Solar Water Heater with Parabolic Concentrator & Preheated Water Inlet

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Abstract:- **The solar water heater with parabolic concentrator & preheated water inlet (shown in Fig. 3) consists of both principles of direct radiation and diffuse radiation system. The performance of conventional domestic solar water heater is increased by adding two parabolic concentrator's i.e. upper parabolic concentrator (1) & lower parabolic concentrator (2) on both the sides of the flat plate solar water heater. The Solar water heater with parabolic concentrator & preheated water inlet addresses many of the issues associated with current technology system.**

Normally, less area is exposed to sun. So energy collected will be low. Here due to application of parabolic concentrator the energy flex on the absorber plate high. It gives more efficiency when compared to the custom plate type solar water heater. The efficiency of this solar water heater with parabolic concentrator & preheated water inlet is increased due to fallowing reasons:

1. **The rays which fall on parabolic concentrator reflect back onto the bottom of flat plate absorber (3).**
2. **Addition of regenerative cycle i.e. preheated hot water inlet (8) and this preheated water is now supplied to flat plate type double sided absorber plate.**

Keywords:- **Parabolic concentrator, direct & diffuse radiation, bottom side heating, double sided absorber plate.**

I.BACKGROUND OF CONCEPT

Whilst the range and quality of products on the market have increased to meet the demand, flat plate solar collector of the type used in many modern domestic hot water systems have not changed significantly in the past twenty years. The quality of solar water heater is not up to the standard expected by the customers. These types of absorber typically have low thermal collective efficiency, particularly, throughout the winter season.

The present invention solar water heater with parabolic concentrator & preheated water inlet significantly increases efficiency than the conventional solar water heater.

II.AIM OF CONCEPT:-

The concept investigates both design and production aspects of a new collector to provide an optimized design for advanced domestic solar water heaters. The design incorporates features from both the reverse flat plate and the bifacial absorber collector. The features being investigated in this project include:

1. Stationary concentrators designed to give a winter bias to the annual performance cycle.
2. Double-sided absorber plates with convection suppression to reduce heat loss while achieving lower production costs through the reduction of absorber plate area.
3. New thermosyphon plumbing concepts that allow greater flexibility in the placement of the solar collector relative to the tank while minimizing reverse circulation at night.
4. Regenerative tank for providing preheated water inlet to Flat plate absorber.

III.INTRODUCTION:-

Solar energy is quite simply the produced directly by the sun and collected elsewhere, normally the Earth. The sun creates its energy through a thermonuclear process that converts about 650,000,000 tons of hydrogen to helium every second. The power from the sun intercepted by the earth is approximately 1.8×10^{11} MW. The quality of solar water heater is not up to the standard expected by the customers. These types of absorber typically have low thermal collective efficiency, particular throughout winter season. The quality of solar water heater is not up to the standard expected by the customers, so this is a best and cheap concept which will fulfill the requirement of customer.

The objective of this concept used in this paper is to increase the performance of the conventional domestic solar water heater by adding two parabolic concentrator on both sides of the flat plate solar water heater. A conventional flat plate solar water heater when interfaced with parabolic concentrator type of solar collector shows noticeable increase in the collective efficiency and performance when compare to the conventional solar water heater a novel design of collector has been proposed which addresses many of the issues associated with current technology system. This concept aims to develop the new design using latest computer simulation tools and to develop computerized design optimization tools for the design of advance solar water heater.

IV.CONSTRUTION:-

As the Fig (3) shows, the setup of Solar water heater with parabolic concentrator & preheated water inlet incorporates features from both bifacial absorber collector and Reversed flat plate. Double sided absorber plates with convection suppression to reduce heat loss while achieving lower production cost through the reduction of absorber plate area. Bifacial absorber collector design consists of two identical stationary parabolic concentrator with a flat plate absorber mounted above them, shown in Fig 1(a). While the reversed flat plate collector has an inverted absorber plate with a stationary concentrating reflector underneath, this design allows the collector to be given a seasonal bias by modifying the shape of the concentrating mirror shown in Fig 1(b).

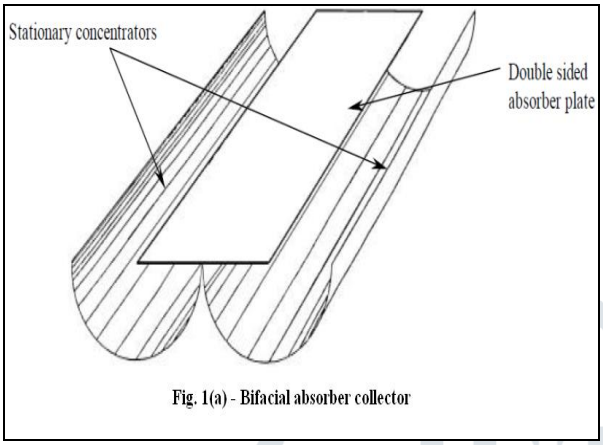

Fig. 1(a) - Bifacial absorber collector

Fig 1(a)

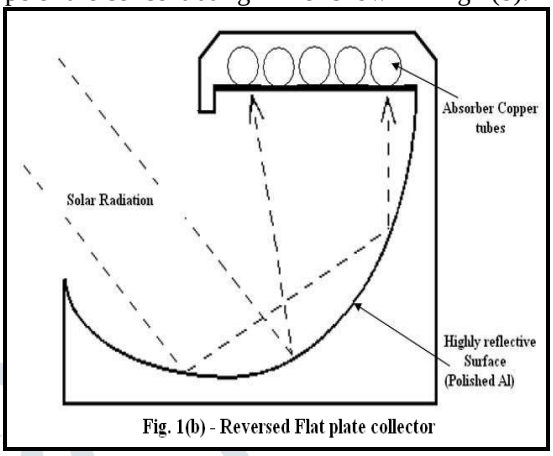

Fig. 1(b) - Reversed Flat plate collector

Fig 1(b)

The arrangement of Double sided Absorber plate is shown in Fig.(2), it consist of the Rectangular box made up of 6mm (thickness) plywood material having 2.5 x 1.5 x 0.5 feet long opened at top and bottom for providing mirror for trapping more and more ray inside the box. The mirror is toughened glass which traps the radiation and doesn't allow the heat to pass outside. Two parallel long copper pipes is placed across the length having OD of 250mm (and length 2.5 ft) and projected out on the either side of box. The piping arrangement consist of 5-7 copper pipes, OD of 150mm having 1.8 Ft long is placed perpendicularly between this two parallel large OD copper pipes as shown in Fig (2). The copper pipes are cut at a required length and joined by using brazing operation and checked whether leakage is present or not, if present then brazed that particular part. The intermediate portion between two successive tube places along the length is covered with plates which are painted black to collect more and more heat. The adiabatic tank (4) is placed at an elevation as shown in Fig. 4. A regenerative tubing (6) arrangement is placed inside the tank, acting as a heat exchanger between hot water and cold water stored in tank. The heat is exchanged via. Tubing and losses heat which is absorbed by cold water and this preheated water is supplied to absorber (3). After exchange of heat the water in the tubing has a sufficient temperature which can be used for our commercial purposes and can be collected as per our need from hot water tap (7).

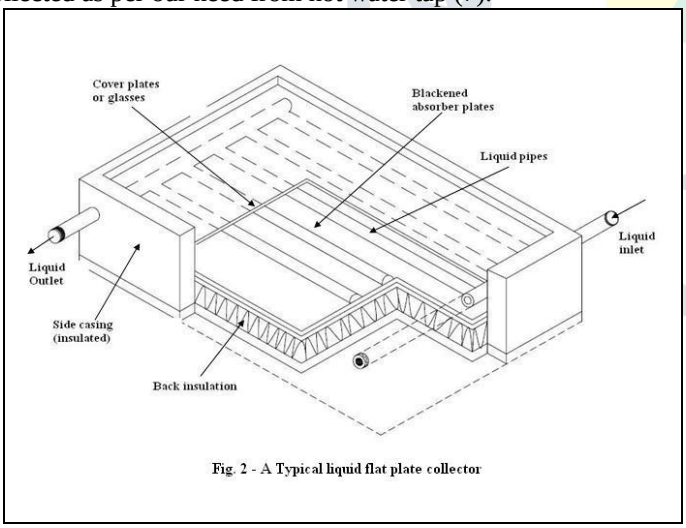

Fig. 2 - A Typical liquid flat plate collector

Fig. 2

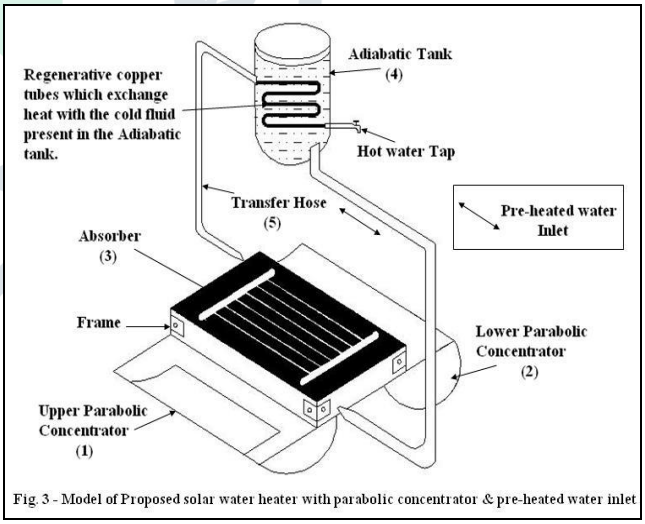

Fig. 3 - Model of Proposed solar water heater with parabolic concentrator & pre-heated water inlet

Fig. 3

V.WORKING:-

The set up is kept at suitable angle according to the time in an open space as shown in Fig 4. Solar radiation is absorbed by the absorber plate and absorber tube (usually made of copper) and transferred through water that circulates inside the copper tubes. This is an incident radiation that means direct absorption. The temperature rises from atmospheric condition. As we have attached the parabolic concentrator in upper side (1) and lower side (2), some part of rays are reflected and focused to bottom side of the absorber plate (3).

The heat transfer takes place between the copper tube and the water flowing through it. The transfer will be more as we gave black paint coating to the tube and plate. The storage tank also known as adiabatic tank(4) and it is insulated from outside to minimized the heat loss, which is always kept at higher elevation in order to obtain thermo siphon effect in which hot water moves

up without any external force like pumping. The tank is provided with a regenerative close loop (6) as shown in fig. this provide the preheating of inlet water and due to which the efficiency will be increased. The heated water from the absorber tube rises through the transfer hose (5) to the regenerative tank and accumulates. The preheated water present at bottom of the tank comes down to the absorber tube for the further heat addition, through preheated water inlet hose (8). The hot water can be used for our commercial/industrial purposes from hot water tap (7).

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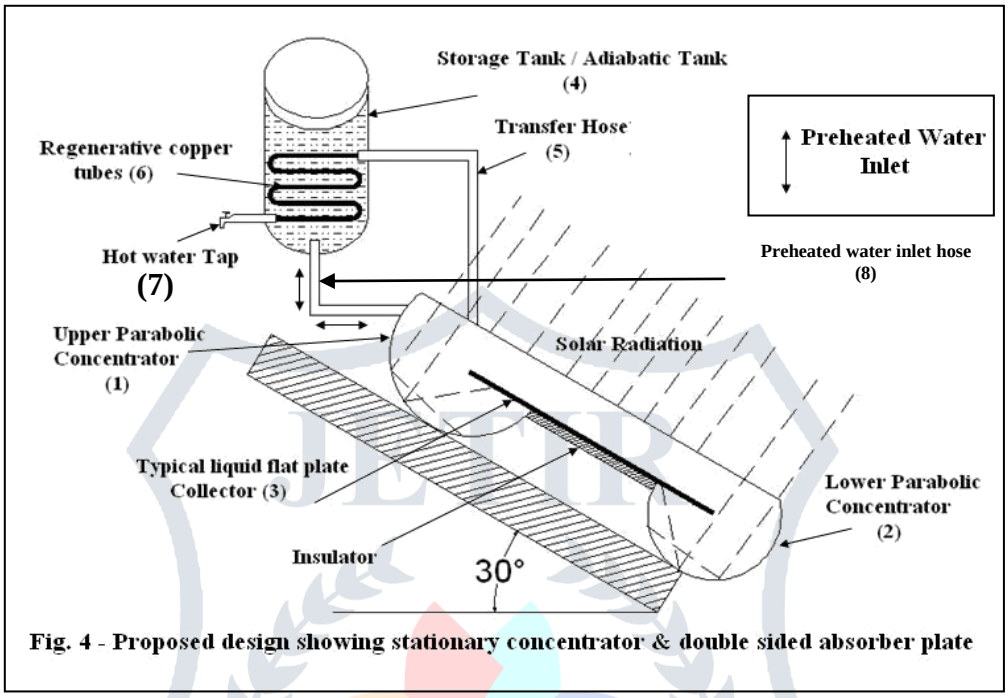

Fig. 4 - Proposed design showing stationary concentrator & double sided absorber plate

Fig. 4

VI.SETUP OF PROPOSED SOLAR WATER HEATER:-

Fig. 5 (Front View of Setup)

Fig. 6 (Side View of Setup)

VII.CONCLUSION:-

The existing conventional solar water heater is observed and the modification is made by incorporating the parabolic concentrator and regenerative tank to flat plate collector. The proposed model is provisionally tested and the result obtained shows the collective efficiency of our proposed design is higher than conventional flat plate water heater of same size and capacity. The entire surface is fabricated with commonly available materials, hence by implementing our design the customers doesn't have to

pay al lot. Due to the financial constraint we have not used solar tracking mechanism in our setup, the stand is made and it is kept at an inclination of 30° which easily serve our purpose. It is believe that further efficiency of solar water heater can be increased by adding the appropriate solar tracking system and by use of some different materials for parabolic concentrator.

REFERENCES:-

[1]. Principle of solar engineering, by D.Y. Yogi Goswami & frank Kreith, Non-conventional sources, by G.D.Rai.
[2]. Solar energy, Fundamentals and application, by H.P.Garg & J.Prakash.
[3]. Solar energy, Principles of thermal collection and storage, by S.P.Sukhatme & J.K.Nayak.
[4]. Rabl, A.(1976), Comparison of sola concentrators, solar Energy, 18, 93-11