

# REVIEW OF PERFORMANCE AND ANALYSIS OF ISI FLAT PLATE COLLECTOR WITH MODIFIED FLAT PLATE COLLECTOR

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## Abstract :

The market of solar water heater of natural circulation type (thermo-siphon) is fast growing in India. Initial cost of the solar water heater system at present is high because of store type design. It is necessary to make the product more popular by reducing the cost. This is possible by reducing area of liquid flat plate collector by increasing tube diameter and reducing riser length. Hence it is essential to make solar water heater in affordable range of the general public class. Present work is based on review of comparative performance and analysis of ISI flat plate collector with modified flat plate collector. The paper will be helpful for those who are working in the area of solar water heating system and their use in domestic areas.

**Keywords:** *Buoyancy, Induced flow, Thermo-Siphon.*

## 1. Introduction

Solar energy is the primary source of energy for our planet. Solar energy is very large, inexhaustible and clean source of energy. The power from the sun intercepted by the earth is many thousand of times larger than the present consumption rate on the earth of all commercial sources. Increased utilization of solar energy in India could result in all around benefits, both in terms of cleaner environment and monetary gain.

The solar thermal energy is collected in a device called solar collector. It consists of a dark surface called absorber, fluid flow passage and suitable provisions for heat loss reduction. When exposed to the sun, the absorber absorbs the solar radiation and transfers a part of it to the fluid flowing over/under it. The present work is concerned with the flat plate design only. The flat plate collectors are the most popular as they are simple in design, have no moving parts and require little maintenance. They are also relatively cheap and can be used in variety of application.

The market for solar water heater of natural circulation type (thermo-siphon) is fast growing in India. It is necessary to reduce the electricity consumption for domestic and industrial water which is required to be 85<sup>0</sup>C (low grade energy). Presently the dimensions and other quality standards are governed by the IS 12933 issued by Bureau of Indian standards for the best performance. However experience shows that a solar flat plate collector having increasing diameter of copper tube of flat plate collector with integral fins performances are better than the ISI flat plate collector. The present work is an study on the comparative performance analysis of ISI flat plate collector with modified flat plate collector.

## 2. Review of work carried out

Dr.V.R.Bhore.et.al [1] Describes method for testing a flat plate collector operating under natural circulation mode of heat transfer. The present procedure for the system performance characterization as per the code IS 13929 is complex in nature and is difficult to use. This paper propose a simple method for testing of a solar flat plate collector operating under natural circulation mode in general and that of a domestic water heating system

in particular. The method can be used for indoor as well as out door testing of the collectors. The method suggested in this paper is simple and can be used with minimum instrumentation and provides absolute performance index with a greater accuracy for direct comparison of the different collectors.

Dr.S.V.Prayagi.et.al [2] Present work deals with solar water heating system in particular. Performance of the solar collectors can be determined using developed empirical correlation to understand logically the effect of parameters like tube length, tube diameter and fluid flow characteristics for buoyancy induced flow through pipes. This analysis is simple for the forced convection situation, where the flow rate is artificially maintained constant to a desired value and the heat transfer coefficient can be easily predicted using the information available in the literature. However for the natural convection situation, it is very difficult to analyze as appropriate correlations for predicting the value of induced mass flow rate due to thermo-siphon effect. The present investigation is to establish correlations for heat transfer and flow characteristics for the buoyancy induced flow through inclined tube. Experiments were performed to establish heat transfer and induced flow characteristics of buoyancy induced flow inside a circular pipe. The heat transfer co-efficient is strongly influenced by heat flux. The heat transfer coefficient is found to be weak function of the tube inclination and independent of tube length. The Nusselt number (heat transfer coefficient) tends to increase with the increase in the diameter of the test section and is proportional to 2<sup>nd</sup> power of the tube diameter. The mass flow rate increases with the heat supplied and the variation is parabolic. The mass flow rate is strongly influenced by heat flux. The Reynolds number (mass flow rate) of water tends to increase, with increase in diameter of the test section and is proportional to 2<sup>nd</sup> power of diameter.

Dyer J.R.et.al. [3] In this paper author used the concept of a theoretical and experimental study of laminar natural- convective flow in heated vertical duct. The ducts are open ended and circular in cross section and their internal surfaces dissipate heat uniformly. Temperature and velocity fields and the relationship between Nusselt and Rayleigh numbers were obtained by solving the governing equations by a step-by-step numerical technique. Two Rayleigh numbers were introduced on expressed in terms of the uniform heat flux and the other in terms of the mean wall temperature. The influence that the prandlt numbers has on the relationship between the Nusselt and Rayleigh numbers was discussed. Three inlet conditions were examined which give the same Nusselt relationship at small Rayleigh numbers and the differences between the Nusselt relationships obtained at large Rayleigh number were only small.

Wen-Shing Lee.et.al [4] studied the thermal performance of latest heat storage in two phase thermo-siphon solar water heater, which utilizes the superior heat transfer characteristics and eliminates drawbacks found in the conventional solar water heater. This study also examines the functions of charge and discharge thermal behaviors in a two phase thermo-siphon solar water heater. The present article is to provide a two phase thermo-siphon solar water heater in which a passive type of control is adopted to eliminate the above drawbacks found in the conventional solar heating system.

Govid N.K.Kulkarni.et.al [5] In this paper a methodology proposed by author is to determine the design space for synthesis, analysis and optimization of solar water heating system. The proposed methodology incorporates different design constraints to identify all possible designs or a design space on a collector area vs. storage volume diagram. It has been observed that there exists a minimum as well as a maximum storage volume for a given solar fraction and collector area. Similarly existence of a minimum and a maximum collector area is also observed for a fix solar fraction and storage volume. The concept of design space approach for synthesis, analysis and optimization of solar thermal system is presented in this paper. Employment of the design space approach for optimization and parametric analysis of solar thermal system may reduce the labour, expertise and expense involved. The methodology is simple, flexible and does not need any special computational setup, thus offering a prospect of application in domestic as well as industrial configurations.

Yasin Varol.et.al[6] This paper describes the concept of Natural convection heat transfer and fluid flow were investigated inside a wavy and inclined solar collector, numerically. Parameters that affect the flow and temperature field are Rayleigh number, inclination angle, aspect ratio. The heat transfer is increased with increasing Rayleigh number and aspect ratio.

### 3. Conclusion

The solar water heating system with modified flat plat collector is not over complicated as compare to ISI flat plat collector and will be straight forward to use and easy to maintain. Simultaneous testing of number of various collectors will be possible. It is found that the modified flat plate collector with increase in diameter of test section, Nusselt number and Reylonds number is increased with second power of tube diameter. Hence it

shows that there is better performance of modified flat plate collector over ISI flat plate collector. The modified flat plate collector by increasing tube diameter and reducing riser length will perform better than ISI design flat plate collector from efficiency point of view. Also this system could well serve in rural areas due to reduction in the cost, electricity consumption of solar water heater and other similar part of the world in need of hot water.

### References:

- [1] Bhole V.R. ; Thombre S.B. (2002). 'A Simple Method for indoor and outdoor testing of a flat plat collector operating under natural circulation mode', proceedings, international conference on recent advance in solar energy conversation systems, MANIT, Bhopal.
- [2] Prayagi S.V. ; Thombre S.B. (IJEST-2011). 'Parametric Studies on Buoyancy Induced Flow Through Circular Pipes in Solar Water Heating System'.
- [3] Dyer J.R.(1975). 'The development of Laminar Natural Convective flow in a vertical Uniform Het Flux Duct', International Journal of Heat & Mass Transfer, Vol.18, Issue-12, 1455-1465.
- [4] Wen-Shing Lee ; Bo-Ren Chen Sih-Li Chen. (2006). 'Latent Heat Storage in a Two-Phase Thermosyphon Solar Water heater', International Journal of Solar Energy Engineering, ASME.
- [5] Govid N.K.Kulkarni ; Shireesh B. Kedare ; Santanu Bandyopadhyay. (2006). 'Determination of Design space and optimization of solar water heating systems', Solar Energy 81 (2007) 958-968, Elsevier Ltd.
- [6] Yasin Varol. (May 2007). 'Buoyancy induced heat transfer and fluid flow inside a tilted wavy solar collector', building and environment, Vol. 42, Issue 5, Pages 2062-2071.