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OPTIMIZATION OF AIR SPACING OF SOLAR FLAT PLATE LIQUID COLLECTOR WITH TWO STRUCTURED GLAZING COVERS

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ABSTRACT

Flat Plate Liquid collectors are simplest and most common device used to convert solar energy to Useful heat. It inevitably employ a Transparent cover to trap short wave solar irradiation and Reduce convection and radiation losses as well. Design with more than one cover, further reduce convection and radiation losses. The performance of Flat plate collector is dependent on Heat Losses. Heat Losses vary with Distance between Absorber Plate and Lower Glazing and also with Distance between lower glazing and top glazing. Thus optimizing these two spacing is an important issue in design of Flat Plate Collectors. A part of solar irradiation falling on Transparent cover is reflected back by both of the surfaces of the cover. Etching process reduces loss due to reflection. The Present investigation is about optimization of the two Air Spacing parameters in order to Design most efficient Double Glazing Collector with Unstructured covers (Low iron content Glass) and Structured Covers(Low iron content Glass Soft etched with acid on both side).

I. INTRODUCTION

Solar flat plate liquid collectors are the most common solar collector for solar water heating system. A typical solar flat plate liquid collector is an insulated box with a glass or plastic cover (often called Glazing) and a dark colored absorber plate with a fluid channel for heat transfer.

B.Kalidasan and T.Srinivas[1] studied effect of number of transparent covers and refractive index of covers on performance of solar water heaters in order to optimize these variables. Investigation and simulation were made with 0-3 number of covers and different refractive index values in limits of 1.1 to 1.7. The results show that the efficiency of the flat plate collector increase with number of covers and decreases after an optimum number of covers. It also decreases with an increase in refractive index. The combination of optimum number (two covers) and lower refractive index (1.1) results improved useful heat.

When more than one glazing is used, two parameters become important for most efficient design of collector. First is spacing between absorber plate and lower glazing(L1) and secondly, spacing between lower glazing and top glazing(L2). These two parameters must be optimized in order to minimize Heat loss from absorber plate and top glazing.

Dhrupad Sarma, Parimal Bakul Barua, Diganta Hatibaruah[2] made experimentation to find out the optimum Spacing of Glazing covers; of Single, Double and Triple Glazed Black painted Flat Plate Collector (FPC) and hence to find out the optimum combination of Number of Glazing and Spacing of Glazing covers with minimum Top Heat Loss. The conclusion was that Optimum Spacing of Glazing cover is 10 mm for Single, Double and Triple Glazed FPC. Experiments were designed taking both the spacing (L1 and L2) equal. But The temperature of absorber plate is quite high compared to the temperature of lower and top glazing covers. This compelled to make experimentation with unequal spacing. In the present study experimentation were designed with unequal L1 and L2.

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II. MATERIALS AND METHODS

2.1. Experimental Setup

A box type Flat plate liquid collector with two covers is designed for experimentation with facility to adjust distance between absorber plate and Lower glazing and also the distance between lower and top glazing. The dimensions of container of cuboids shape set-up is are 354 mm X 354 mm X 135 mm. The dimensions of two covers is 300 mm X 300 mm X 4 mm. In one set of experiment, unstructured covers made of Low iron content glass of 4 mm thickness are used and in another set of Experiment structured covers are used, which were made of the same Low iron content glass of 4 mm thickness and etched with hydrofluoric acid on both side. Absorber plate is black painted galvanized Iron metal sheet of 1 mm thickness with copper tube of 10 mm dia. brazed at the bottom side.

Table 1: Flat Plate Collector Specifications

Description	**Specification**
Collector dimensions (Length x Width x Thickness)	354 mm x 354mm x 135mm
Collector type	Flat plate
Number of glass covers	2 Glass covers
Cover plate dimensions (Length x Width)	300 mm x 300 mm
Absorber plate dimensions (Length x Width)	300 mm x 300 mm
Absorber plate material	Galvanized Iron Sheet 1 mm, Plate and tube Type
Riser material	Copper tubes, size 10 mm Dia
Location of collector tray	Yamunanagar (30.7° N,77.18°E)

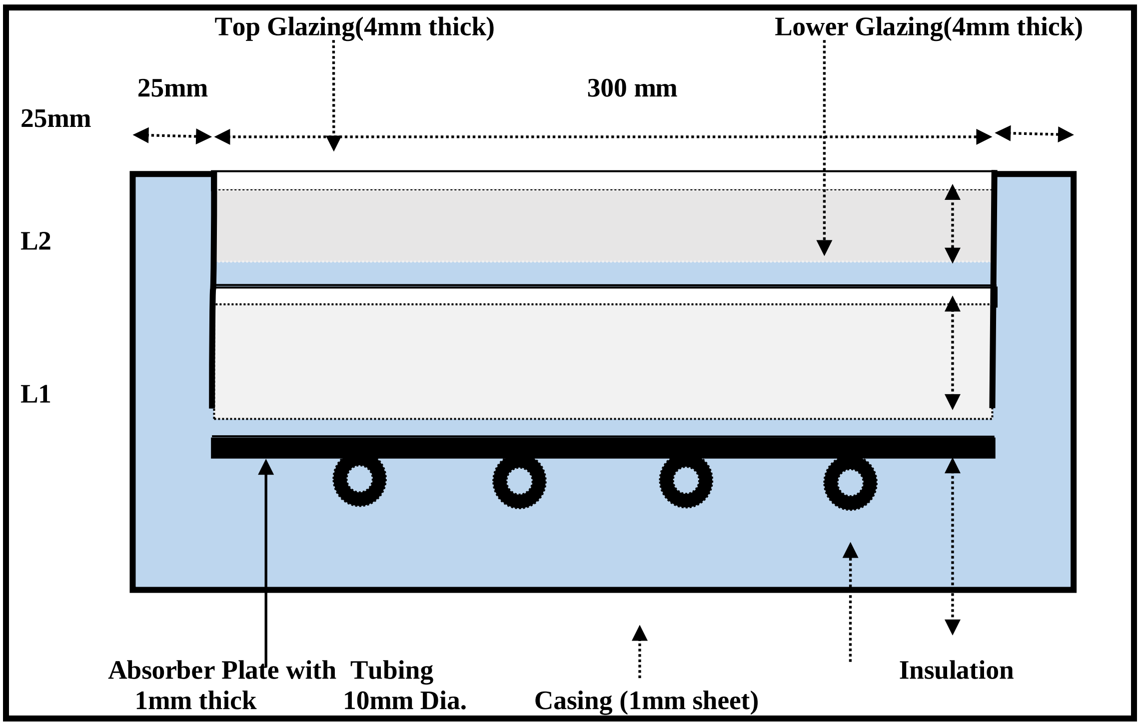

Fig 1 : Experimental Setup

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There are three supports provided at a distance of 35 mm, 40 mm and 45 mm respectively, leading to movement of the lower glazing at three different heights. Similarly there are three supports provided at a distance of 20 mm, 25 mm and 30 mm respectively, leading to movement of the top glazing at three different heights.

2.2 Methodology

Solar radiation of equal amount is allowed to strike on the glazing for each experiment. Similarly Inlet temperature of fluid is kept constant and close to ambience temperature. Experiment was conducted in static condition of heat transport fluid. The final Temperature of the fluid is noted down at the end of every experiment. Covers are changed for the analysis of effect of unstructured and structured covers. Distance between absorber plate and bottom glazing (L1) and distance between two glazing covers (L2) is varied to different values for the analysis of effect of air spacing between absorber plate and Lower glazing (L1) and air spacing between lower glazing and top glazing (L2).

Fig 1 : Experimental Flat Plate Collector

Fig 2 : Black Painted Absorber Plate

Fig 3 : Copper Tubing at rear of Absorber Plate

Fig 4 : Sleeve for Spacing Adjustment

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III. RESULTS AND DISCUSSION

3.1 Experimentation

The Experimental analysis was made to gain a fundamental understanding and comparing of the net heat transfer to heat transport fluid in context of flat plate solar collector for an unstructured surface and a structured surface. The Experimental analysis was also done for optimizing air spacing between absorber plate and lower glazing (L1) and air spacing between lower glazing and top glazing (L2).
The following experimental observations were made for the net heat transfer to heat transport fluid through unstructured glazing covers and structured glazing covers: The outlet temperature of the heat transport fluid in case of flat plate collector with unstructured covers was observed to be 41.4 , 45.7 and 42.1, when L1 was kept constant at 35 mm and L2 was varied to 20 mm, 25 mm and 30 mm respectively.
1.The outlet temperature of the heat transport fluid in case of flat plate collector with unstructured covers was observed to be 41.4 , 45.7 and 42.1, when L1 was kept constant at 35 mm and L2 was varied to 20 mm, 25 mm and 30 mm respectively.
2.The outlet temperature of the heat transport fluid in case of flat plate collector with unstructured covers was observed to be 42.2 , 46.6 and 42.9, when L1 was kept constant at 40 mm and L2 was varied to 20 mm, 25 mm and 30 mm respectively.
3.The outlet temperature of the heat transport fluid in case of flat plate collector with unstructured covers was observed to be 42.1 , 45.2 and 41.9, when L1 was kept constant at 45 mm and L2 was varied to 20 mm, 25 mm and 30 mm respectively.
4.The outlet temperature of the heat transport fluid in case of flat plate collector with structured covers was observed to be 43.2 , 47.7 and 44, when L1 was kept constant at 35 mm and L2 was varied to 20 mm, 25 mm and 30 mm respectively.
5.The outlet temperature of the heat transport fluid in case of flat plate collector with structured covers was observed to be 44.1 , 48.6 and 44.8, when L1 was kept constant at 40 mm and L2 was varied to 20 mm, 25 mm and 30 mm respectively.
6.The outlet temperature of the heat transport fluid in case of flat plate collector with structured covers was observed to be 44.1 , 47.2 and 43.8, when L1 was kept constant at 45 mm and L2 was varied to 20 mm, 25 mm and 30 mm respectively.

3.2 Result

Results are tabulated for Final fluid temperature with structured covers, for various values of L1 and L2 as below

Table 2: Observations

L1 mm	L2 mm	Initial Fluid Temp.	Final fluid temp. with unstructured covers	Final fluid temp. with Structured covers	% tage gain over unstructured cover
35	20	22.0^{0} C	41.4	43.2	4.3
35	25	22.0^{0} C	45.7	47.7	4.3
35	30	22.0^{0} C	42.1	44.0	4.5
40	20	22.0^{0} C	42.2	44.1	4.5
40	25	22.0^{0} C	46.6	48.6	4.3
40	30	22.0^{0} C	42.9	44.8	4.4
45	20	22.0^{0} C	42.1	44.1	4.7
45	25	22.0^{0} C	45.2	47.2	4.4
45	30	22.0^{0} C	41.9	43.8	4.5

The maximum temperature were observed in both the type of covers. when L1 is 40 mm and L2 is 25 mm and the same is tabulated as below

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Table 3: Comparison of Glazing covers

COVER TYPE	L1	L2	Initial Fluid Temp.	Final Fluid Temp. after Equal Radiation
Unstructured	40 mm	25 mm	22.0 ^{0} C	46.6
Structured	40 mm	25 mm	22.0 ^{0} C	48.6

IV. CONCLUSION

1. Structured double glazing (Low iron content glass cover etched with hydrofluoric acid on both side) improve the outlet Temperature of fluid in the range of 4 to 5 % over that of temperature obtained with unstructured double glazing. This also indicates that the Structured glazing improves overall performance of the solar collectors.
2. Outlet temperature was observed to be maximum for L1 = 40 mm and L2 = 25 mm in case of structured double glazing under equal amount of solar radiation falling on it and equal inlet temperature of heat transport fluid. This is consistent with the L1 and L2 in case of unstructured double glazing. This implies that optimum spacing between absorber plate and lower glazing (L1) and optimum spacing between lower and top glazing (L2) is independent of glazing structure. This might be because glazing structure changes its reflectance only and spacing are relevant for conductive and convective losses by the hot air entrapped in between.

V. REFERENCES

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VI. AUTHOR BIBLOGRAPHY

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