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TITLE: A REVIEW ON FABRICATIONS OF SOLAR FLAT PLATE COLLECTOR USING AEROFOIL TUBES WITH CONVENTIONAL CIRCULAR ABSORBER TUBES

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Abstract

Flat-plate collectors (FPC) are used to harness the solar radiations to heat the water specifically used for household purpose. The thermal efficiency of FPC is mainly affected by the shape of the absorber tubes and the absorbing capacity of absorber plate. The objective of this present paper is to evaluate and compare the thermal efficiency of flat plate solar thermal collector with varying shape of the absorber tubes. In the present study, the experiments were conducted on solar flat plate collectors having conventional circular and aerofoil shape absorber tubes. The experiments were carried out under identical conditions such as mass flow rate, intensity of solar radiations and size of collector for both types of flat plate collectors. The results obtained from both the collectors are compared and it is observed that there is increase in the outlet water temperature from aerofoil absorber tubes as compared with the conventional circular absorber tubes. It is observed that the flat plate thermal collector with aerofoil shape absorber tubes gives a 10 to 12% higher efficiency than the conventional circular absorber tubes under identical operating conditions. This is due to the fact that the aerofoil shape absorber tubes provides more surface area for transferring the heat to the water which in turn gains more amount of heat as compared with the conventional circular shape absorber tubes.

Key words: *Aerofoil shapes absorber tubes, solar flat plate collector ,conventional circular tubes* **.**

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1.**INTRODUCTION**

In the view of depletion in conventional energy sources, many researchers have carried out the research work in the field of renewable energy sources. The objective of these research works is to use the maximum available solar energy. There is a wide application of flat plate collectors which uses both direct and diffused solar radiation. The main components of flat plate collectors are absorber tubes, absorber plate, casing and insulation to prevent the thermal energy loss. Many researchers have carried out their research work in the field of FPC in order to enhance its thermal performance. Literature review which is carried out in the field of flat plate collector is discussed below.

Flat Plate Collector:

It is a metal box with a glass or plastic cover (glazing) on top and a dark-colored absorber plate on the bottom with insulation at sides and bottom of the collector to minimize heat loss typically mounted on a roof that heats water using the sun’s energy. The main components of a flat plate solar collector are:

- Absorber plate
- Tubes or fins
- Glazing
- Thermal insulation
- Cover strip

Solar collectors are the key component of solar water heating systems. Solar collectors are the devices used to convert solar energy into heat energy. Sunlight passes through the glazing

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and strikes the absorber plate, which heats up, changing solar energy into heat energy. The heat is transferred to liquid passing through pipes attached to the absorber plate.

2. LITERATURE REVIEW

Manjunath M.S et al. [1], compared the effect of surface geometry of solar collector having dimple geometry with that of a flat plate solar collector of the same size as shown in Figure 3. A CFD analysis was carried out for the two cases, subjected to a constant heat flux of 600 W/m2 and 1000 W/m2. It can be inferred from the study that the absorber plate temperature shows a rise of average surface temperature of about 5^{0}C for the dimple solar collector when compared to a flat plate solar collector. Most importantly, the average exit water temperature shows a marked improvement of about 5.5^0 C for a dimple solar collector as compared to that of a flat plate solar collector.

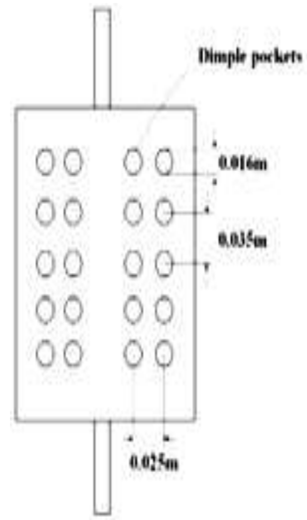

Fig.1

Sunil K. Amrutkaret al. [2], Figure 5 shows a few of the very large number of flat plate solar collectors which are currently
used. In this figure, diagrams A (1, 2) show conventional liquid heaters with the tubes soldered or otherwise fastened to upper or lower surfaces of metal sheets.

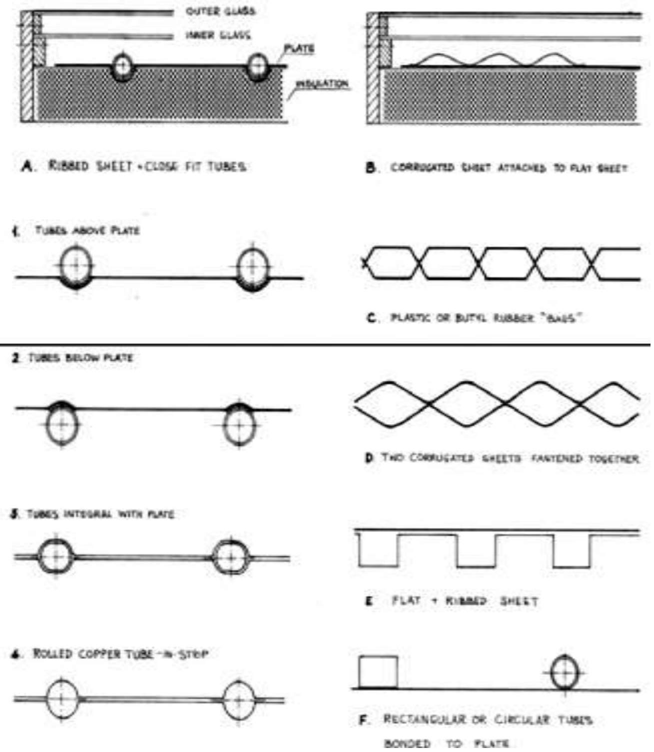

Fig. 2: Absorber Plate and Tubes Bonding Sections

P. Rhushi Prasad et al. [3], conducted experiments for a week during which the atmospheric conditions were almost uniform and data was collected both for fixed and tracked conditions of the flat plate collector. The results show that there is an average increase of 40C in the outlet temperature. The efficiency of both the conditions was calculated and the comparison shows that there is an increase of about 21% in the percentage of efficiency.

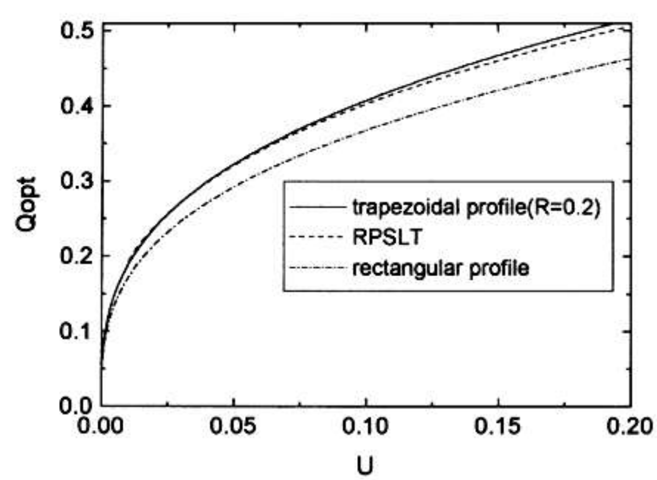

Fig .3 : The Maximum Energy Transfer Rate by Different Profile as a Function of Plate Volume

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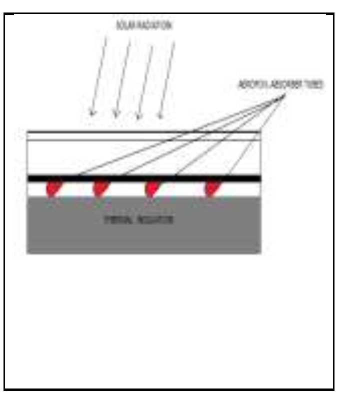
Y. Raja Sekhar et al. [4], evaluate top loss coefficient of the flat plate collector both theoretically and experimentally. By performing experiment they concluded that the emissivity of the absorber plate has a significant impact on the top loss coefficient and consequently on the efficiency of the flat plate collector. The efficiency of FPC is found to increase with increasing ambient temperature. There is no significant impact of tilt angle on the top loss coefficient.

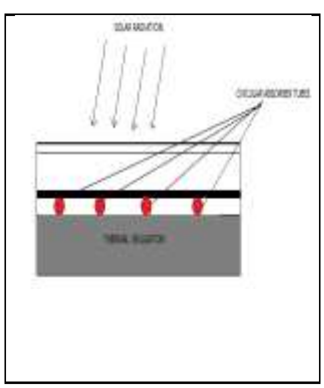
K.E. Amori et al. [5], compared the performance of two similar locally-fabricated solar water heaters. One of the collectors features a new design for accelerated absorber; its risers were made of converging ducts whose exit area was half that of the entrance. The other collector was a conventional absorber, with risers of the same cross sectional area along its length. They conducted experiments on the two solar water heaters from January to April of 2009 for different water withdrawal profiles, continuous, interrupted and no load, as well as for horizontal and vertical storage tank orientations. Two types of storage tanks were investigated, those with two concentric cylinders, and those with helically-coiled tubes in the cylinder. Results show that a considerable enhancement of thermal performance
(approximately 60%) of absorbed heat (useful gain) at solar noon was obtained for the new design, in comparison with the conventional type. The instantaneous efficiency was 31.5% for the accelerated absorbed flat plate at solar noon, while that of conventional absorber was (16.5%). The longitudinal water temperature variations in the risers of accelerated absorber were larger than that of the conventional absorber.

3. MANUFACTURING

3.1 METHOD AND MATERIALS

The method used here are gas welding, soldering and in the experimental setup the flat plate collector consists of both tubes that is aerofoil and circular tubes.
The material used for making tubes are copper, aluminium and high thermal conductivity materials but in this setup mainly aluminium is used.





4. 5.

Fig.4 FPC with Aerofoil absorber tubes

Fig.5 FPC with Circular absorber tubes

Fig.6 Cross section of Aerofoil absorber tubes

3.2 FABRICATION

Aluminium sheet is cut into double size to make a sandwich type work, which has one benefit that there is no requirement of brazing of tube to sheet; but disadvantage is that cost of aluminium sheet is doubled. Finally black paint is coated to improve heat absorption capacity.

3.3 EXPERIMENTAL SETUP

Fig.7

4.CONCLUSION

The performance of a solar flat plate collector using aerofoil and circular shape absorber tubes has been investigated. The experimental data is compared for both the solar flat plate collectors. Based on the experimental results it can be concluded that FPC with aerofoil shape absorber tubes gained more amount of solar radiation as compared with the circular shape absorber tubes. It is observed that with increase in mass flow rate of water flowing through the absorber tubes, the efficiency of both the collectors also get increases. Absorber with aerofoil shape gives optimal efficiency due to increase in surface area of contact between absorber plate and fluid flowing through the tubes so it can be concluded that the use of aerofoil shape absorber tubes is beneficial in conventional flat plate collector.

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