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A Study of Configuration and Analysis of Performance of Solar Air Heater

Shrikant Vidya*

Assistant Professor, Department of Mechanical & Chemical Engineering, Galgotias University, Greater Noida, Uttar Pradesh, India

Abstract – This article has built, developed and checked two Solar Air Heaters (SAH). The first absorber layer is constructed of black pine, while the second is made of black aluminum sheet and we have discussed about the Solar Air Heaters and its classification, Function of Solar Air Heater, Application of Solar Air Heater, then wo did experimental setup to analyze the performance of solar air heater which is concluded that the highest efficiency for the SAH at inclination angle was 22 degrees, and the velocity inside the rig. was 1.8 m/s. the efficiency of SAH was 94.6% for wood base and 87.4% for sheet metal base.

Keywords – Performance, Solar Air Heater, Configuration, Application

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INTRODUCTION

Solar energy is used in household devices such as solar air conditioning, solar ball, solar battery, solar chimney, solar refrigerator, solar panels, solar heater and other applications. Air plays an important function as heat transport fluid in energy storage systems. Solar air heater (SAH) is an important solar energy application. Generally speaking, SAHs consist of an aluminum or a stainless steel collector, vitrifying material and absorber sheets that are metal materials that serve as the heat conductor. You consume and heat the energy from the sun. The thermodynamics are used to produce this hot air. Solar radiation is the cause of the operation. This is transformed into a solar air heater which generates hot air.

The primary objective of developing solar heating systems is to capture the full solar power at low expense. These processes are divided into two divisions depending upon operating fluids, such as gas (mainly air) or liquid fluid (mainly water).

Liquid heaters are confronted with issues such as heating, freezing, erosion, leakage and salt deposition not seen in solar heaters. Applications in solar heaters are also commonly utilised in various areas, such as domestic, farming and industrial applications. They are often used to heat houses and create an enjoyable atmosphere in marine and textile materials.

The Solar Air Heater (SAH), owing to its low resource use, low heat transmission and adverse physical properties of air, plays a major part in Solar Heater systems.

Because of its poor heat transfer coefficient between the absorber plate and the circulating air, the efficiency of SAH is smaller. The heat transfer intensity is improved by I growing heat transfer coefficient (ii), which increases the heat transfer region in contact with operating fluid (iii) decreases the heat leakage from the collector to the surroundings and (iv) uses thermal storage medium.

Classification of Solar Air Heaters

Solar air heater is known as an air channel and an air channel style in two kinds. Single flow single pass, dual-flow double pass, single flux double pass and single-flow recycled doubling passes are also sub-classed in the air channel configuration. Flat Plate, Extended Surface Assisted, Porous Media Assisted is the sub-classification channel designed. Figure 1 illustrates the SAHs grouping.

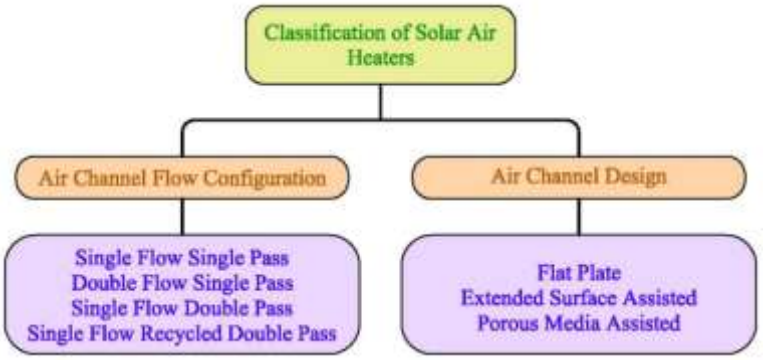


Fig 1: Classification of Solar air heaters.

The above types are discussed below:

The performance and exit temperature of the solar air heater depend on a key parameter of the air flow channel configuration.

In Single Flow Single Pass SAH, air reach and exit directly from the entrance and exit of the channel where the air flows both from upper and lower channels, as in Double Flow Single Pass SAH. Thus, in this sort of SAH, the thermal efficiency and heat transmission range is greater than the last. The air passes out of the upper channel and switches its way at the end of the channel and joins the lower channel in single flow double pass SAH. Air flows directly from there through the underlying channel. The Solar Air Heater Single Pass recycled Double Pass is installed using a single inlet and outlet, which transfers part of the heat to the lower channel and then flows through the main air channel.

The shift in the design of air canals will enhance SAHs' performance. The Flat Plat SAH features a smooth absorber plate without any components such as fine, impediment or ruggedness, so that it has less performance. With the expanded SAH surface elements such as fines, ripples, obstacles or ruggedness are added to the absorber layer, thereby increasing the surface region, extending the area of absorption and coefficient of heat transfer by combining the channel air flow.

The SAH porous media improves both thermal performance and temperature outlet. The SAH flux channel increases both the field of heat transfer and the air flux mixing.

Function of Solar Air Heater

The solar air collector is responsible for collecting energy from sun and transferring this energy to the air via the collector using the absorber media.

The solar air heater attracts air from the inlet and circulates it in the solar collector in which heat is collected. This warm air is blown into the room through a canal.

Application of Solar Air Heater

Today, air is often used as heat transfer fluid in several forms of solar energy conversion systems. Solar energy plays an important part in the drying and heating of room than can be achieved with warm air. If a black surface is exposed to the light, it is passed to the air at high temperature when it blooms. The black radiation is spread. In order to improve heat distribution and thereby achieve higher temperatures, the absorbing surface and air flux must be in close contact with collectors. One or more translucent coverings should be provided for air collectors to mitigate thermal loss. Heated air is used to dry farm goods such as grains, fruits, plants, aquatic products and so on at a low temperature energy source.

EXPERIMENTAL SETUP

Two solar air heating devices, each 1.2 m^2 and protected by glass plate with a thickness of 5 mm, consist of black-colored wood and metal sheet absorbers. The experimental setup used in this work consists mainly of the following components (Figure 2)

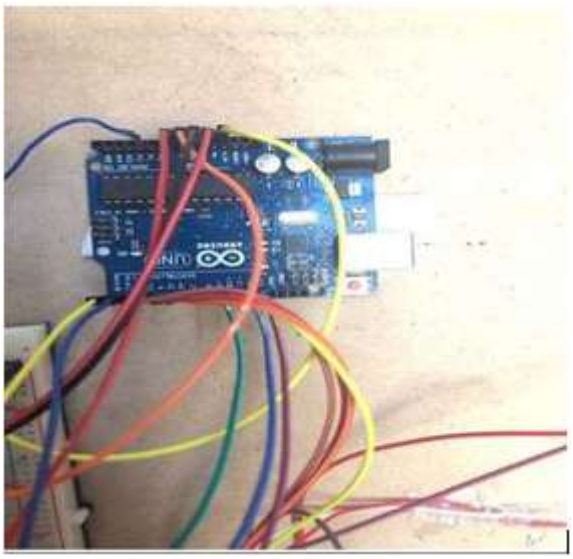
- The air flows are heated and the heater leaves at higher temperatures, with the air heater being filled with atmospheric air and flowing into each heater.
- Two variable fans, which introduce the air in the heater at variable speed and hence variable weight flows.
- Arduino Controller which obtains digital air velocity values inside each heater
- Copper constant thermocouples for measuring the air temperature inlet and outlet.

The metrological data (solar intensity and ambient temperature) were recorded using a metrological station.

The tilt angle was varied at intervals of 5 degrees at different steps from 15 to 50 degrees for each defined airspeed within the collector and after constant condition is achieved (which is indicated for the consistent air inlet and outlet air temperatures). The ideal angle of inclination that gives maximal increases in the air temperature within the collector was replicated on many occasions. Any single process with a particular air speed was replicated many times.

The collector

Inlet Fan



Arduino Controller

Figure 2: Experimental setup component

RESULTS AND DISCUSSIONS

The relationships between heater performance and air temperature rise are seen in Figures 3 through 5, when flowing inside both heaters at different slant angle and a 500 W/m2 solar pressure, and at 1,2 m/s fan speed. The performance of both heaters improves as the air temperature increases with the movement inside the heaters, as seen in those figures and these air temperature values rise. In the wood heater the gain in performance is more pronounced because the heat loss in the wood heater to the environment is much less than in the metal heater to the surroundings and thus less losses in the wood heater contribute to greater efficiency.

These data show that the highest wood heater efficiency comes at 45 degradation, while the max. metal output is 69.4 percent. This often comes from a tilt angle of 45 degrees, while the max. metal efficiency is 69.4 percent.

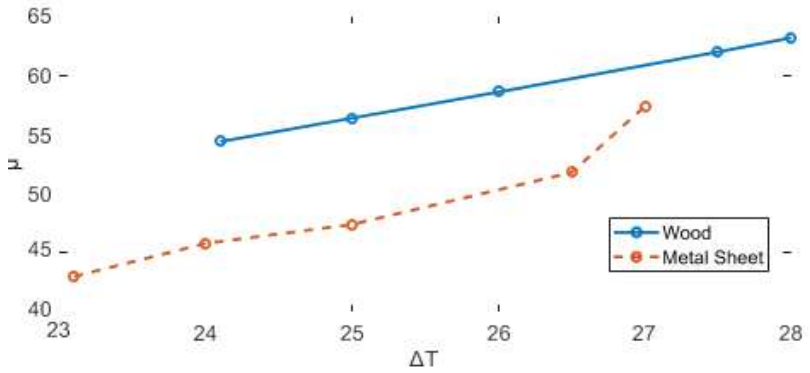


Figure 3: The variation of heater efficiency with the increase in air temperature (Zero tilt angle)

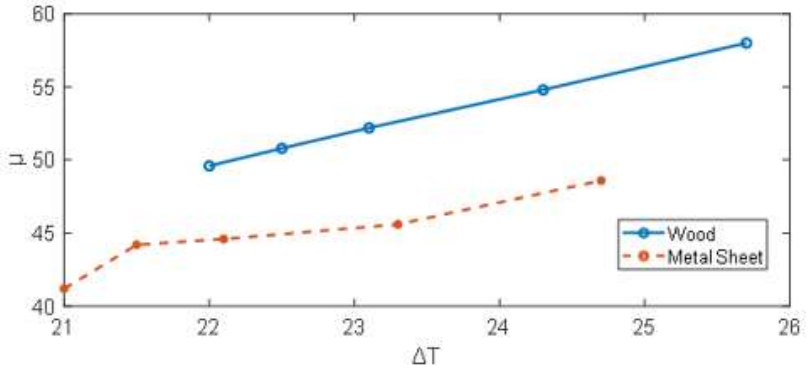


Figure 4: The variation of heater efficiency with the increase in air temperature (tilt angle equals 22 degree)

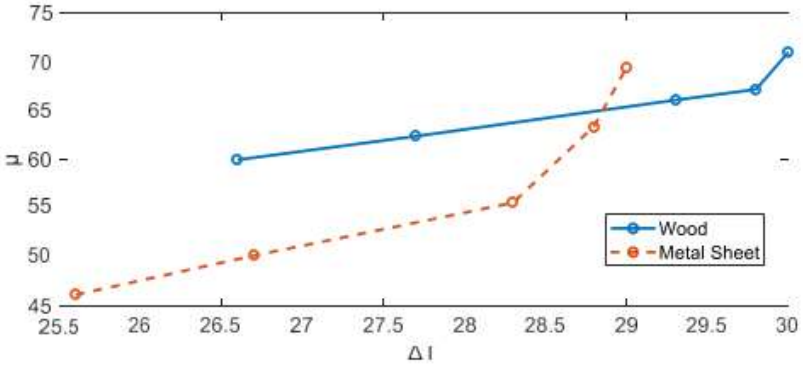


Figure 5: The variation of heater efficiency with the increase in air temperature (tilt angle equals 45 degree)

The second part of the experimental work with a fan speed of 1.8 m / second was developed. In this section the angle of inclination has been adjusted manually to three values namely 0, 22 and 45, similarly as the heater performance change with the rise in the air temperature as it passes through the heaters.

Figures 6 to 8 indicate a relationship that is almost in line with the general pattern of the first part of the work. The performance of each heater increases linearly with the air temperature rise, as these statistics show. This gain in efficiency is greater in the wood heater, which is because there is much less thermal loss from the boiler heater to the environment than from the metal heater to the room and therefore less heater losses contributing to greater production.

This statistic shows that when the tilt angle is fixed in 22 degrees with a value of 94.6% the highest wood heater efficiency is achieved, whereas the maximum efficiency of the metal was 87.4%, which also was obtained if the tilt angle is equivalent to 22 degrees.

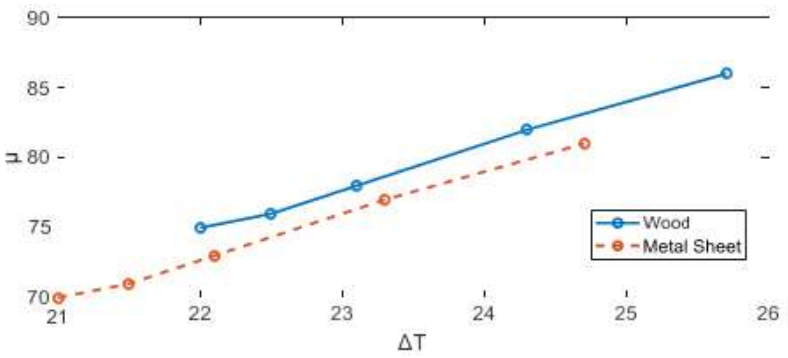


Figure 6: The variation of heater efficiency with the increase in air temperature (Zero tilt angle)

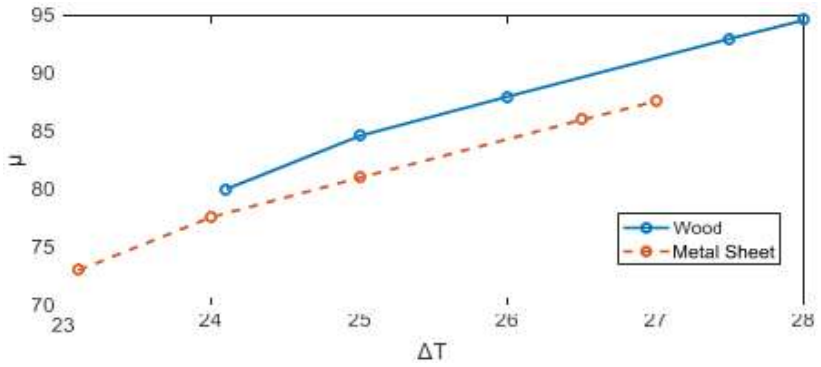


Figure 7: The variation of heater efficiency with the increase in air temperature (tilt angle equals 22 degree)

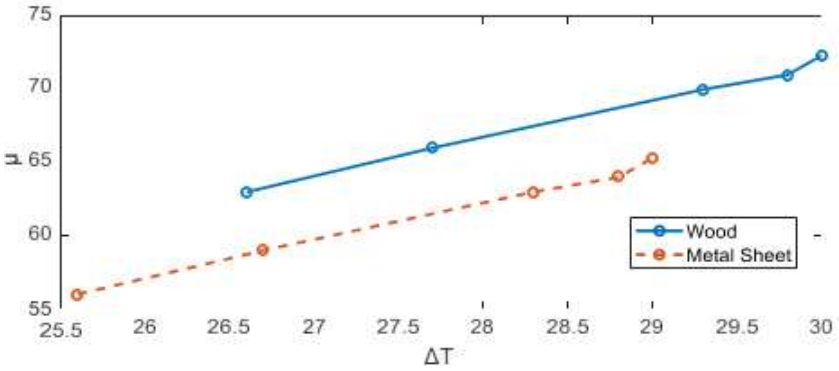


Figure 8: The variation of heater efficiency with the increase in air temperature (tilt angle equals 45 degree)

As mentioned in the figures above, the highest achievable performance was 94.6% which is the same for the wood heater at 1,8 m/s fan speed and a tilt angle of 22°.

CONCLUSION

Solar Air Heater is a basic system used to generate hot air for production of heat or space heating as a means of renewable energy heating technologies. Due to its compact architecture, quick to manufacture and sustain and low cost, SAH devices are useful.

The paper examined and analyzed two SAHs and their results. In each test, three separate decline angles of the collector 0o, 22o and 45o were carried out; one was done with a wood basis or the other with a base metal; and two air input values were used.

It was found that the highest efficiency for the SAH at inclination angle was 22 degrees, and the velocity inside the rig. was 1.8 m/s. the efficiency of SAH was 94.6% for wood base and 87.4% for sheet metal base.

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Corresponding Author

Shrikant Vidya*

Assistant Professor, Department of Mechanical & Chemical Engineering, Galgotias University, Greater Noida, Uttar Pradesh, India