

PERFORMANCE ANALYSIS OF SOLAR AIR HEATER WITH DIFFERENT ABSORBER MATERIAL IN SINGLE PASS

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ABSTRACT:

In this study, two different types' absorber plates were designed and compared of their energetic performances, the absorber plate was as Toughened glass plate (type I) and GI absorber plate (type II), Energy efficiency of the heater was investigated with airflow velocity of 6m/sec, 9m/sec, 12m/sec, Experimentally and compared with each other, The results showed that efficiency of the heater with the tough glass absorber plate better than GI plate however, the resulting air temperature from heater with Toughened glass absorber plate higher than GI plate.

Keyword: solar air heater, airflow velocity, energy efficiency.

1. INTRODUCTION:

Solar air heater is a device, which covert solar radiation into the heat energy. This research study has been carried out for increasing the performance of the single pass solar air heater. Day by day industries and societies accepted the solar systems because of its eco friendly nature and less maintenance cost and long life products. This research study has been focused on two of materials one of Toughened glass and other is GI plate used in the single pass solar air heater. two of materials one of Toughened glass and other is GI plate is the greatest metallic porous media which provided the high conductive large contact surface area to the air. The productivity output parameters was better as compared to the efficiency and temperature ,This research study is a comparative study of the efficiency Toughened glass better than GI plate the single pass solar air heater.

NOMENCLATURE

Symbol	Description	Units
m	Mass flow rate of air	kg/s
ρ	Density of air	kg/m ³
A	Area of flow	m ²
v	Velocity of air	m/s
H	Specific heat of air	kJ/kg
I	Intensity of solar radiation,	W/m ²
T _i	Inlet of air temperature	°C
T _o	Outlet temperature of air,	0c
η	Efficiency of solar collector	%
α	Angle of attack	
L	Length of the collector	m
B	Breadth of the collector	m

2. The properties of experimental of Two-type solar air heater

Specification	Type I	Type II
Length	1.90m	1.90m
Breadth	0.96m	0.96m
Height	0.2m	0.2m
Duct dia	0.04m	0.04m
Top cover plate	Plain toughened glass	Plain toughened glass
Middle plate	Toughened glass with black matte paint coated	GI plate with matte black paint coated
Bottom plate	Plain toughened glass	MS plate

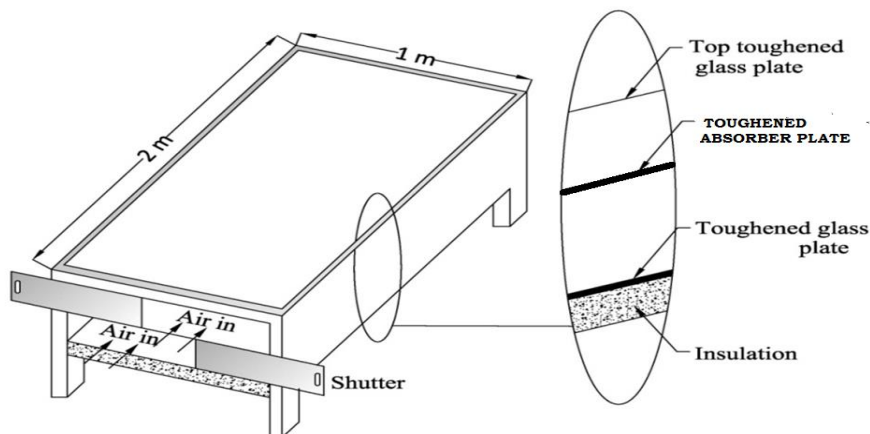


Fig. 2.1 schematic diagram of solar air heater -Toughened glass absorber plate

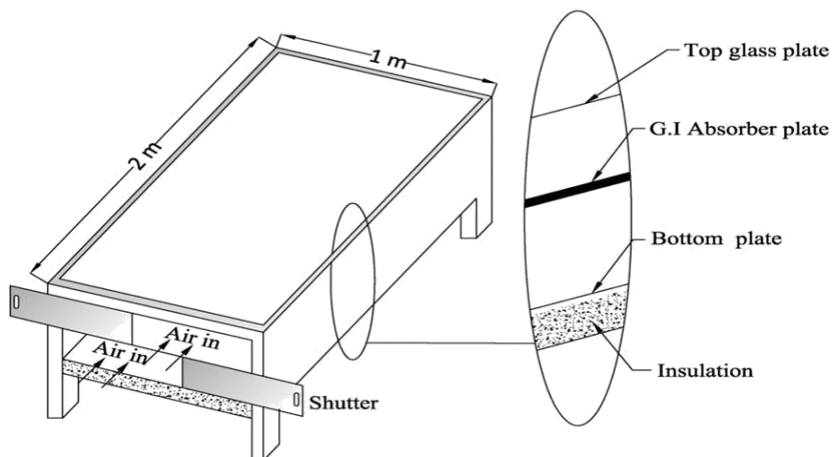


Fig. 2.2 schematic diagram of solar air heater - GI absorber plate

3. METHODOLOGY

3.1 EXPERIMENTAL SETUP AND MEASUREMENT PROCEDURE:

The solar air heater is designed to study the performance during single pass conditions. Experimental conditions employing single pass is of two type namely solar air heater is one Toughened glass and other GT plate, single pass represents the recirculation of air flow from between cover glass and absorber plate channel. Single pass are schematically. The one sets of solar air heater single pass was fabricated and tested at uniform Solar intensity, Performance of the solar air heater at various air velocities (6 m/s, 9m/s, 12 m/s) is studied.

A “Solar Air Heater” was constructed to determine and compare the efficiencies of solar air heater systems and the absorber plate temperature. The experimental setup was located at Solar Energy Laboratory in the Mechanical Engineering department of ANNAMALAI UNIVERSITY. The experiments were conducted between 7th March 2017 and 30th March 2017.

The experiments were carried between the hours of 09:45 AM and 3:00 PM each day, At the starting the blower is switched on 15 min. the closer shutter the bottom because single pass flow, before proceeding to the experiment. During the experiment the readings are taken at an interval of 15 min. in between the day timing 9:45 AM to 03:00 PM. For the same solar intensity, the readings are taken for two different experimental setups that is single pass. The readings are taken for fifteen consecutive.



Fig 3.1 Photographic view of experimental Setup two different air heaters

4. MATHEMATICAL FORMULATION

4.1 Thermal efficiency of solar air heater:

Specimen calculation: - for the 1ST Table single pass (Time: -9:45:00 A.M.)

4.1.1 Mass flow rate: -

$$\text{Mass flow rate} = \rho * A * V * 3600$$

Where

$$\begin{aligned} \rho &= \text{density of air} \\ \rho &= P / (R * (T + 273)) \\ &= (1.103 * 10^5) / [287 * (33 + 273)] = 1.15 \text{ kg/m}^3 \\ T &= 30 + 273 = 303 \text{ K} \end{aligned}$$

$$\text{Area} = (\pi/4) * d^2$$

Where

$$d = 0.04\text{m}$$

$$A = (\pi/4) * (0.04)^2 = 1.25 * 10^{-3} \text{m}^2$$

$$\text{Mass flow rate (m)} = 1.15 * 15 * 3600 * 1.25 * 10^{-3} \\ = 77.86 \text{ kg/s}$$

4.1.2. Heat available per unit area

$$\text{Heat available per unit area} = \left(\frac{\text{Pyranometer reading} \times 3600}{\text{Pyranometer constant}} \right) \text{ kJ/h m}^2 \\ = \frac{3600 \times 6.7}{9.64} \\ = 2502.07 \text{ kJ/hr.m}^2$$

4.1.3. Heat available in the heater: -

Heat available in the heat = Solar intensity × Area

Area = Area of the Collector

= width * length

$$= 1.90 \times 0.96$$

$$= 1.824 \text{ m}^2$$

$$\text{Heat available in the heater} = 2502.07 \times 1.824 \\ = 4563.78 \text{ kJ/hr}$$

4.1.4 Total heat gained by the air: -

$$\text{Total heat gained by the air} = M * Cp(T_{ao} - T_{ai})$$

Where

$$M = \text{Mass flow rate} = 77.86 \text{ kg/s}$$

$$C_p = 1.005 \text{ kJ/kg}^{\circ}\text{K}$$

$$((T_{ao} - T_{ai}) = (35+273) - (45+273) = 10\text{K}$$

$$Q = 77.86 * 1.005 * 10 \\ = 938.98 \text{ kJ/hr}$$

4.1.5 Efficiency

$$\text{Efficiency} = (\text{Heat gained by the air/heat available in the heater}) \\ = (938.98/4563.78) * 100 \\ = 20.575\%$$

5. Result and Discussion:

The productivity versus time, however Toughened glass absorber plate and a GI absorber plate of sunlight based air warmer is appeared in figure (1) and air speed stream rate 6m/sec, amid the examination as can see from figure the effectiveness of however, Toughened glass absorber plate higher than the proficiency of a GI absorber plate, the outcome demonstrated that the gatherer proficiency increments with increment the air speed stream rate of air and sun based radiation

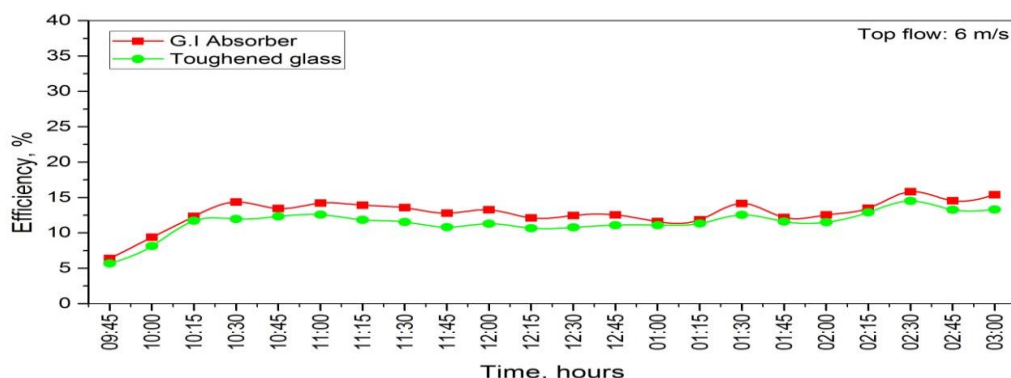


Fig (1) Time Vs Efficiency single pass flow air velocity = 6 m/s

The productivity versus time, however Toughened glass absorber plate and a GI absorber plate of sunlight based air warmer is appeared in figure (2) and air speed stream rate 6m/sec, amid the examination as can see from figure the effectiveness of however Toughened glass absorber plate higher than the proficiency of a GI absorber plate, the outcome demonstrated that the gatherer proficiency increments with increment the air speed stream rate of air and sun based radiation.

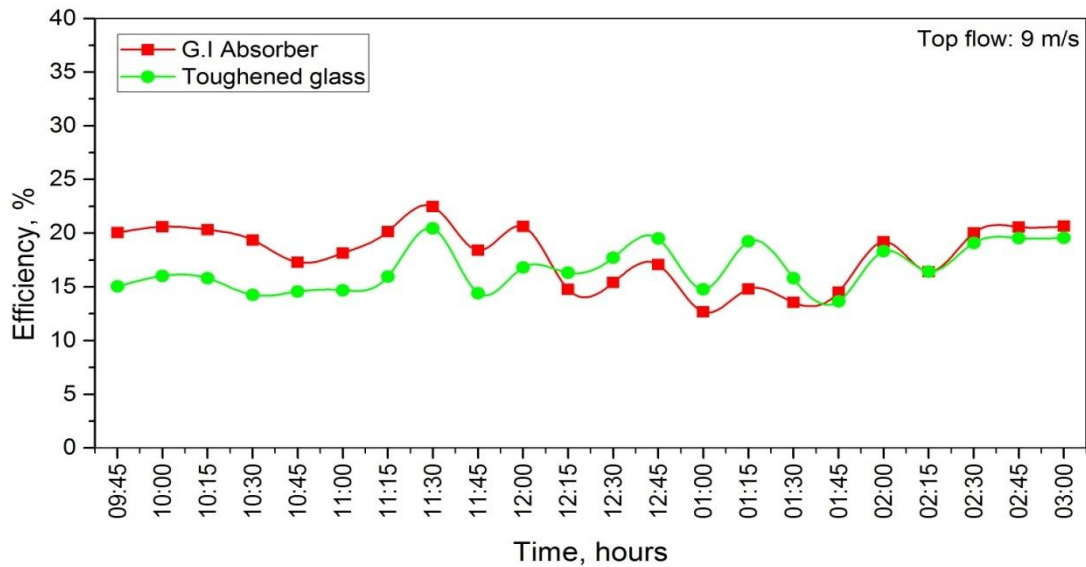


Fig (2) Time Vs Efficiency single pass flow air velocity = 9m/s

The productivity versus time, however Toughened glass absorber plate and a GI absorber plate of sunlight based air warmer is appeared in figure (3) and air speed stream rate 6m/sec, amid the examination as can see from figure the effectiveness of however Toughened glass absorber plate higher than the proficiency of a GI absorber plate, the outcome demonstrated that the gatherer proficiency increments with increment the air speed stream rate of air and sun b radiation

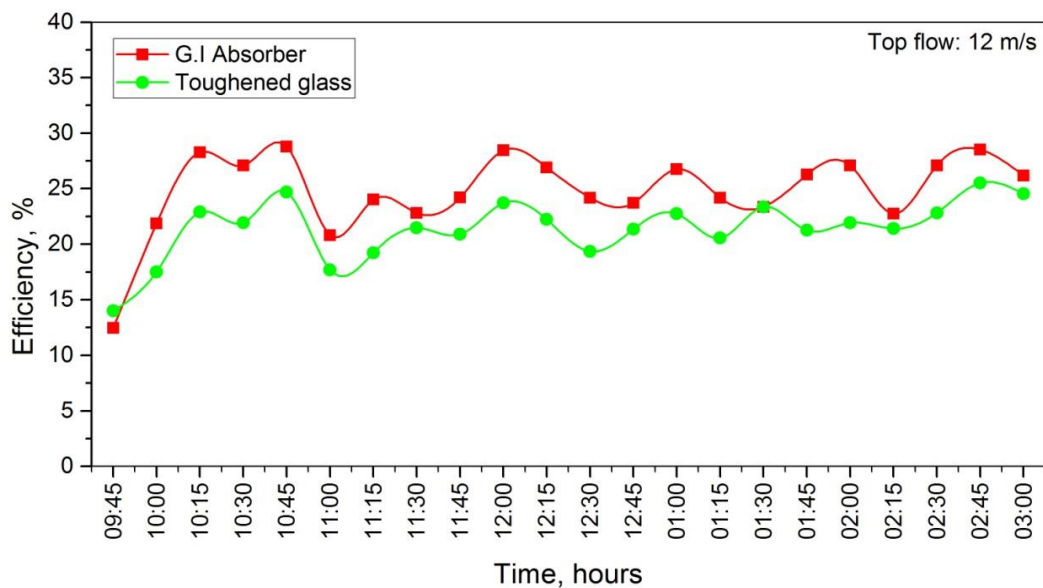


Fig (3) Time Vs Efficiency single pass flow air velocity = 12 m/s

6. CONCLUSION

In this paper two identical solar air heaters, one with Toughened Glass as absorber plate and another one with G.I as absorber plate is fabricated and test for its performance under the same operating conditions From the result tabulation and Graphical representation, from the analysis of various two types of solar air heaters conventional, single pass Solar air heaters, it is concluded that for the same air flow that the performance of Toughened Glass absorber air heater (type-I) is efficient batter than G.I absorber air heater (type-II)
The temperature outlet of air heater tough glass is higher than GI palate temperature

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BIOGRAPHY

HASSAN IBRAHIM ELSANOSI received the B.E in Mechanical Engineering from Sebha University, Faculty of Engineering Sciences & Technology, Bark, Libya in 2014 and completed Master Degree of Engineering in Energy Engineering and Management from Annamalai University, Faculty of Engineering & Technology, Annamalainagar, Chidambaram Tamilnadu in 2017