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SOLAR WATER HEATER USING ALUMINUM CANS

Prof. Sanjay Mitkari
Department of Mechanical Engineering,
G H Raisoni College of Engineering and Management Pune Maharashtra
sanjay.mitkari@ghrcem.raisoni.net

Amarnath Gadade, Nagesh Hiregouda, Nagnath Hawale, Sarthak Joshi
UG Student, Mechanical Engineering,
G H Raisoni College of Engineering and Management, Pune, Maharashtra, India.
amarnathgadade444@gmail.com , hiregoudanagesh05@gmail.com, nagnathhawale2002@gmail.com
joshisarthak66@gmail.com

ABSTRACT
Solar water heating system proves to be an effective technology for converting solar energy into thermal energy. With an efficiency of about 70%, solar thermal conversion outperforms direct solar electrical conversion, which typically achieves only around 17% efficiency. Hence, solar water heaters play a vital role in the domestic as well as industrial sector due to its ease of operation and simple maintenance. Extensive work on improving the thermal efficiency of solar water heaters resulted in techniques to improve the convective heat transfer. To improve convective heat transfer, a passive technique was utilized. These techniques, when adopted in solar water heaters, proved that the overall thermal performance improved significantly. This paper critically analyzes different techniques designed to enhance solar water heater thermal efficiency. Furthermore, it delves into the constraints of existing studies, highlights unexplored areas, and recommends potential advancements.

Keywords
Solar water heater, Waste aluminum cans, Heat transfer, Natural convection, Waste management, Recycling, Cost-effective solar solutions, Water heating efficiency, Thermosiphon effect

1. INTRODUCTION
A low cost pipe type solar water heater having a capacity of 100 liters for the storage use in urban as well as rural areas has been developed. The unit works on push through principle i.e. hot water will come out from the outlet when the cold water in it through the outlet. The unit consist of ten number of pipe fabricated from 34SWG copper pipe. All ten pipes are arranged in parallel, each separated by a distance of 1201 µm.. The free edge at the sites is not to exceed 60 mm from the center of the extreme and riser tube.

2. MATERIALS AND METHODS
The solar water heater system was designed and constructed using easily available materials. Waste aluminium soda cans were used as the main component for heat absorption. The cans were prepared and arranged in a specific configuration to maximize solar energy absorption. A water circulation system, including piping and a storage tank, was integrated into the setup. The performance of the system was evaluated under various weather conditions.

3. NEED
Now a day's huge amount of electricity is consumed for various purposes. One of the purposes is heating water for utility is where we are going to focus. Using solar water is what one can try to minimize the consumption of electricity. And using Aluminum cans as a collector will further reduce the cost and wastage of cans.

4. OBJECTIVES
The primary objectives of this research include:
a) Assessing the thermal efficiency of a solar water heater constructed using waste aluminium soda cans.
b) Evaluating the cost-effectiveness and viability of using these cans compared to traditional solar water heater materials.

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c) Investigating the environmental impact of utilizing waste aluminium soda cans in the construction of solar water heaters.
d) Exploring the potential for scalability and widespread adoption of this technology.

5. RESEARCH SCOPE

1. To produce solar water heaters using waste aluminium cans and reduce the cost.
2. The economic aspects will be fulfilled i.e. the poor families can afford the solar water that we have produced.

6. LITERATURE SURVEY

In understanding key factors in the adoption of Solar water heaters using waste Aluminium cans.
Findings:
1. Energy-related emissions from commercial buildings Significant: Contribution to GHG
Emissions: Commercial buildings are major contributors to greenhouse gas (GHG) emissions, accounting for a significant portion of global energy-related emissions.
2. A comprehensive review on integrated collector-storage solar water heaters: Efficiency and Performance: Integrated collector-storage (ICS) solar water heaters have demonstrated high thermal efficiency and reliable performance in various climatic conditions.
3. Survey of the various types of solar thermal collectors and applications: The findings emphasize the importance of selecting the appropriate collector technology based on specific requirements, climatic conditions, and desired temperature levels.
4. Describes the design of the PTC which increase the outlet temperature by reducing heat loss: In this design the maximum efficiency of the collector is 32% and has the ability to achieve high output temperature, the maximum temperature at the header of the evacuated tube is 235 degrees Celsius and is therefore suitable for high-temperature applications such as industrial uses.
5. Design and Fabrication of Thermosiphon Water Purification System: The thermosiphon system proved to be an efficient and cost-effective method for purifying water, particularly in areas with limited access to electricity or unreliable power supply. The fabricated prototype demonstrated excellent performance in removing contaminants and bacteria from the water, achieving satisfactory purification levels.
6. System performance of heat pipe solar water heaters: The experimental results showed that the natural convection heat pipe system was capable of heating water to 100˚C and performed best among the systems tested.
7. Acknowledgement of Evacuated Tube Solar Water Heater over Flat Plate Solar Water Heater: The findings regarding the comparison between evacuated tube solar water heaters and flat plate solar water heaters revealed several advantages of evacuated tube systems. The study acknowledged that evacuated tube solar water heaters consistently outperformed flat plate solar water heaters in terms of efficiency and heat output.

- **Current solar energy systems:**

Solar technologies are commonly grouped into three major categories, generally differing in the ways they collect, store and use energy. Passive solar systems involve utilization of the sun's radiation as light or possibly heat. Generally, a domestic hot water supply at temperatures in the range of 50 to 60 degree Celsius is considered to be acceptable (SOPAC Technical Report, 1999).

- **Present alternative method of solar water heating system:**

An alternative method of solar water heating system involves the use of evacuated tube collectors. Unlike traditional flat plate collectors, evacuated tube collectors consist of rows of glass tubes containing an inner metal tube that acts as a heat-absorbing surface. This design allows for improved heat transfer and higher efficiency, even in colder climates or during cloudy weather. The vacuum-sealed tubes minimize heat loss and protect against thermal conduction, making them highly efficient in capturing solar energy. The absorbed heat is then transferred to a heat exchanger, which heats the water that flows through it. This alternative method offers several advantages, including higher energy conversion rates, greater resistance to temperature fluctuations, and the ability to heat water at lower solar radiation levels. These benefits make evacuated tube collectors an attractive option for solar water heating, particularly in regions with less consistent sunlight or colder climates.

- **Importance of Solar water heater using waste aluminium cans in Coming Age:**

Solar water heater are spreading across the globe drastically because of the increase in energy demand and economic factors which somewhat reduced by solar water heater. By using the aluminium cans as the solar

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collector it will further reduce the cost of the heater. The usage of waste cans will also help in reducing the waste produced and making something useful.

7. METHODOLOGY

1. How Does Solar Heater using Aluminium Cans Works?

- Our Solar heater basically works on the principle of thermosiphon effect.
- Thermosiphon is a method of passive heat exchange, based on natural convection, which circulates a fluid without the necessity of a mechanical pump.
- Thermosiphoning is used for the circulation of liquids and volatile gases in heating and cooling applications such as heat pumps, water heaters, boilers and furnaces.
- As the sun shines on the collector, the water inside the collector flow-tubes is heated. As it heats up, this water expands slightly and becomes lighter than the cold water in the solar storage tank mounted above the collector. Gravity pulls the cooler, heavier water from the tank down into the collector. This cold water then displaces the heated water, pushing it from the collector and into the top of the tank, which warms the tank's water.

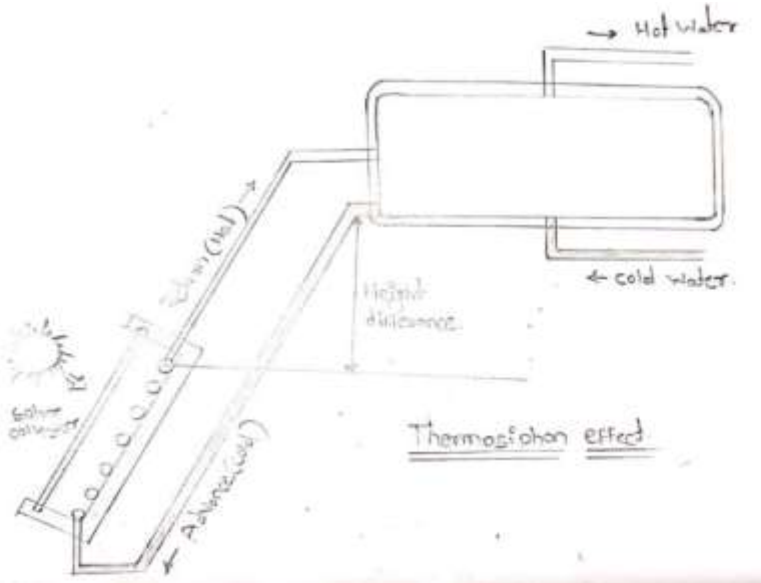

Fig. 1: Thermosiphon effect

2. Technical Challenges

Assembly of cans is one of the important part in this model we are going to manufacture. Fluid flow rate is improper that have to be managed by the time.

3. Components:

Solar water has mainly four parts that are given below.

1. Solar Collector – The collector is made of using aluminium cans that are thrown in the garbage or which are waste.
2. Storage Tank – The storage tank of capacity 50 litres is provided to store the water which we are going to heat.
3. Frame – The frame is like backbone which supports the model by holding the collector and storage tank.
4. Connecting pipes – The pipes are to make sure the inlet and outlet flow of water through storage tank and collector. Every component is equally important. But most Solar water heater will come with multiple sub components.

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4. Testing:

The testing of collector of solar water is conducted in open space usually on roofs of building during day time to know how much amount of heat is transferred by it.

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5. Readings and Calculations:

Initial temp of water in collector
25.2 o c

Time (hr)	Temp of water in collector (without coating) T (wc)	Temp of water in collector (with coating) T (c)
1 hour	35.6^0 C T1(wc)	39.1^0 C T1(c)
2 hour	40.3^0 C T2(wc)	45.4^0 C T2(c)
3 hour	43.5^0 C	48.3^0 C
4 hou	45.7^0 C	51.2^0 C
5 hour	48.4^0 C	55.7^0 C

Table 1: Observation Table

6. Factors affecting solar water heating performance: The performance of a solar water heating system depends on the following factors.

6.1. Ambient conditions:

The amount of incident radiation determines the absorbed solar radiation by the collector while the ambient temperature determines the thermal losses from the collector. Cloudy conditions limit the beam isolation levels and thus the radiation absorbed by the collector especially the concentrating collectors (Duffie J.A and Beckman W.A, 1991).

6.2. Collector orientation and tilt:

The quantity of solar radiation a system absorbs is influenced by its geographic alignment and the angle of the collector. Collector orientation is critical in achieving maximum performance from a solar energy system. In general, the optimum orientation for a solar collector in the northern hemisphere is true south (azimuth of 180°) as illustrated in Figure 1.

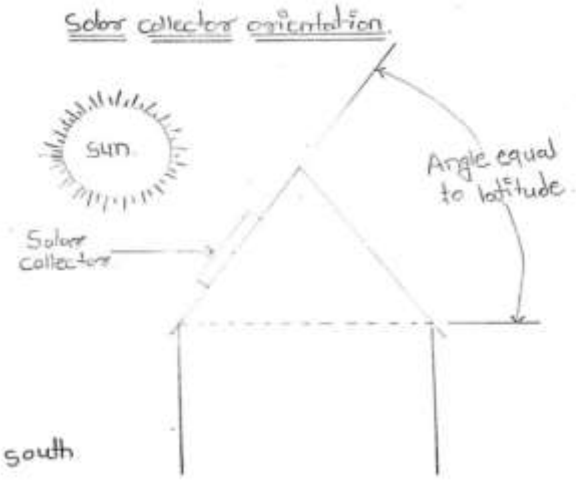

Fig.2 Solar collector orientation

6.3. Collector array arrangement:

The efficiency of a collector array is influenced by the way its modules are interconnected. In a parallel configuration, the inlet and outlet ports of each module are connected to share headers. When all modules are

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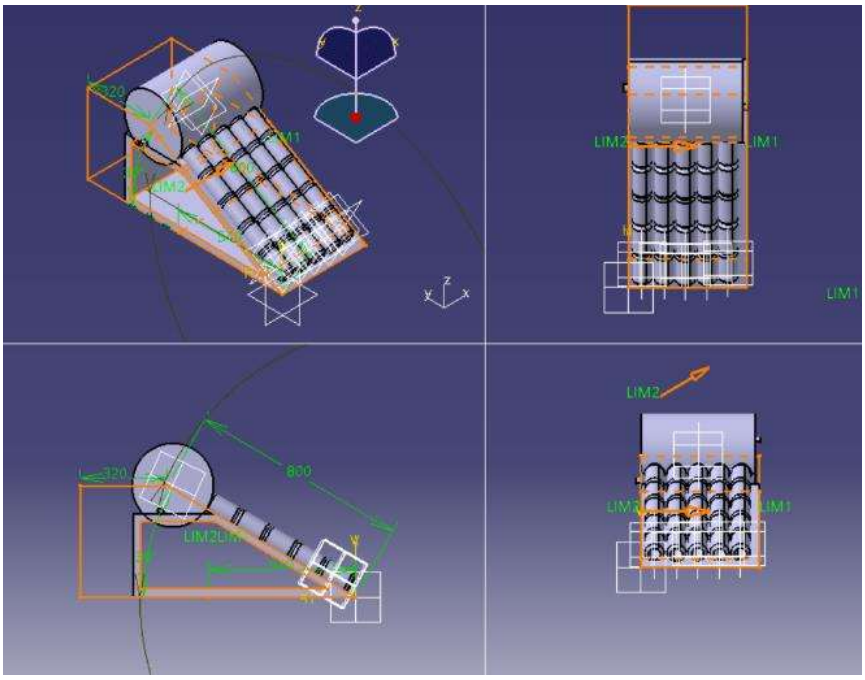
identical, they receive the same inlet temperature and yield the same outlet temperature. As a result, the overall performance of the array mirrors that of an individual collector. In contrast, a series configuration leads to variations in performance among the modules; the inlet temperature of each successive module is determined by the outlet temperature of the preceding one (Duffie J.A. and Beckman W.A., 1991).

8. MODEL

Fig3. Project model

9. DESIGN



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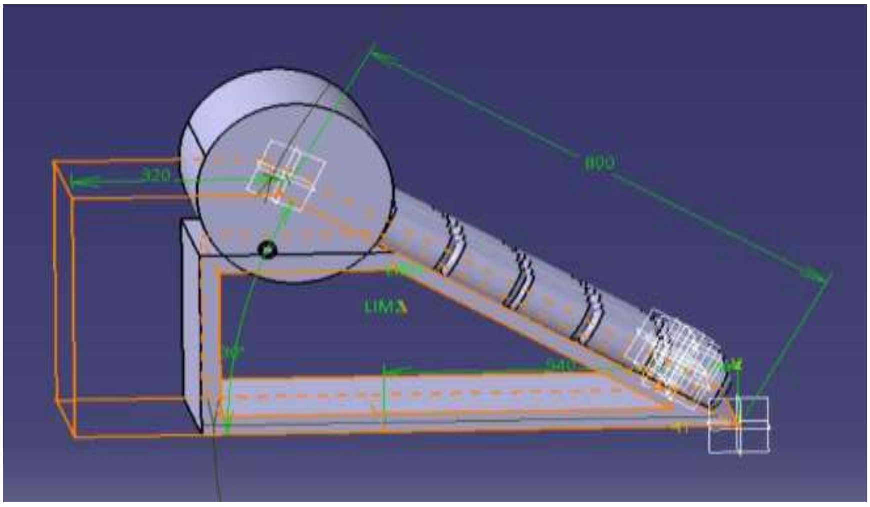

Fig 4. 3D design

Maintaining a low fluid flow rate through the collector—typically between 1 to 4 gallons per minute—enhances its thermal efficiency by promoting greater thermal stratification within the storage tank. In such a stratified tank, the fluid at the bottom remains cooler than the fluid at the top. Since the collector draws water from the tank's lower, cooler section, the inlet temperature is minimized. This reduction in inlet temperature helps to limit thermal losses, thereby improving the system's overall heat gain (Duffie J.A and Beckman W.A, 1991).

Solar energy collectors:

1. Flat plate collectors
2. Evacuated tube collectors
3. Parabolic concentrating collectors

10. RESULT

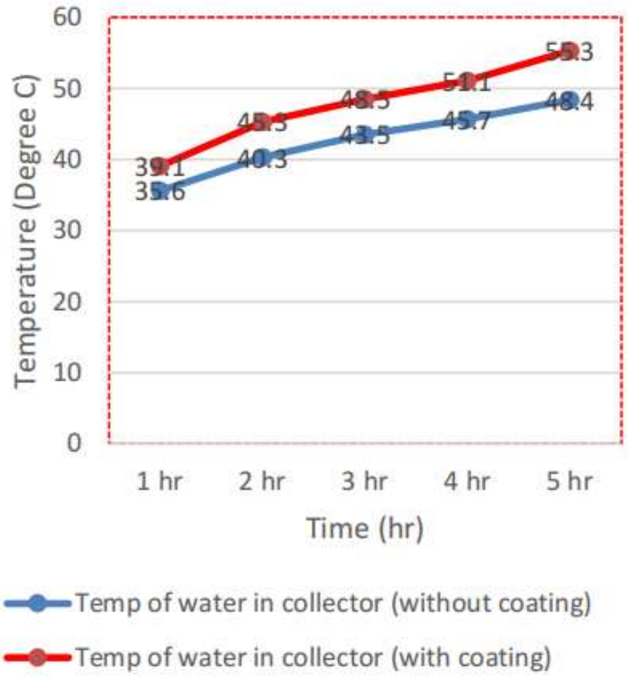

Chart 1: Temperature rise w.r.t. time

The research identified the situations when the heating is observed more. And determined how likely to adopt solar water heater using waste aluminium cans. These included different time periods as show in the graph/chart, considering the normal weather conditions

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11. CONCLUSION

This study primarily concentrated on lowering the cost of conventional solar heaters while offering a solution to waste management challenges. It investigated the use of discarded aluminum cans in the construction of a solar water heating system. The objective was to tackle two major concerns simultaneously—effective waste utilization and clean energy production. By incorporating used aluminum cans as the primary material in the collector, the project introduced a creative and economical approach to both issues.

Extensive testing and evaluation confirmed that the solar water heater made from recycled aluminum cans is both practical and efficient. The cans' surface area effectively absorbed solar radiation, which was then transferred to the water, leading to a notable rise in temperature. Additionally, the project highlighted the ecological advantages of using waste materials in renewable energy applications. By redirecting aluminum cans away from waste streams and applying them in a green technology context, the study supported efforts in recycling, environmental conservation, and sustainable development reduction, recycling, and environmental preservation. It is important to note that while the solar water heater using waste aluminium cans exhibited promising results, there are areas for further improvement and optimization. Future research could focus on enhancing the design and construction of the system, exploring different configurations, and investigating additional methods to increase its efficiency and reliability. Additionally, conducting long-term monitoring and analysing the system's performance under various climatic conditions would provide valuable insights for real world implementation.

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