

# PERFORMANCE IMPROVEMENT TECHNIQUES IN SOLAR FLAT PLATE COLLECTOR: A REVIEW

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## ABSTRACT

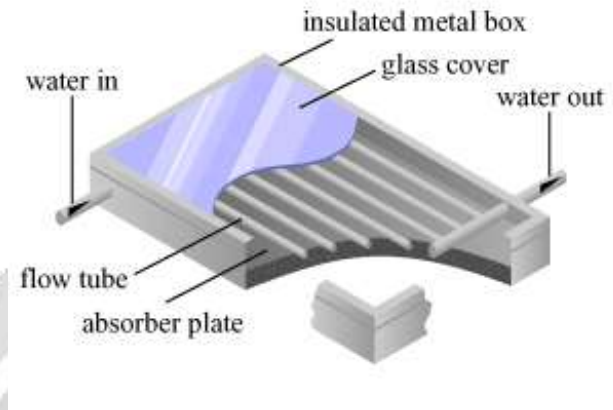
Solar energy is radiant light and heat from the Sun harnessed using a range of ever-evolving technologies such as solar heating, photovoltaic, solar thermal energy, solar architecture and photosynthesis. It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on the way they capture and distribute solar energy or convert it into solar power. This research mainly focuses on the different researches adopted for improvement in performance of solar flat plate collector water heater.

**Keyword:** - solar flat plate collector, renewable energy, solar energy

## 1. INTRODUCTION

The solar energy is an impotent source of energy. The sun emitted large number of photons on earth. The used of solar energy is very important for today's world because of energy scarcity. The numbers of researches were presented by different researcher for maximum utilization of solar energy. The adoption of this solar energy broadly classified on the basis of their used as active and passive mode. Active solar techniques include the use of photovoltaic systems; concentrated solar power and solar water heating to harness the energy and passive techniques included the used of insertion or modified of surfaces for heat transfer improvement. Objective of this paper is to presents wide studies of the research carried out on solar water heater and in this paper both experimental and theoretical developments in the field of solar water heater have been reviewed thoroughly and studied The developments are being carried out continuously in the field solar energy utilization. The different techniques were adopted such as used of cover materials, absorber plate materials, absorber and glazing coating etc. along with the changes in the design, fluid used for heat transfer. The used of conventional energy resources and its bad impact on environment have created renewed interest for the use of non conventional energy resources. As a result, there is considerable research and development activities have developed to identify reliable and economically possible alternate clean energy sources. The main principle of solar water heater is to convert the solar radiation into heat to satisfy energy needs but with some restrictions it is not used in large amount. The most common reasons only due to its poor efficiency and higher initial cost. So for overcome this there is requirement of advancement in the solar water heater using flat plate collector to overcome its limitations so that it can be used as a substitution or alternate of conventional heaters and power generation devices. The Solar collectors are distinguished as low, medium, or high temperature heat exchangers. There are basically three types of thermal solar collectors: flat plate, evacuated tube, and concentrating, even though there are immense geometric differences but their purpose remains the same. For conversion of the solar radiation into heat to satisfy some today's energy needs, the recent development is plays

vital role. The heat produced by solar collectors due to emission of solar photons can supply energy demand directly or it could be stored as needed. In the today's scenario to match demand of energy production of energy is associated with the thermal performance of the collector. The thermal performance of this flat collector must be needed to evaluated.



Solar collector is depends on the instantaneous useful energy collected on flat plate collector. The flat plate collector plays very vital role for absorbing the photons from the sun. The solar energy collection of any system designed for operation in the low temperature range, from ambient to 60 °C, to ambient to 100°C. The design of solar flat plate collector shows the less absorption of solar energy. The flat plate collector surface may not be truly flat it may be a combination of flat, grooved or of other shapes as the absorbing surface with some kind of heat removal device like tubes or channels.

## 2. AUGMENTATION TECHNIQUES

Heat transfer enhancement or augmentation technique refers to the improvement of thermo hydraulic performance of heat exchangers. Existing enhancement technique can be broadly classified into three different categories:

- 1) Passive Technique
- 2) Active Technique
- 3) Compound Technique.

Passive Technique generally uses surface or geometrical modification to the flow channel by incorporating insert or additional devices.

Promote higher heat transfer coefficient by disturbing or altering the existing flow behavior (except for extended surfaces) which also leads to increase in the pressure drop. Following methods are generally used

- a) Inserts
- b) Extended surface
- c) Surface modification
- d) Use of Additives

Active heat transfer techniques involves some external power input for the enhancement of heat transfer, some examples of Active heat transfer techniques included pulsation by cams and reciprocating plunger, the use of magnetic field to disturb the seeded light particles in a flowing stream etc.

## 3. LITERATURE REVIEW

### 3.1 FLAT PLATE SOLAR COLLECTOR

A simple construction of flat-plate solar collector consists of a waterproof, metal or fiberglass insulated box with dark black colored absorber plate, with one or more transparent glazing. The absorber plates of solar flat

collector are typically made out of metal due to its high thermal conductivity and it is painted with special selective surface coatings in order to absorb and transfer heat better than regular black paint. The glazing covers reduce the convection and radiation heat losses to the environment. The collector gains energy from the photons of sun.

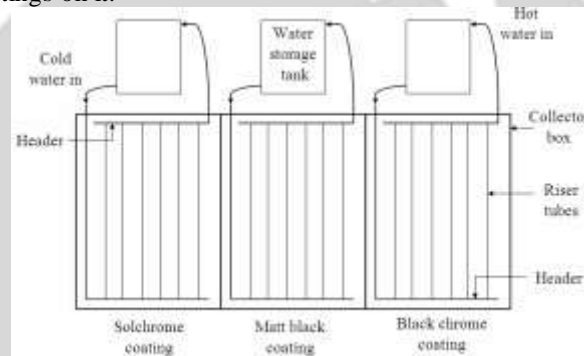
**3.1.1. SURFACE MODIFICATION**

Surface modification is the act of modifying the surface of a material by bringing physical, chemical or biological characteristics different from the ones originally found on the surface of a material. Almost all types of materials can be coated on similar or dissimilar materials.

According to **Yuechao Deng** that improvement in solar flat plate collector. In this research thermal performance for the novel flat plate solar water heater with micro heat pipe array absorber is studied and analyzed for maximum thermal performance improvement. The test results for the collector's instantaneous efficiency show that improvement in the efficiency 0.85 respectively also it is observed that the thermal efficiency of solar flat collector improves with effective gain in solar radiation. [1]

According to **Dr. Karima E. Amori** studied for thermal improvement of solar hot water system with the used of accelerated riser in flat plate collector. The performance of accelerated riser solar flat plate collector is compared with simple SWH. The convergent types riser is used for study. The results shows that approximately 60% improvement in thermal performance of solar water heater. [2]

**Madhukeshwara. N** investigated on the performance characteristics of solar flat plate collector with the used of different selective surface coatings on it.



The three different types coating is used for this works, the results shows that performance of flat plate collectors enhanced to some extent.[3]

**Mustafa** investigated the innovation in solar flat plate collector for improving its performance. The three different types layers is used on the solar collector, the results obtained improves the performance of solar collector and heat gain capacity. [4]

**S. Rajasekaran** works on the performance analysis of coated solar flat plate collector. In this work the solar collector is coated with epoxy-polyether and aluminum with copper oxide coating, the results of this research shows the improves in efficiency of solar collector by 40 to 47%.

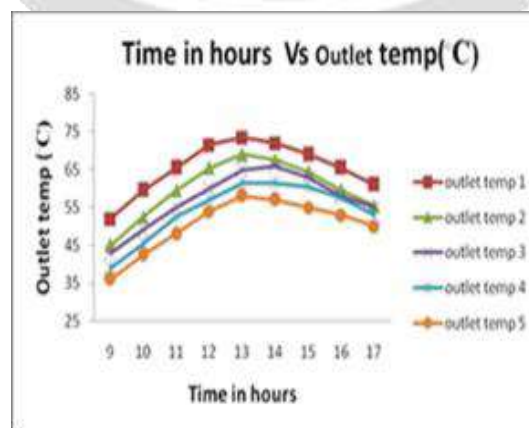


Fig. curve for hourly variation of fluid outlet temperature. [5]

### 3.1.2 EXTENDED SURFACE

Extended surface is also called as fins. Fins are surfaces that extend from an object to increase the rate of heat transfer to or from the environment by increasing convection. The amount of conduction, convection, or radiation of an object determines the amount of heat it transfers. Increasing the temperature gradient between the object and the environment, increasing the convection heat transfer coefficient, or increasing the surface area of the object increases the heat transfer. Sometimes it is not feasible or economical to change the first two options. Thus, adding a fin to an object, increases the surface area and can sometimes be an economical solution to heat transfer problems.

**Sethuraman Ramasamy** investigated on the thermal performance analysis of the solar water heater with circular and rectangular absorber fins. The solar water heater is provided with the fins for maximum heat transfer.

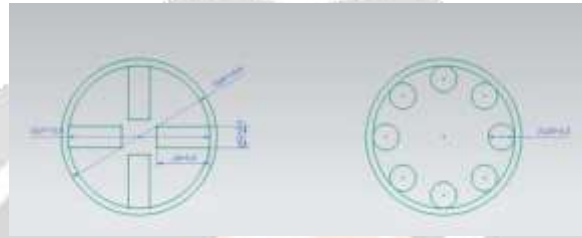


Fig. 2-D diagram for Rectangular and circular fin

The results obtained shows that the performance of solar flat plate collector gain the, maximum radiation and improves the performance. [6]

### 3.1.3 USE OF ADDITIVES

The use additives is a technique applied to enhance the heat transfer performance of a base fluids. Innovative material, nanosized particles have been used in convectonal heat transfer fluid. The fluid with nonosized particles suspended in them are called "Nano fluids".

#### TYPES OF HEAT TRANSFER FLUID

- Air
- Water/Distilled Water
- Ethylene glycol
- Hydrocarbon oils
- Phase change fluids
- Silicones

**E. Natarajan** suggested that the use of nanomaterials in the solar flat plate collector to increase the heat transfer and this can be useful for improving the energy saving due to its compact designs. [7]

**Lee** suggested that the use of ethylene glycol as heat transfer fluid. The ethylene glycol fluid is transferred within riser for obtaining the maximum heat transfer rate. The result shows that improvement in the thermal performance of solar flat collector. [8]

**K. Vasudeva Karanth** has been studied on the Numerical and experimental study of a solar water heater for enhancement in thermal performance, Numerical analysis of the solar water heater which involves conduction and convection due to radiation heat transfer using Computational Fluid Dynamics (CFD) as a tool has not been the focus of study so far. It is generally understood that sinusoidal flow passage tends to increase turbulence which in turn increases convective heat transfer. The result of study noted from the experimental and numerical analysis that the straight tube configuration has better performance than that of sinusoidal pipe configuration. [9]

### 3.1.4 INSERTS

Inserts refer to the additional arrangements made as an obstacle to fluid flow so as to augment Heat transfer. Different types of inserts are:

- 1) Twisted Tape and Wire coils
- 2) Ribs and Baffles

### 1) Twisted Tape

Twisted tape increases the heat transfer Coefficient at a cost of rise in pressure drop. The Swirl inserts and tape twister technique creates a flow disturbance and the pressure drop losses are much higher compared to the gain in heat transfer coefficient.



### 2) Ribs and Baffles

There are several technique to enhance the heat transfer coefficient of gases in internal cooling one of the common internal cooling enhances techniques is the placement of internal flow swirls, tape twisters or baffles. Different shape ribs and baffles also create bulk flow disturbance, but unlike tapes or swirls, ribs and baffles are discrete objects.



**S. Vijayakumar** has investigated the results of the heat transfer have been compared wellwith the available results. The heat transfer rate in the collector hasbeen found to be increased by 18% to 70%. It has been observed that heat losses are reduced consequently increasing the thermal performance about 30% over the plain water[10]

**M. Yahya** investigated on the CFD analysis of solar hot water heater with integrated storage system. The performance of flat plate collector with different types insertion in riser tube is an alyzed by CFD i.e.  $\theta = 5^\circ, 10^\circ \& 15^\circ$

The performance in two ways

- Tilted dependence
- Time dependence.[11]



#### 4. CONCLUSIONS

The research review shows that the solar energy have wide range of application, the investigation on the solar water heater is widely investigated for improving the performance of solar flat collector by different researcher. The above presented work shows that the different techniques were incorporated for maximized the performance of SWH.A numerous hopeful advancement are taking place in the field of solar water heating system using flat plate collector. This improvement in the field will leads to possible changes in performance of solar flat collector.

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