis. In order to

demonstrate to the reader the extent of the application of the various types of collectors, typical examples are presented [6].

It has been reported that Santosh Kumar et al. have designed and fabricated a solar water heater, evaluating its performance in the Allahabad climate. A renewable energy heating technology is the use of solar water heaters to produce hot water for the generation of heat or the heating of spaces. An iron absorber plate with a diameter of 10 cm is painted black to absorb maximum radiation. A mass flow rate of 0.0015 kg/s is used to evaluate the system performance and by using the same rate a daily efficiency of 11% is achieved [7].

3. Methodology

Initially the ball valve should be closed and the tank should be filled with water. This setup should be installed on the terrace to have direct contact with sun rays. By turning on the AC pump allows the water stored inside the reservoir to flow through the copper pipe which get coupled with it. But it doesn't allow the water to exhaust out since the valve is in closed position, so the water will be remained stationary inside the pipe. The sun rays are focused on the copper pipes with the help of reflection sheets covered on the curve surface. This makes the pipe to heat, there by the heat gets transferred to the water stored in it. This causes the temperature of water to rise and the hot water is collected by opening the valve. The thermocouple installed at the inlet and outlet region calibrate the temperature changes which is displayed through LCD display.

3.1. Materials

- Copper tube
- Aluminium sheet
- Ply wood
- Frame
- Mirror
- Sheet metal
- A C pump

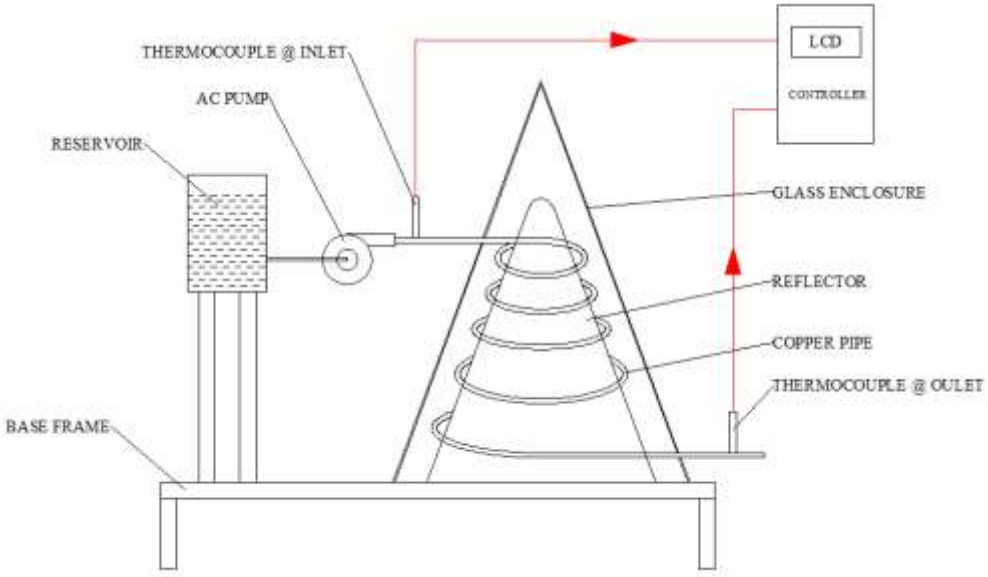

Fig.1. Proposed method

4. Experimental setup

Efficiency of solar water heaters is determined in the study. Galvanized iron absorbing plates measuring 2 meters by 3 meters are used in flat-plate collectors. To prevent the heat loss Silica and insulation placed under absorber plate. A water regulator controls the flow rate of the water and sunlight meter measures the solar intensity. Digital thermocouples are used to measure the temperature at various points in the system.

4.1 Exergy Analysis

To calculate the efficiency of solar collectors, following equations are used

$E_{in} = mc_p(T_i - T_a - T_a In (T_i / T_a)$

$E_{out} = mc_p(T_o - T_a - T_a In(T_o / T_a)$

E_{out} = ("Outlet Exergy Rate")
E_{in} = ("inlet exergy rate")
A_c = ("aperture area")
T_s is 4076.85 Celsius

5. Results

In this experiment, the solar intensity is measured using a solar intensity meter and variation is shown in Figure 2. The proposed system is manufactured and analysis are executed for the fixed mass flow rate. Figure 3 illustrates the temperature difference.

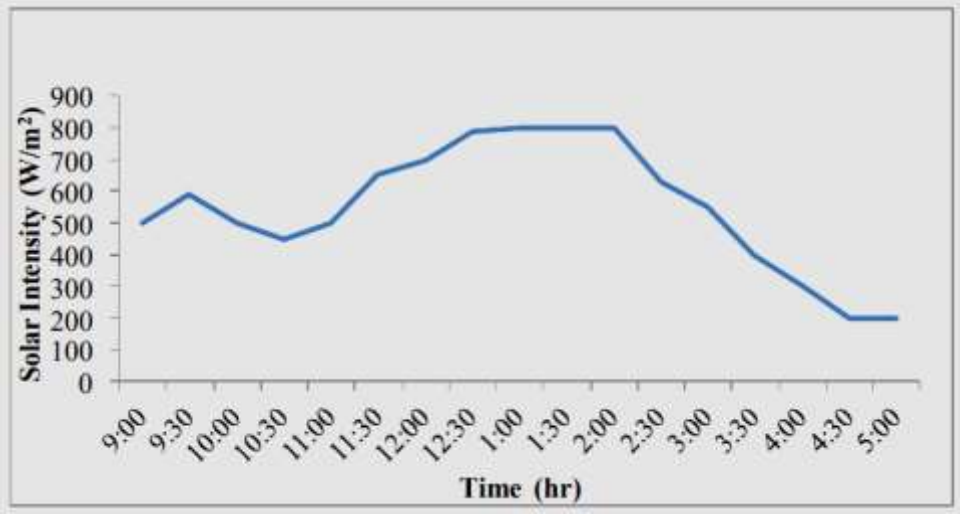

Fig.2. Difference in Solar Intensity

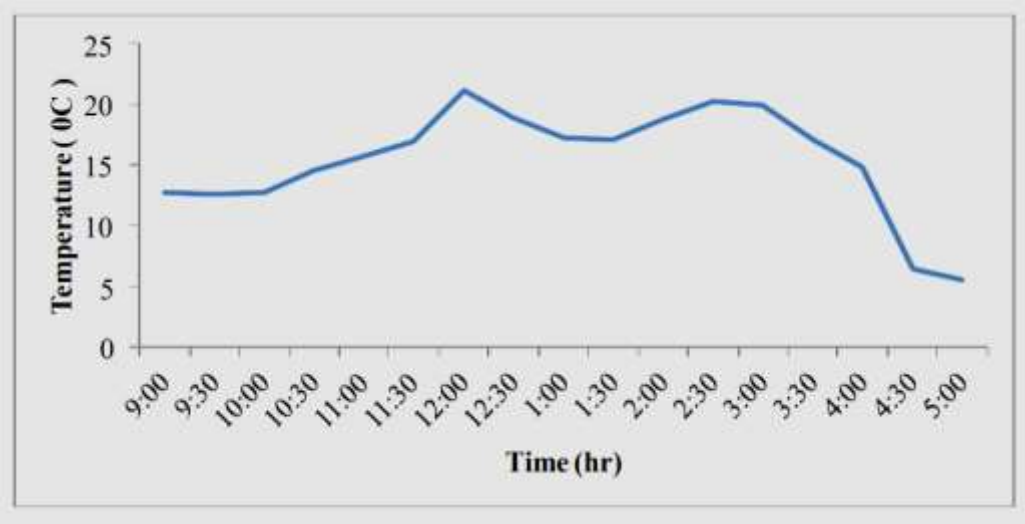

Fig.3. Temperature Difference (ΔT)

6. Conclusion

This paper examines the performance of a flat plate collector using the first and second laws of thermodynamics. The experiment on solar water heater is conducted utilizing two analysis namely "energy" and "exergy". The analysis is illustrated using a theoretical model that takes into account non-uniformity in absorber plate temperature distribution. Since flat plate collectors have low efficiency due to convection heat transfer loss, solar water heaters are fabricated at an affordable production cost. The water temperature obtained is significant. Experimental validation has been performed on the model, and the results have agreed well with experimental results. A maximum instantaneous temperature of 600C was observed when water was ejected from the system at a rate of 0.0017 kg/s, resulting in an efficiency of 13% for a day.

Finally, The authors genuinely thank AICTE, New Delhi, India for the budgetary help with completing this work under MODROB (AICTE FILE No 9_ 240/ IDC/MODROB/ policy 1/ 2019_ 20). Dated.20.7.2020

References

1. Shukla, R., Sumathy, K., Erickson, P., & Gong, J. (2013). Recent advances in the solar water heating systems: A review. *Renewable and Sustainable Energy Reviews*, *19*, 173-190.
2. Sadeghi, G., Mehrali, M., Shahi, M., Brem, G., &Mahmoudi, A. (2022). Progress of experimental studies on compact integrated solar collector-storage retrofits adopting phase change materials. *Solar Energy*, *237*, 62-95.
3. Singh, S. K., Rai, A. K., &Sachan, V. (2016). Fabrication and Performance Study of a Solar Water Heater. *International Journal of Advanced Research in Engineering and Technology*, *7*(4), 01-05.
4. Duffie, J. A., & Beckman, W. A. (2013). *Solar engineering of thermal processes*. John Wiley & Sons.
5. Jayant, A., Gupta, P., Garg, S. K., & Khan, M. (2014). TOPSIS-AHP based approach for selection of reverse logistics service provider: a case study of mobile phone industry. *Procedia engineering*, *97*, 2147-2156.
6. Maridurai, T., Irfan, A. M., Vengadesan, E., Loganathan, K., Aminudeen, M. M., &Ahamed, K. H. (2018). Review on material aspects of solar thermal collectors. *International Journal of Mechanical Engineering and Technology*, *9*(7), 286-292.
7. Kazem, H. A. (2016). Photovoltaic solar thermal (PV/T) collectors past, present and future: A review. *International Journal of Applied Engineering Research*, *11*(22), 10757-10765.
8. Aramesh, M., &Shabani, B. (2020). On the integration of phase change materials with evacuated tube solar thermal collectors. *Renewable and Sustainable Energy Reviews*, *132*, 110135.
9. Evangelisti, L., Vollaro, R. D. L., &Asdrubali, F. (2019). Latest advances on solar thermal collectors: A comprehensive review. *Renewable and Sustainable Energy Reviews*, *114*, 109318.
10. Kalogirou, S. A., Karellas, S., Braimakis, K., Stanciu, C., &Badescu, V. (2016). Exergy analysis of solar thermal collectors and processes. *Progress in Energy and Combustion Science*, *56*, 106-137.
11. Buker, M. S., &Riffat, S. B. (2015). Building integrated solar thermal collectors–A review. *Renewable and Sustainable Energy Reviews*, *51*, 327-346.
12. Colangelo, G., Favale, E., Miglietta, P., & de Risi, A. (2016). Innovation in flat solar thermal collectors: A review of the last ten years experimental results. *Renewable and Sustainable Energy Reviews*, *57*, 1141-1159.
13. Barone, G., Buonomano, A., Forzano, C., &Palombo, A. (2019). Solar thermal collectors. In *Solar hydrogen production* (pp. 151-178). Academic Press.
14. d'Antoni, M., &Saro, O. (2012). Massive solar-thermal collectors: a critical literature review. *Renewable and Sustainable Energy Reviews*, *16*(6), 3666-3679.
15. Phelan, P., Otanicar, T., Taylor, R., &Tyagi, H. (2013). Trends and opportunities in direct-absorption solar thermal collectors. *Journal of Thermal Science and Engineering Applications*, *5*(2).
16. Battisti, R., &Corrado, A. (2005). Environmental assessment of solar thermal collectors with integrated water storage. *Journal of Cleaner Production*, *13*(13-14), 1295-1300.