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PERFORMANCE ANALYSIS OF SOLAR AIR HEATER WITH DIFFERENT ABSORBER MATERIAL

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ABSTRACT:

In this paper study two different type absorber plate were designing compared with their energetic performance , the absorber plate was as though 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 . Experiment compared with each other , the result showed the efficiency of the heater with though glass absorber plate better than GI absorber plate however , the result airs temperature from heater with though glass absorber plate higher than GI absorber plate .

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

1. INTRODUCTION:

Solar energy is an inexhaustible resource. The sun produces vast amounts of renewable solar energy that can be collected and converted into heat and electricity. In the application of solar energy to the heating of dwellings and other uses, the primary element in the heating system is the ‘‘Collector’’. Solar energy is the one most abundant renewable energy source and emits energy at a rate of 3.8×1023 kW, of which, approximately 1.8×1014 kW is intercepted by the earth. The solar collector converts the solar radiation to energy in the form of sensible or latent heat in a fluid (air or water) which is passed through the collecting unit. One of the useful applications of solar energy is air heating. Solar air heating (SAH) is a solar thermal technology in which the energy from the sun, solar insulation, is captured by an absorbing medium and used to heat air. SAH as a renewable energy, the technology is used for air conditioning and often used for heating purposes. One of the most potential applications of solar energy is the supply of hot air for the drying of agricultural, textile, marine products, heating of buildings to maintain a comfortable environment especially in the winter season and re-generating dehumidify agent. Unlike other sources of energy, solar energy can play a significant role for air heating system because the warm air is also the final receiver of energy

This energy possesses a thermal conversion mode which necessitates a simple technology which is adapted to the site and to the particular region for many applications. All these systems are based on the solar air collectors. Solar energy collectors are employed to gain useful heat energy from incident solar radiation. They can be concentrating or flat plate type different air heating system with and without storage systems and its potential

applications are presented. It is typically the most cost-effective solar technologies, especially in commercial and industrial applications and it addresses the largest usage of building energy in heating climates, which is space heating and Industrial process heating. The performance of solar arias meteorological parameters (direct and diffuse radiation, ambient temperature and wind speed), design parameters type of collector, collector materials and flow parameters (air flow rate, mode of flow). The principal requirements of these designs are a large contact area between the absorbing surface and air solar air heaters can be used for many applications including crop drying and space heating. Solar air heaters have many attractive advantages over liquid heaters regarding the problems of corrosion, boiling, freezing and leaks.

NOMENCLATURE

Symbol	Description	Units
$\dot{m}$	Mass flow rate of air	kg/s
ρ	Density of air	kg/m^3
A	Area of flow	m^2
	Velocity of air	m/s
	Specific heat of air	kJ/kg
I	Intensity of solar radiation,	W/m^2
	Inlet of air temperature	^0C
	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 diameter	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

Absorber plate

Type-I

The absorber plate placed above the glass wool, the absorber material selected as toughened glass plate with the thickness of 4mm. The glass plate coated with black paint in bottom side for effective absorber of solar radiation.

Type-II

The absorber plate placed above the glass wool, the absorber material selected as GI plate with the thickness of 20 SWG. The copper plate is commercially available coated with black paint in top side for effective absorber of solar radiation.

Glass cover plate

The one glass cover plate placed above the absorber plate and another one is below the absorber plate with the air gap of 0.06 m each. The thickness of glass cover plates are 4 mm each.

Duct

The duct provided in outer end of the air heater for air outlet.

Shutter The airflow passage is opened and closed

with help of shutters.

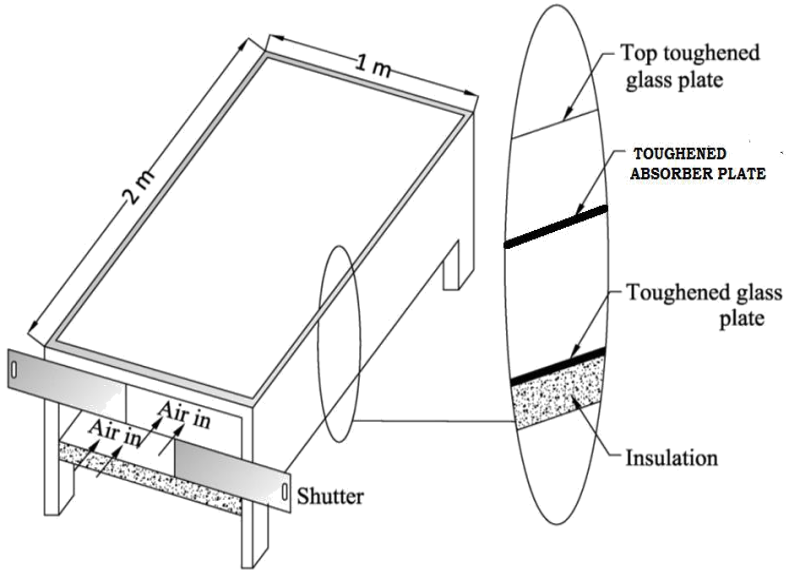

Fig. 2.1 schematic diagram of solar air heater – though glass absorber plate

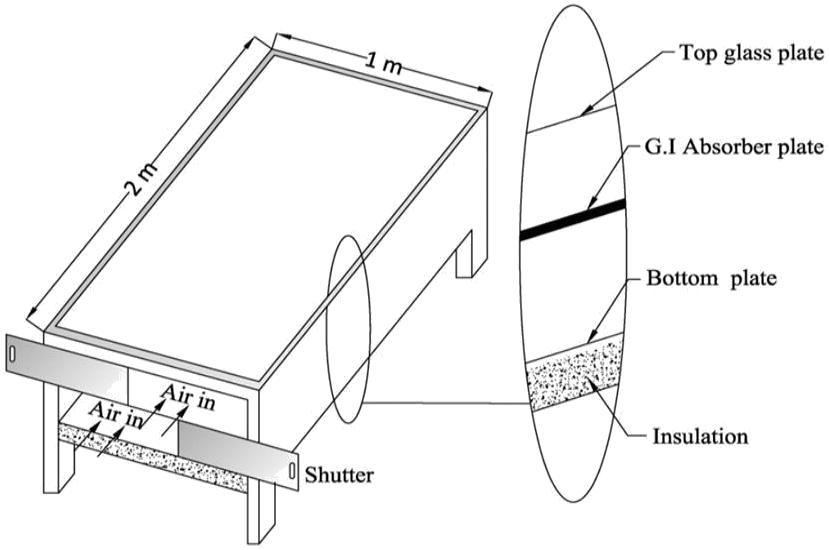

Fig. 2.2 schematic diagram of solar air heater –

GI absorber plate

3. METHODOLOGY

3.1 EXPERIMENTAL SETUP AND MEASUREMENT PROCEDURE:

The solar air heater is designed to study the performance during both flow conditions. Experimental conditions employing double pass is of two types namely both flow; Double pass represents the recirculation of air flow from lower channel to bottom channel. Both flows are schematically. The one sets of solar air heater both flow 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. The experimental setup was located at Solar Energy Laboratory in the Mechanical Engineering department of ANNAMALAI UNIVERSITY. The experiments were conducted between 15th 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. 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 bottom flow, top flow and both flow. The readings are taken for fifteen consecutiv

Fig 3.3 Photographic view of experimental set up two different air heaters

4. MATHEMATICAL FORMULATION

4.1Thermal efficiency of solar air heater:

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

4.1.1 Mass flow rate*:* -

Mass flow rate = ρ = /(*(+ 273) * *3600

= (1.103*10^5)/ [287*(33+273)] = 1.15 kg/m^2

T = 30+273 = 303 K

Area = (π/4) *d^2

A = (π/4) *(0.04)^2 =1.25*10-^{3}m^2

Mass flow rate (m)= 1.15×15×3600×1.25×10^{-3}

=77.86 kg/s

4.1.2. *Heat available per unit area* Heat available per unite area

$= \left(\frac{\text{Pyranometer reading} \times 3600}{\text{Pyranometer constant}}\right)_{kJ/hr.m^2}$

$= \frac{600 \times 6.7}{9.64}$

= 2502.07 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 × 0.96

= 1.824 m^2

Heat available in the heater = 2502.07 × 1.824

= 4563.78 kJ/hr

4.1.4 Total heat gained by the air: -

Total heat gained by the air = ∗ (–) M = Mass flow rate = 77.86 kg/s

C_p = 1.005 kJ/kg*K

((-) = (35+273) - (45+273) = 10K

Q = 77.86×1.005×10

= 938.98 kJ/hr

4.1.5 Efficiency

Efficiency = (Heat gained by the air/heat available in the heater)

= (938.98/4563.78) ×100

= 20.575%

5. Result and Discussion:

The efficiency versus time, though glass absorber plate and a GI absorber plate of solar air heater is shown in figure (5.1) and air velocity flow rate 6m/sec, during the experiment as can see from figure the efficiency of though glass absorber plate higher than the efficiency of a GI absorber plate,

the result shown that the collector efficiency increases with increase the air velocity flow rate of air and solar radiation.

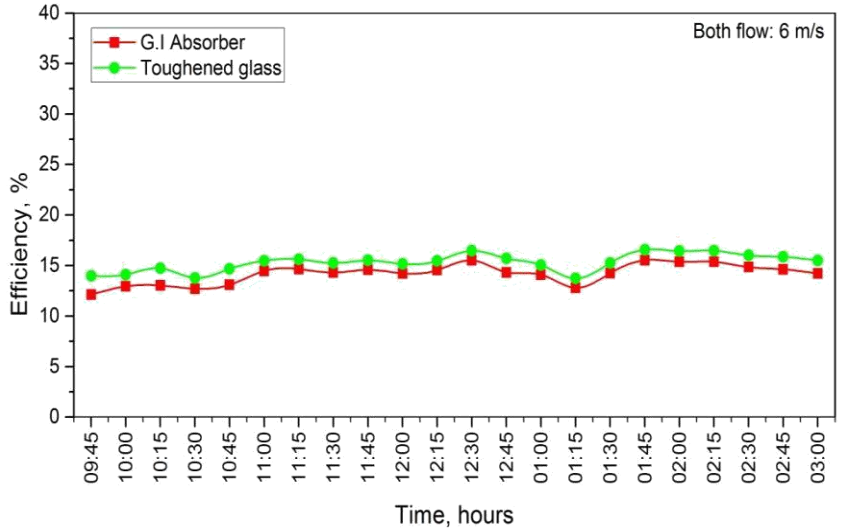

Fig 5.1 Time Vs Efficiency both flow air velocity = 6 m/s

The efficiency versus time, though glass absorber plate and a GI absorber plate of solar air heater is shown in figure (5.2) and air velocity flow rate 6m/sec, during the experiment as can see from figure the efficiency of though glass absorber plate higher than the efficiency of a GI absorber plate,

the result shown that the collector efficiency increases with increase the air velocity flow rate of air and solar radiation.

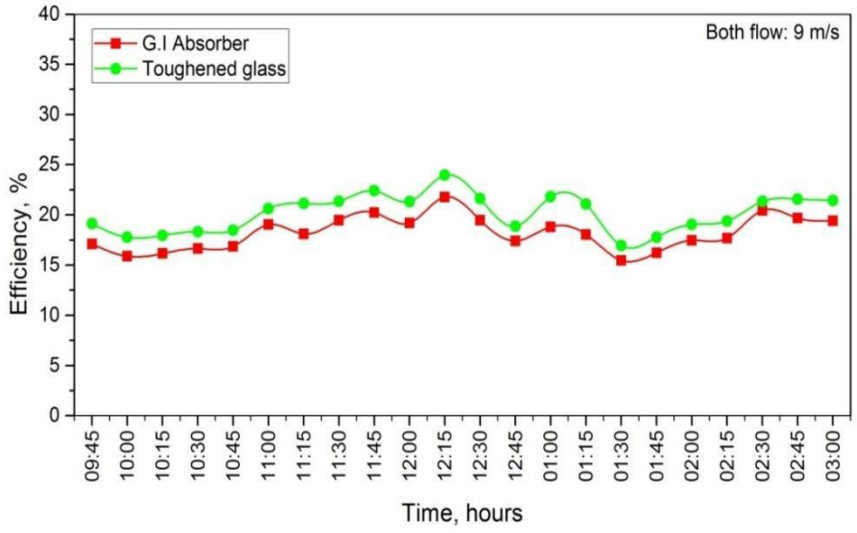

Fig 5.2 Time Vs Efficiency both flow air velocity = 9 m/s

The efficiency versus time, though glass absorber plate and a GI absorber plate of solar air heater is shown in figure (3) and air velocity flow rate 12m/sec, during the experiment as can see from figure the efficiency of though glass absorber plate higher than the efficiency of a GI absorber plate,

the result shown that the collector efficiency increases with increase the air velocity flow rate of air and solar radiation.

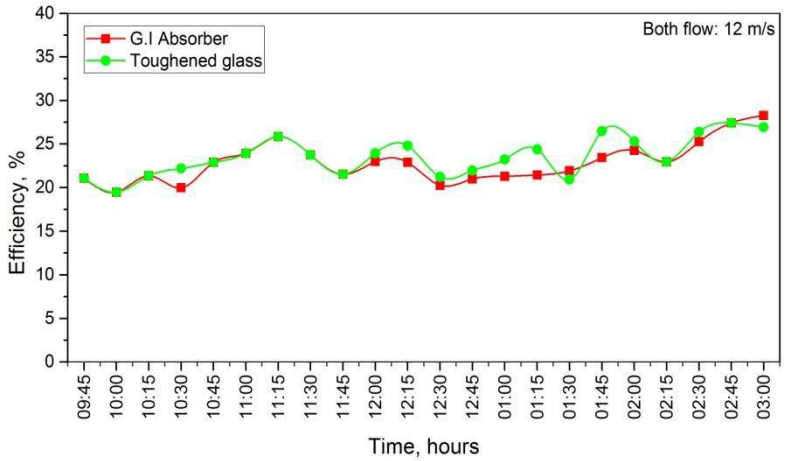

Fig 9.10 Time Vs Efficiency both flow air velocity = 12m/s

6. CONCLUSION

In this project 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, it is understood that the performance of Toughened Glass absorber air heater (type-I) is efficient than G.I absorber air heater (type-II) in bottom and both flow and only top flow the performance of G.I absorber air heater (type-II) is efficient than Toughened Glass absorber air heater (type-I)

The main disadvantage of the G.I absorber plate of solar air heater, it has corrosion problem of absorber plate due to moisture present in the air and it requires maintenance. Due to more heat the metal absorber plate having special black color coating produces bad odour that imparts the bad odour on the drying products (industrial, agriculture, food and chemical drying products).

The main Advantage of the Glass absorber plate of solar air heater is that it does not impart bad odour to the drying products and there is no corrosion problem due to moisture present in the air

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BIOGRAPHIES

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