An Analytical Research Based on Solar Water Heater Geyser

Birendra Kumar[1]
[1]Assistant Professor, Department of Mechanical Engineering
Motihari College of Engineering, Motihari, East Champaran, Bihar, India
Email: bk.11pg010@gmail.com
Mohd Ateeque[2]
[2]Assistant Professor, Department of Mechanical Engineering
Motihari College of Engineering, Motihari, Bihar, India
Email: ateeque9782@gmail.com

Abstract-
A solar water geyser is a heating appliance that produces heat by harnessing solar energy. A thermal heat collector is used to gather solar light energy, which is then used by a solar geyser. Within the solar geyser system, the thermal collector encloses and concentrates solar radiation from the sun. There are several ways that solar geyser systems work; we went with an approach known as active solar geyser. The current review study examines current solar water heating technologies and their respective uses. Hot water is used in homes, businesses, and industries now days. A variety of resources, such as coal, diesel, gas, etc., are used to produce steam and heat water. The main substitute for traditional energy sources is solar energy. The method to capture the abundant amount of free solar thermal energy is the solar thermal water heating system. The solar thermal system is intended to fulfil the requirements for energy. The solar radiation availability, the customer's required temperature, the solar system's geographical configuration, and other factors all affect the system's size. As a result, the solar water heating system must be designed with the aforementioned considerations. The term "active solar geyser" describes a system that uses a pump to circulate water between the collector and the tank. The goal of this project is to design and build a household solar geyser.

Keywords— *Solar Energy Collector, Active & Passive System, Heat Transfer Fluid, Solar Water Heater Geyser.*
DOI Number: 10.48047/nq.2020.18.6.NQ20188 **NeuroQuantology 2020; 18(6):89-95**

INTRODUCTION

A solar thermal unit absorbs and converts the solar heat energy required to satisfy heat needs in various temperature ranges. The solar thermal energy absorbed by the collectors heats the water in a typical solar water heating system. The low-density heated water rises, and cold water rises from the tank because of the gravity head and higher density. The solar water heater is designed and analyzed in this paper to get the simulation of the system to enhances the effectiveness of the solar water heater. Researchers are also researching alternative energy technology, including wind and solar, as many countries are seeking to minimize reliance on non-renewable energy sources (i.e., fossil fuels). The huge use of conventional non-renewable energy emits greenhouse gases that are major contributors to climate change. On the other hand, renewable sources of electricity, such as solar and wind, do not make greenhouse emissions. They are durable and cost-free. The key goal of the project is to improve the effectiveness of the solar heat heating system. In this paper little study has been carried out on improving the device to improve its efficiency. To replicate the 3D model system, the whole heating system is designed using Solid Works and has been carefully analyzed. The sun has been a powerful presence and force throughout the history of human existence on

earth. It has been regarded by many cultures as a god of one form or another, and understood by most to be the ultimate source of life on this planet. It has also been intentionally exploited by many clever means over the centuries, in order to better utilize this life giving energy. As far as renewable energy sources go, the sun represents the best and most stable we have. It is infinite with respect to all practical timescales, immensely powerful, understood and predictable in its overall trends and patterns, and for the foreseeable future beyond anthropogenic effects. In short, the perfect energy source; but it is not without difficulties. Solar heater is a device which is used for heating the water, for producing the steam for domestic and industrial purposes by utilizing the solar energy. Modern systems designed for capturing the suns energy and transferring it to water, either for immediate use or as a storage medium, have been studied and put to use since the 1970's, when they were first used for pool heating in California. Continued research and innovation has resulted in products feasible in much colder and less sunny climates today (Bennet T, 2007). The history of using the sun for energy goes way back to the Ancient Greeks and Romans as their buildings were constructed such that the rays of the sun provided light and heat for indoor spaces. The Greek philosopher Socrates wrote, "In houses that look toward the south, the sun penetrates the entrance in winter." Romans advanced this art by covering the openings to south facing building with glass, in order to retain the heat of the winter sun.

LITERATURE REVIEW

The solar water heater collects light with a collector on the roof and turns them into gas. Then the heat is transferred by a rotating pump to a water tank. The thermal regulator activates this exchange, but only when the collector is cooler than water in the reservoir. Not only does it eliminate the use of electricity without the need for rotating pumps, but it also avoids overheating. Where the sunshine is inadequate, the water will be preheated, and a back-up mechanism will take over to get the water to the appropriate temperature. Thus, this device can be used during the year at a stable temperature. Solar water heating system is an effective application for the thermal energy transfer of solar energy. In comparison to the solar electric direct conversion method with an efficiency of just 17%, solar thermal conversion efficiency stands at about 70%. Thus, in domestic as well as industrial applications, solar water heaters play a critical role because of the ease of service and quick maintenance. Extensive work has contributed to strategies to increase the thermal performance of solar water thermal heaters. To improve convective heat transfer, the passive technique was used. As used in solar water heaters, these techniques demonstrated a major increase in overall thermal efficiency. The solar water heater is presented in Figure 1.

Figure 1- Components of the Solar Heater

Solar thermal water heating systems (STWH) are cost-efficient as well as energy effective. The STWH systems are ideally suited for hot weather and direct sunshine but are still very well suited in cooler weather in the United States. The challenges, such as freezing, are solved by different principles of the STWH structures. Most systems of STWH have a solar collector on the roof of the residence facing south. Flat plate solar panels contain four parts: translucent covers for reduced convection and heat loss radiation; dark-color, flat plate panels for optimum heat absorption; heat transfer fluid conducting pipes extracting heat from the sensor; and heat isolated backpacks to avoid conductive conduction, Loss of sun. There is a network of black tubes that flow water or some other fluid within this collector. The fluid in the tube is rarely cold in the panel and heated by the panel while the black outside of the tubes receives heat from the light. The heat transfer fluid and the chosen materials for the tubes are critical criteria for the device to resist drastic frosting and overheating temperatures. When the substance is water, it joins a hot water holding tank straight away. The heat is then moved from the working fluid to the water in the hot water tank using another working fluid by heat exchange in the tank.

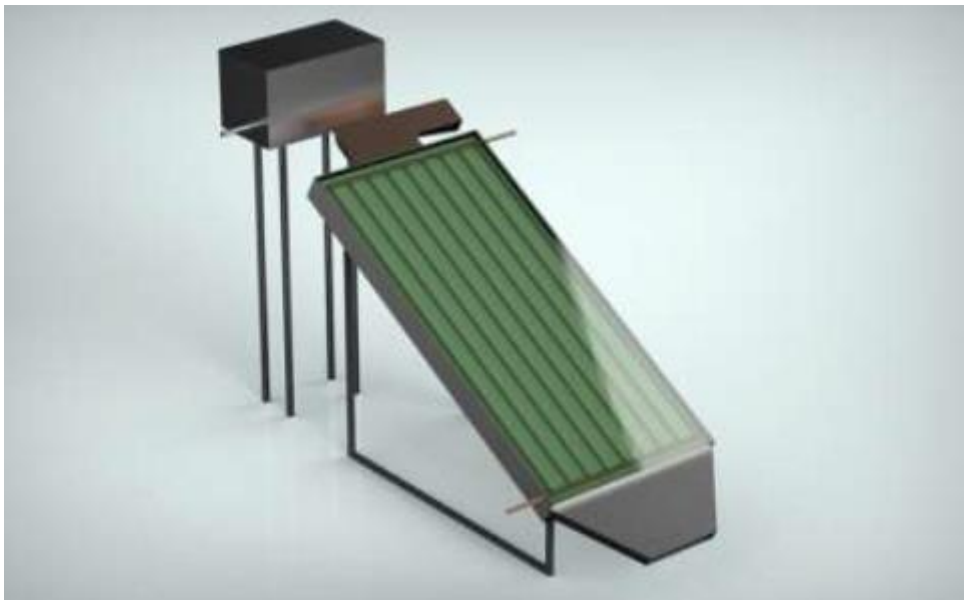

Figure 2- 3D Model of Solar Water Heater

Solar thermal applications began in China in the 1970s. By the end of the 1980s, China started producing flat platform solar water heaters by launching the Canadian copper-aluminum flat screen composite absorber production lines and by creating its production line of anodic selective coatings. However, because of issues such as cost and compatibilities in winter, development was slow. Significant technical and product breakthroughs made in the 1990s in vacuum pipe production allowed China to build a self-designed vacuum pipes production line and to mass-produce a solar water heater with a vacuum piping system. Such accomplishments in technology and research have led to the continuous development of solar collector and heater efficiency with the vacuum tube and heat pipe all-glass and reduced expense. It brings considerable impetus to the Chinese solar thermal industry's industrialization. A CAD model of a Solar Water heater is illustrated in Figure 2. It shows the collector and frame of the solar water heater. The tubes are designed inside the collector which contains the hot water which goes to the tank and from there, the cold water comes to the tubes to get the heater through the solar energy. Since the mid-1920s impressive advances have been recorded in modeling and simulation technologies. The mechanical differential analyzer was also used to solve only a small number of ordinary differential equations. In the 1950s, as electronics replaced cumbersome equipment, significant technical change was recorded. The simulation was eventually encouraged by broad-based growth and industrialization.

DESIGN METHODOLOGIES AND CONSTRAINTS

Create a 3D model of the water solar heater geyser first, followed by a working model that outlines the design constraints and methodology. These are its design constraints:

(i) Geometric Constrains- Geometric Constrains is dimensional conditions imposed on Design Methodology.

- Length of the Tubes 1800mm.
- Distance between two tubes is 125mm.
- Diameter of tube if 58mm.
- Geometric constraints are applied for designing the Design Methodology.

(ii) Sustainability Constraints- This paper is basically the related to energy sustainability, so sustainability constraints are taken into account.

- We are using Solar Energy.
- Use of renewable energy.

(iii) Economic Constraints- Purpose of economic constrain is to make the product market compatible.

- Economical material is being used for this model.

- Material used in this project is easily available in market.

(iv) Environmental Constraints- The purpose of Environment Constraints is to limits the production which may cause pollution in environment.

- This paper is environment friendly, and it does not have any negative impact on the environment.
- No noise pollution, no air or land pollution.
- This product will help to keep the environment clean because it makes use of the renewable energy instead of the fuel for heating which causes some air pollution.

(v) Health and Safety Constraints- Health and Safety Constraint is implemented for limiting the manufacturing of such products which may be harmful with respect to Health and Safety. This paper makes use of the renewable energy instead of fuel for the heat generators, causing the environment safe and healthy.

(vi) Manufacturability Constraints- Concern of the Manufacturability constraint is to assure the design methodology which is easy to manufacture in bulk quantity.

- Solar heater is manufacture in the possible easiest way for bulk production,
- Material used in the product is easily available in the market.

(vii) Social Constraints- Purpose of social constraint is to design the product which is according to the requirements of human and it should address some social issues. This paper has addressed the issues of Sustainable energy and Air pollution.

(viii) Ethical Constraints- Ethical constraint is applied to limit the product which may hurt the feelings of people. Its purpose is to provide the user with expected results without the breach on any ethical boundaries. Design of the Solar Heater is under the define ethical constraint.

COMPUTED THEORETICALLY

(i) Solar Water Heating Geyser- It is a geyser which is being operated by the solar energy. It depends on the phenomenon of the natural convection, which circulate the water through the vacuum tubes to the hot water tank.

(ii) Solar Water Heating- There are some collectors, which are used to collect the or capture heat from the sun. Then, they retain it and then transfer it to the liquid. Solar thermal heat is capture by the phenomenon of greenhouse effect (ability of the reflective surface to reflect the longer waves and transmit the short waves radiations. Heat is produced when light with shorter wave radiation hits the collector's absorber. Which then trap inside the collector. There are two type of collectors: Flat Plate and Evacuated Tube.

(iii) Flat Plate and Evacuated Tube Solar Collectors- A flat plate collector consists of multiple vertical copper tubes which are arranged in parallel configuration, these tubes are connected from the top and the bottom with copper tubes usually larger in diameter. The larger diameter tubes are perpendicular to the smaller tubes, this gives the plate a rectangular shape. The tubes are enclosed inside a well-insulated box with a cover made out of tempered glass. The Flat collector plate is usually connected to risers, the heat is gained by collecting the solar energy from the sun which gets absorbed by the copper to heat the circulating water. Evacuated tubes are made of vacuum tubes. They are tubes with an inner and an outer layer of glass, the tube then is vacuumed. These tubes are fitted with a copper heat pipe filled with a non-toxic liquid. The Evacuated tube is a poor heat conductor, but the vacuum between the layers ensures that the solar radiation is almost fully absorbed and intraped inside it. The energy gets absorbed by the copper heat pipe inside the tube, which in return heats the circulating water manifold.

(iv) Direct and Indirect Solar Configurations- In Direct configuration, the water circulates form the tank to the solar collector directly. The water gets passed through the collector where it gets heated. In Indirect configuration the fluid which flows to the solar collector is not the actual geyser water itself rather it is a glycol mixture, which is contained in a closed loop, running from the geyser to the collector and back again.

(v) Active & Passive Configuration- Passive and Active explains how the system water circulates from tank to the heat collector. In a passive configuration water is being circulated by phenomenon of natural convection. In this configuration geyser is located above the solar collector. In Passive configuration, the hot

water rises to the top of the system where it is collected, the denser cold water moves to the lower part of the tank to get heated. Active configuration is also known as Pumped Configuration. In this configuration the geyser is located below the solar collector. This system make use of the circulation pump, to pump to move the water in the system from the tank to the collector and vice versa.

CONCLUSION

To sum up, the solar geyser demonstrated its efficiency for usage in Saudi Arabia. Three hours after daylight, the system achieved its target temperature of 50 C˚. It then continued to increase, reaching its highest temperature of 62 C˚ at 1 PM, and remaining mostly steady for the remainder of the night. One of the difficulties the team faced was finishing the project in eight days, which meant we had to practically master time management to accommodate Ramadan's irregular working hours. This time crunch was caused by a supplier shipment delay. We learned a tone and developed our teamwork immensely. We gained knowledge of many renewable energy systems, particularly the global solar energy technology. One of the cornerstones for the future of renewable energy is the information we have gained. Each team member has been assigned a job that aligns with their areas of strength in the division of labor cool was signed. One of the best methods for converting solar energy into thermal energy is solar water heating (SWH), which is regarded as a developed and commercialized technology. To boost the system's efficiency and dependability, there are still chances to enhance its performance. A brief overview that focuses mostly on the design elements and associated technological developments of the SWH systems in terms of cost-effectiveness and energy efficiency has been provided.

REFERENCES

[1] Brothers, H. (2019, September). Solar Water Heater. Renewable Energy. Retrieved March, 2021 from https://www.haroonbrothers.com/renewable-energy/solar/solar-waterheater/

[2] Solar, P. (2020). Solar Geyser | Solar Water Heater. Renewable Energy. Retrieved March, 2021 from http://www.paksolarservices.com/solar-geyser.html

[3] Han, W. S., Lu, M., McPherson, B. J., Keating, E. H., Moore, J., Park, E., ... & Jung, N. H. (2013). Characteristics of CO 2 driven cold water geyser, C rystal G eyser in U tah: experimental observation and mechanism analyses. Geofluids, 13(3), 283-297.

[4] Jurgens, P. J. (2011). Feasibility analysis & operational design for local manufacturing of solar water heating equipment.

[5] Sankar, K., Selvam, K., Ashwin, K. J., & Prasanth, S. S. (2021). Analysis of Corrosion Resistance in Domestic Water Geysers by Coating Nano-Film Using Thermal Spray Coating. Trends in Manufacturing and Engineering Management, 123-134.

[6] Vijayan, S., Subramanian, N., & Sankaranarayanasamy, K. (Eds.). (2020). Trends in Manufacturing and Engineering Management: Select Proceedings of ICMechD 2019. Springer Nature.

[7] Al-Madani, Hussain (2006). “The performance of a cylindrical solar water heater.” Renewable Energy Vol. 31, pp 1751-1763.

[8] Bennet T. (2007). “Solar thermal water heating, a simplified modeling approach”.

[9] B Sivaraman and N Krishna Mohan (2005). “Experimental analysis of heat pipe solar collector with different L/di ratio of heat pipe”, Journal of Scientific & Industrial Research, Vol. 64, pp 698-701.

[10] Charles Smith (1995). “History of Solar Energy Revisiting, Past Solar Power Technology Review”.

[11] Data-Annual Report (2001). “International Energy Agency of Solar Heating and Cooling Programme”.

[12] Dharamvir Mangal, Devander Kumar Lamba, Tarun Gupta, Kiran Jhamb (2010). “Acknowledgement of Evacuated Tube Solar Water Heater Over Flat Plate Solar Water Heater” International Journal of Engineering (IJE), Vol. 4, pp 279-284.

[13] Duffie J.A and Beckman W.A. (1991). “Solar Engineering of Thermal Processes”, Second Edition, Wiley-Interscience, New York.

[14] Eicker, U (2003). “Solar Technologies for Buildings” West Sussex:Wiley.

[15] Harrison J, Tiedeman T (1997). “Solar Water Heating Options in Florida”, Florida Solar Energy Centre. Rpt: FSEC-EN-9-85.

[16] Ken Butti, John Perlin (1980) “A Golden Thread,” Van Nostrand Reinhold Company.

[17] K. Sivakumar, N. Krishna Mohan and B. Sivaraman (2005) “Performance analysis of elliptical heat pipe

solar collector" Indian Journal of Science and Technology.
[18] K. S. Ong, W. L. Tong, Sheriwati, K. Low (2011). "System Performance of Heat Pipe Solar Water Heaters" 10th IHPS, Taipei, Taiwan, pp 261-266