International Journal of Scientific Research in Science, Engineering and Technology (www.ijsrset.com)
© 2020 IJSRSET | Volume 7 | Issue 2 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
DOI : https://doi.org/10.32628/IJSRSET207275

Approximate Representation and Exposition of ISI Flat Plate Collector including Revised Flat Plate Collector : A Review

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ABSTRACT

Cosmic power is one of the numerous renewable energy sources that can use in a Photovoltaic (PV) system or Thermal. Solar collectors play a crucial role in solar thermal systems. They convert solar radiation into heat and transfer the heat to working fluids Such as water or air. The Flat-plate collectors are the numerous common type of solar collectors and typically used as a water heater or air heater. These collectors have low efficiency and low outlet temperature. Recently, many scientists have attempted to improve the efficiency and performance of flat-plate collectors via different methods. This review paper describes the results of the experimentation carried out to study and compare the performance of the modified flat plate collector having increasing riser tube diameter and reducing riser tube length with the conventional ISI marked solar liquid flat plate collector. To study, the comparative performance characteristics of a modified flat plate collector with ISI flat plate collector operated under natural circulation mode. The suggested design found to be better than the existing ISI design of the absorber plate from an efficiency point of view. The actual useful heat gain (Qu) in the suggested design understudy found to be more by 30% than that in the case of ISI collector. However, the modified flat plate collector found to operate at a relatively lower exit temperature than the conventional ISI marked collector.

Keywords : ISI Flat Plate Collector, Induced flow, Absorber Plate, Buoyancy, Thermo-Siphon

I. INTRODUCTION

In current years cosmic power has been vigorously served as a viable energy source. One of the most straightforward and most direct applications of this energy is the conversion of solar radiation into heat. The way that the residential sector can diminish its impact on the climate is by the placing of solar flat plate collectors for water heating. Although it should say that some of these collectors have been in service for the last 40-50 years without any real, meaningful changes in their design and operational principles. A typical flat-plate collector consists of four components-

(i) Transparent Cover,
(ii) Collector Box,
(iii) Absorber Plate, and
(iv) Tubes fixed to the Absorber Plate.

The collector plates receive the maximum permissible amount of cosmic irradiance and transfer this heat to the working fluid, which is flowing in the absorber tube. The liquid used for heat transfer generally flows through metallic tubing, which connected to the

absorber plate. The absorber usually made of metallic materials such as aluminium, copper or steel, and the surface is generally black.

The business for Solar Water Heater of general transmission type (Thermo-siphon) is actively growing in India. It is essential to diminish the power dissipation for manufacturing water heating and residential, which expected to be around 850ºC (low-grade energy).

The practice has proved that a solar flat plate collector must be improving pipe diameter, and reducing riser length performs better than an ISI marked solar flat plate collector. This research work represents the results of the experimentation carried out to investigate and analyze the appearance of the collector using the new method. This arrangement also permits the absolute rating of the collectors.

In all, two variety collector arrangements tested, details of which given in Table (A). Both the collectors were operated simultaneously in the normal transmission mode and in the same ambient environment, which promoted direct correlation among them.

An innovative set-up consisted of a collector to be examined, calibrated thermometers, above the tank, stand structure, measuring jars, etc.

Table A : Operating Parameters of both the collector.

Sr. No.	Parameter	ISI	Modified ϕ = 20 mm
1	Pitch	120 mm	120 mm
2	Area	2.12 m^2	1.46 m^2
3	Collector angle	36^0	36^0
4	Riser tube length	1.87 m	1.37 m

II. THE INTENTION OF THE WORK

The primary intention of the review work is to examine the performance parameters of an Exposition of ISI Flat Plate Collector, including Revised Flat Plate Collector.

III. LITERATURE REVIEW

The following research papers are a review in detail, and the extracts of relevant articles are as under:

1.Thundil Karuppa R. Raj et. al. (2012), investigates a new solar flat plate collector which is of sandwich type. The new type of collector is the water sandwich type collector which is made by bracing two corrugated metal sheets on one another. The absorber is made of 2 sheets of GI (1 mm) with integrated canals, painted silica based black paint. The outer casing which provides mechanical strength to the equipment is insulated to reduce the heat losses from back and sides of the collector. The new collector is differ is the absence of heat carrying metallic tubes. The working fluid is made to pass through the channels that are formed when two corrugated metal sheets are braced one over another. Efficiency of the flat plate conventional is 24.17 and efficiency of the new collector is 20.19%.

2. Dr. Karima E. Amori et al.(2012), a study was carried out for thermal improvement of solar water system using accelerated tubes in flat plate collector This study includes a comparison between the performances of two locally fabricated similar flat plate solar collectors. One of these collectors is a new design of accelerated absorber, its risers are of converging ducts (the exit area is half that at the entrance). The other collector is of conventional absorber (its risers have the same cross sectional area along its length). Results show that a considerable enhancement of thermal performance approximately (60%) of absorbed heat (useful gain) at solar noon is obtained for the new design in comparison with the conventional type.

3. A.T. Fatigun et. al. (2012), conduct experiment in which the effect of tube spacing on the performance of a flat plate collector is compares. Two same aperture area of solar flat plate collector is compare of average adjacent tube spacing of 11 cm and 20 cm. Average of 11 cm spacing between adjacent lines yielded 15 turns while 20cm average line spacing yielded 9 turns of tubing per Flat plate. The efficiency of collector 20cm was found to be significantly higher than that of collector 11cm, i.e. 10% and 21% was obtained for collectors and respectively.

4. Dr. S. V. Prayagi et. al. (2011), 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 2nd 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 2nd power of diameter.

5. Y.Y. Nandurkar and R. S. Shelke et al. (2012), conducted experiments in which reducing area of liquid flat plate collector by increasing tube diameter and reducing riser length. Solar flat plate collector having increasing diameter of copper tube of flat plate collector with integral fins performances is 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. It is found that the modified flat plate collector with increase in diameter of test section, Nusselt number and Reynolds number is increased with second power of tube diameter.

6. D. C. Larson (1980), had experimental investigation on Optimization of Flat-Plate Collector-Flat Mirror Systems. the use of a flat plate collector with mirror provides enhanced solar collection, a better matching of solar collection to load requirements and acceptable efficiencies at higher operating temperatures.

7. Govid N.Kulkarni.et.al. (2007), a methodology was proposed by author 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.

8. Amrutkar S.K. et al. (2012), had performance studies on Solar Flat Plate Collector Analysis. The objective of present study is to evaluate the performance of FPC with different geometric absorber configuration. It is expected that with the same collector space higher thermal efficiency or higher water temperature can be obtained. Thus, cost of the FPC can be further bring down by enhancing the collector efficiency. A test setup is fabricated and experiments conduct to study these aspects under laboratory conditions (as per IS standard available for the flat plate collector testing).

9. Ljiljana T. Kostic et al. (2011), proposed an optimum position for the reflectors to improve the thermal efficiency of flat plate collector SWH. For that purpose they were conducted study on thermal collectors with and without flat plate solar radiation reflectors.

10. B. K. Gond et al. (2016), investigates Flat Plate Collector (FPC) is widely used for domestic hot-water, space heating/drying and for applications requiring fluid temperature less than 100ºC. Three main components associated with FPC namely, absorber plate, top covers and heating pipes. The absorber plate is selective coated to have high absorptivity. It receives heat by solar radiation and by conduction; heat is transferred to the flowing liquid through the heating pipes. The fluid flow through the collector pipes is by natural (thermo syphon effect) or by forced circulation (pump flow). For small water heating systems natural circulation is used for fluid flow. Conventionally, absorbers of all flat plate collectors are straight copper / aluminium sheets however, which limits on the heat collection surface transfer area. Thus, higher heat collection surface area is optimized by changing its geometry with the same space of conventional FPC. The objective of present study is to evaluate the performance of FPC with different geometric absorber configuration. It is expected that with the same collector space higher thermal efficiency or higher water temperature can be obtained. Thus, cost of the FPC can be further bring down by enhancing the collector efficiency. A test setup is fabricated and experiments conduct to study these aspects under laboratory conditions (as per IS standard available for the flat plate collector testing). The experimental results revealed that the performance of the solar water heater by using all the materials produced the maximum efficiency of around 40 % to 47 % respectively. And the maximum outlet water temperature reached is below 70^0C respectively. The order of material priority for better efficiency is copper, aluminium, than stainless steel.

IV. TECHNIQUE

A tube considered to be semi-circular in a cross-sectional area attached to the absorber plate so that the city of absorbing surface is more than that of a circular tubing system in a solar flat plate collector. A Solar Flat Plate Collector performance influences by the number of parameters such as numbers of covers, selective surfaces, absorber plates, and the spacing between sheets, etc. In this study, the shape of a flat plate collector considered being ISI Flat Plate Collector, including Revised Flat Plate Collector.

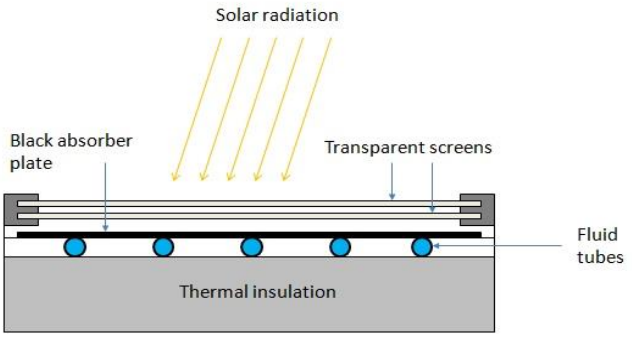

Fig. A. Flat Plate Conventional Collector

Fig. A shows a Flat Plate Conventional Collector, including orthogonal among circular tubes attached to the absorber plate. In this type, the resistance to heat flow to the cell from the plate may have consisted of three components.

V. CONCLUSION

1. The solar water heating system with a revised flat plat collector is not over intricate as corresponds to

ISI flat plate collector and will be straight forward to use and easy to maintain.

2. Simultaneous testing of several various collectors will be possible. It found that the revised flat plate collector with an improvement in the diameter of the analysis section, Reynolds number, and Nusselt number, increased with other influence of tube diameter.

3. Hence it shows that there is a better review of a revised flat plate collector over ISI flat plate collector. The revised flat plate collector by developing tube diameter and diminishing riser length will perform better than ISI design flat plate collector from a performance point of view.

4. Also, this system could well serve in provincial areas due to the electricity consumption of solar water heater, reduction in the cost, and another similar part of the world in need of hot water.

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Cite this article as :

Dr. Rajeshkumar U. Sambhe, Dr. Sagar S. Gaddamwar, "Approximate Representation and Exposition of ISI Flat Plate Collector including Revised Flat Plate Collector : A Review", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Online ISSN : 2394-4099, Print ISSN : 2395-1990, Volume 7 Issue 2, pp. 345-350, March-April 2020. Available at doi : https://doi.org/10.32628/IJSRSET207275
Journal URL : http://ijsrset.com/IJSRSET207275