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OPTIMIZATION OF COMBINED BATCH TYPE SOLAR WATER HEATER CUM DISTILLATION SYSTEM

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ABSTRACT

The review of past research indicates that there is a significant scope of increasing the efficiencies and performance of the domestic solar water heater and distillation device. The effort is being made to integrate two different solar appliances so that they could work in much better way.

Solar water heater cum distillation system is designed and fabricated to carry out two operations simultaneously, heating of water and distillation. This composite unit converts solar energy into thermal energy. Arrangement of trough is being made to improve the efficiency of the system. The system works approximate 12 hours in winter and 16 hours in summer. The various observation and thermal analysis suggesting the efficiency of flat plate collector is 57% and distillation is 42% in winter. Maximum temperature achieved by the system is 51°C in winter season.

I. INTRODUCTION

"Water is everybody life". As all the living creatures are depending in the water for their life. It has played on important role in the environmental cycle. Availability of fresh water in our country fall from 5277 cubic meters in 1955 to 2265 cubic meter in the last five years. Annual per capita about 85% of develop water resources of our country are presently used for irrigation. If the condition will be continue the fresh water requirement by 2025 A.D will be almost at per with exploited water resources including both surface and ground water.

Solar water heater cum distillation device is designed and fabricated to carry out two operations simultaneously, heating of water and distillation. This composite unit performs more than one operation and converts solar energy into thermal energy to make the devices more versatile and efficient.

II. DESCRIPTION OF SOLAR WATER HEATING SYSTEMS

Solar water heating systems use solar collectors and a liquid handling unit to transfer heat to the load, generally via a storage tank. The liquid handling unit includes the pumps used to circulate the working fluid from the collectors to the storage tank) and control and safety equipment. When properly designed, solar water heaters can work when the outside temperature is well below freezing and they are also protected from overheating on

hot, sunny days. Many systems also have a back-up heater to ensure that all of a consumer's hot water needs are met even when there is insufficient sunshine. Solar water heaters perform three basic operations as shown in **Figure 1**:

Collection: Solar radiation is "captured" by a solar collector;

Transfer: Circulating fluids transfer this energy to a storage tank; circulation can be natural (thermosiphon systems) or forced, using a circulator (low-head pump); and

Storage: Hot water is stored until it is needed at a later time in a mechanical room, or on the roof in the case of a thermosiphon system.

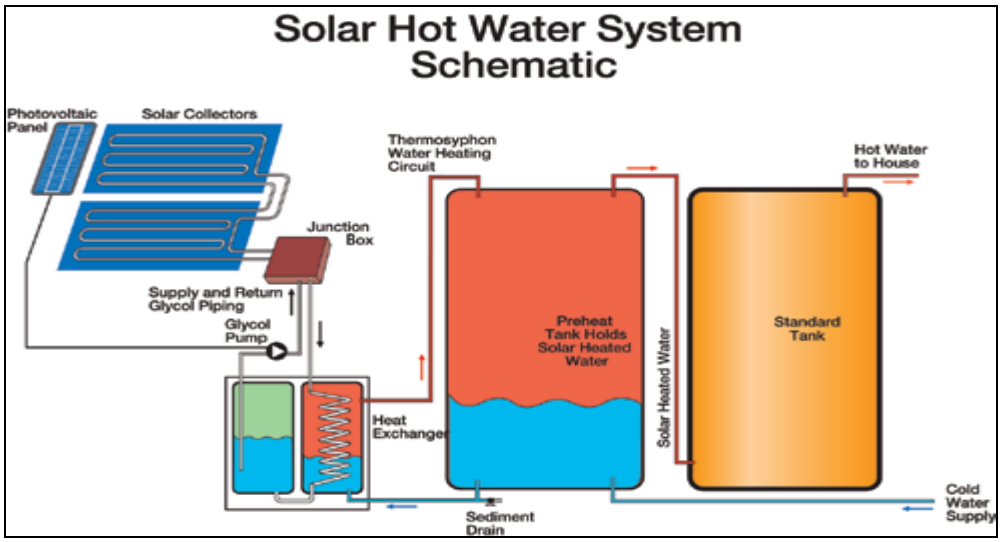


Fig.1:-System Schematic for Typical Solar Domestic Water Heater

III. SOLAR COLLECTORS

Solar energy (solar radiation) is collected by the solar collector's absorber plates. Selective coatings are often applied to the absorber plates to improve the overall collection efficiency.

A thermal fluid absorbs the energy collected. There are several types of solar collectors to heat liquids. Selection of a solar collector type will depend on the temperature of the application being considered and the intended season of use (or climate). The most common solar collector types are: unglazed liquid flatplate collectors; glazed liquid flat-plate collectors; and evacuated tube solar collectors.

- **Unglazed liquid flat-plate collectors**

Unglazed liquid flat-plate collectors, as depicted in ***Figure 2***, are usually made of a black polymer. They do not normally have a selective coating and do not include a frame and insulation at the back; they are usually simply laid on a roof or on a wooden support.

These low-cost collectors are good at capturing the energy from the sun, but thermal losses to the environment increase rapidly with water temperature particularly in windy locations. As a result, unglazed collectors are commonly used for applications requiring energy delivery at low temperatures (pool heating, make-up water in fish farms, process heating applications, etc.); in colder climates they are typically only operated in the summer season due to the high thermal losses of the collector.

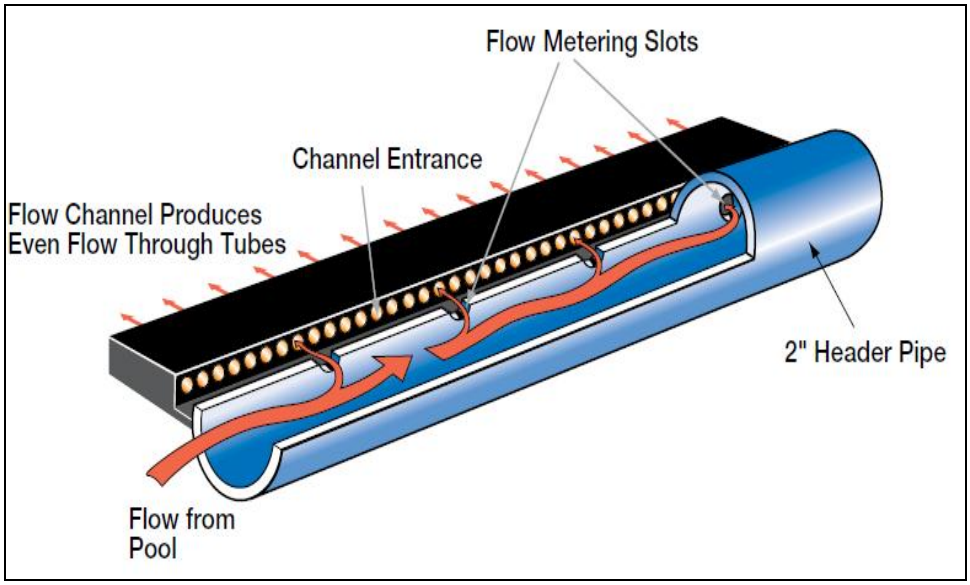


Fig.2-System Schematic for Unglazed Flat-Plate Solar Collector.

- **Glazed liquid flat-plate collectors**

In glazed liquid flat-plate collectors, as depicted in ***Figure 3***, a flat-plate absorber (which often has a selective coating) is fixed in a frame between a single or double layer of glass and an insulation panel at the back. Much of the sunlight (solar energy) is prevented from escaping due to the glazing (the "greenhouse effect"). These collectors are commonly used in moderate temperature applications (e.g. domestic hot water, space heating, year-round indoor pools and process heating applications).

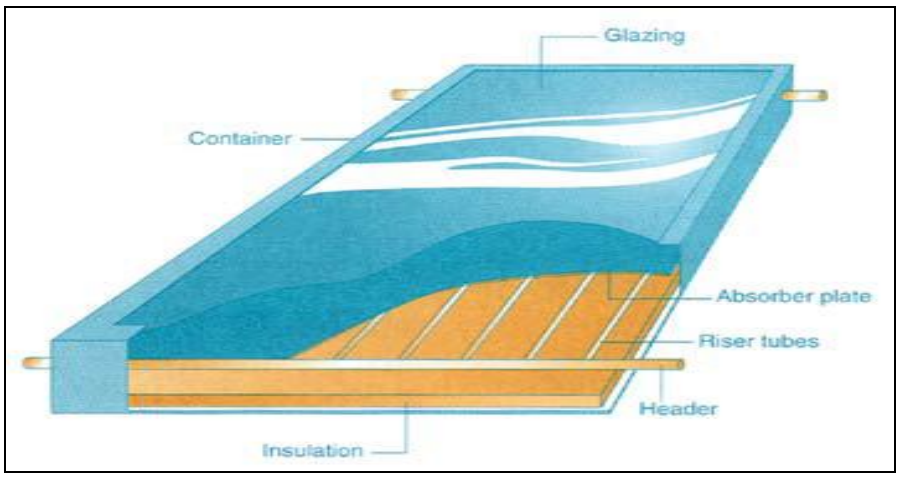


Fig.3 :-System Schematic for Glazed Flat-Plate Solar Collector

- **Evacuated Tube Solar Collectorss**

Evacuated tube solar collectors, as depicted in ***Figure 4***, have an absorber with aselective coating enclosed in a sealed glass vacuum tube. They are good at capturing the energy from the sun; their thermal losses to the environment are extremely low.

Systems presently on the market use a sealed heat-pipe on each tube to extract heat from the absorber (a liquid is vaporised while in contact with the heated absorber, heat is recovered at the top of the tube while the vapour condenses, and condensate returns by gravity to the absorber). Evacuated collectors are good for applications

requiring energy delivery at moderate to high temperatures (domestic hot water, space heating and process heating applications typically at 60°C to 80°C depending on outside temperature), particularly in cold climates.

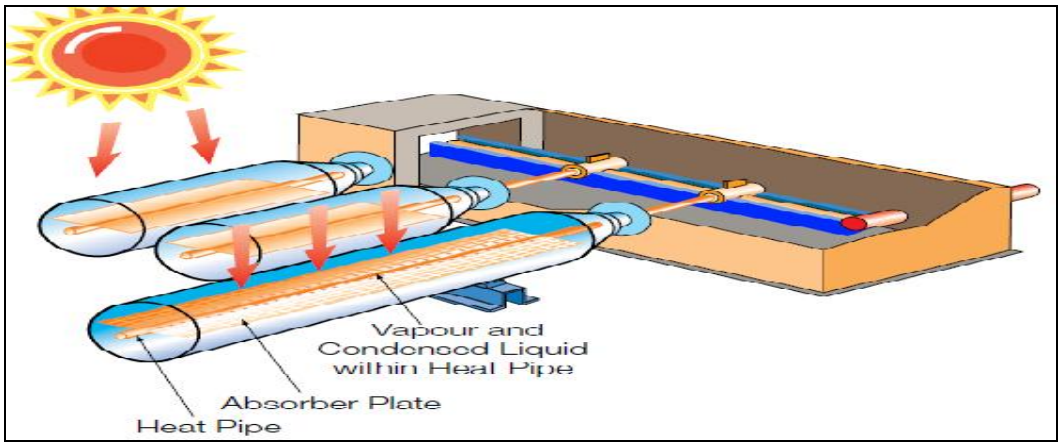


Fig.4 :-System Schematic for Evacuated Tube Solar Collector

IV. EXPERIMENTAL SETUP

Experimental set up consists of two system, batch type flat plate collector and distillation unit. Figure 5 shows the schematic diagram of the general layout and experimental setup.

When solar radiation fell on collector, water was heated and circulated in the system automatically by natural convection (thermo-siphon). Above the hot water storage tank a water trough was provided for cooling glass cover for distillation unit. Temperature difference between the hot water of the storage tank and the top cover produced the convection current inside the storage tank. These current brought the humid air into the contact with relatively cool cover and resulted in condensation of the humidity on the surface of cover. The condensed droplets slid down on the slanting surface of cover and were collected in the distillation tank, and further drained out of the enclosure through the

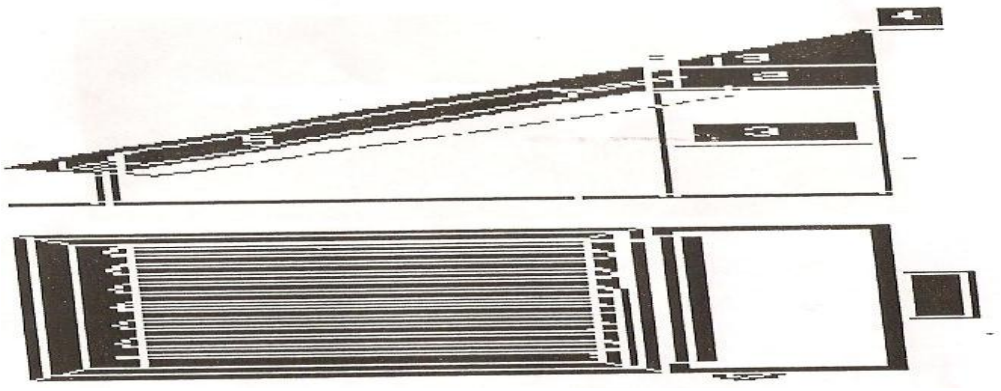


Fig 5- Schematic Diagram of the General Layout and Experimental Setup

V. SPECIFICATION

S.N	PART NAME	MATERIAL	SIZE/GAUGE/KG (MM)	DIMENSION (CM)	QTY
1	BASE STAND	M.S ANGLE	38X38	103X73X70	01
2	TANKS	ALUMINIUM	22 GAUGE	i-100X25X10 ii- 30X30X15 iii-30X12X10	01 01 01
3	FRAME	PLYWOOD	15 MM	i-73X73X15 ii-73X32X45	01 01
4	COPPER TUBE AND ACCESSORIES	COPPER	6.03KG 1.4KG	i-D=3.8 ii-D=2 iii-BENDS=2	- - 12
5	GLASS & REFLECTOR	GLASS	4 MM	i-94X94X4 ii-99X40X4	01 01
		MIRROR	2 MM	i-22X99X2 ii-20X73X2 iii-92X12X3	01 04 04

Fig 6- Photograph of Experimental Setup

VI. EXPERIMENTAL OBSERVATIONS

With Trough

SR.NO	TIME	ATM.TEMP (^oC)	HOT WATER TEMP. (^oC)
1	9:00	28	27
2	9:30	28	29
3	10:00	29	32
4	10:30	29	35
5	11:00	30	40
6	11:30	30	42
7	12:00	30	45
8	12:30	32	47
9	1:00	32	48
10	1:30	33	50
11	2:00	33	51
12	2:30	34	52
13	3:00	34	52
14	3:30	33	51
15	4:00	33	51
16	4:30	33	50
17	5:00	30	48
18	5:30	30	47
19	6:00	29	46
20	6:30	28	45
21	7:00	27	44
22	7:30	27	44
23	8:00	26	43
24	8:30	25	43
25	9:00	25	42

Without Trough

S.N	TIME	ATM.TEMP (^oC)	HOT WATER TEMP (^oC)
1	9:00	26	25
2	9:30	27	28
3	10:00	28	29
4	10:30	29	32
5	11:00	29	35
6	11:30	30	40
7	12:00	30	42
8	12:30	30	45
9	1:00	32	47
10	1:30	32	48
11	2:00	33	50
12	2:30	33	51
13	3:00	33	52
14	3:30	34	52
15	4:00	35	52
16	4:30	34	52
17	5:00	33	50
18	5:30	30	48
19	6:00	30	47
20	6:30	29	46
21	7:00	28	45
22	7:30	27	44
23	8:00	26	43
24	8:30	25	43
25	9:00	25	41

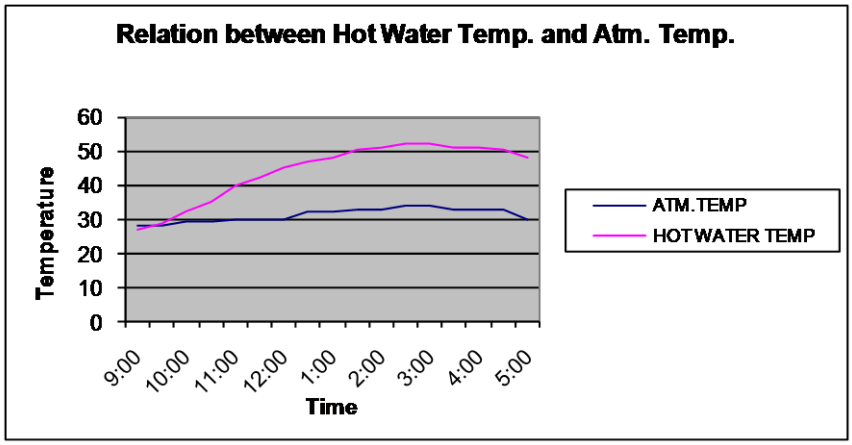
Table 1- Experimental Result

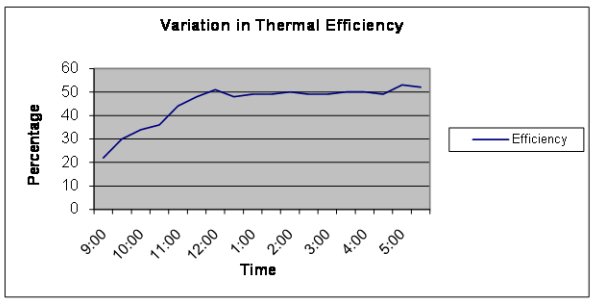
VII. RESULTS AND DISCUSSION

The batch type solar water heater cum distillation device was tested in month of December and January, with trough and without trough condition.

The results obtained during the course of test :

- Maximum temperature of water in storage tank was found 55°C
- With thermal efficiency 55%
- And distillate output is 556ml/day.
- With Trough condition, efficiency of distillation unit is improved around 28%





VIII. CONCLUSION

Based on experimental performance following conclusions can be drawn-

1. Generally, hot water is required during morning and water in insulated tank gets heated through out the day. That heat is utilized in the distillation unit.
2. In many areas there is less availability of drinking water, for such areas the system is very useful.
3. The time required for the heating of water is less due the batch type arrangement with fins.
4. Large area available for heat transfers, hence high thermal performance.
5. Concentration of solar energy on absorber is more due to attachment of mirrors, hence no need of tracking system.
6. Solar energy is available abundantly in our country, hence no running cost of unit.
7. There is no need of electricity for the purification & heating of water
8. The most important advantage of this system is that the water heating and distillation unit present in same unit at economical cost.
9. The system is silent and pollution and maintenance free.

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