Performance on Solar Air Heater Using Angular Fins With Aluminium Scrabs

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Abstract- *The solar air heater is intended to reduce the amount of time it takes to dry crops in agriculture and sheets in leather factories. Because crops might become infected while being dried outside and because some harvests will be lost throughout the process, it takes a long time. The solar air heater is meant to protect against moisture invasion and waste, and this revolutionary design produces high heat and shortens the crop drying time. Aluminum plates, fins, inlet, and outlet pipes, as well as aluminum inlet and fins, are the key materials utilized in this solar air heater. The parameters of this solar air heater are velocity and temperature.*

I. INTRODUCTION

Solar energy comes from the sun, and without it, all life on earth would cease to exist. Because of the enormous amounts of energy that are made freely accessible, if contemporary technology is used to capture them, solar energy has been regarded as a substantial source of energy for many years. A straightforward demonstration of the sun's strength may be observed by using a Utilizing solar energy as thermal energy for heating purposes is the simplest and most effective method. Solar collectors are the most crucial and fundamental parts of the system needed to convert solar energy into thermal energy.

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1.2 SOLAR AIR HEATING

Sun air heating, as the name implies, involves converting solar radiation into thermal heat. Air that is given to a living or working place absorbs and carries thermal heat. Air's transparency prevents it from directly absorbing significant amounts of solar radiation, so a middle mechanism is necessary to enable this energy transfer and deliver the warm air into a living area. Solar air heaters are the technology used to make this procedure easier.

Some of the most fundamental and straightforward thermodynamic principles underlie how solar air heaters work .A solid body absorbs sun energy, which causes the body to warm up. This solid object is generally referred to as the "collector." Some bodies, including those with dark, non-reflective surfaces, are better at absorbing energy than others.

Heat transfer to the air as it travels over the surface occurs from the heated solid mass. Typically, a fan is used to push air across the heated body; the fan may be powered by solar energy or electrical power.

By employing the same fundamental principles and various solid things functioning as collectors, many forms of solar air heater technology are able to accomplish this procedure. The fan that moves the air across the heated surface also functions as a ducting system component to send the hot air into the living area. The heat can also be absorbed by the thermal mass of the room's walls, floors, furniture, and other objects in addition to warming the air there. Such heat is in fact "stored" and gradually evaporates after daylight hours.

1.3 OBJECTIVE

The main objective of this solar air heater is to Accelerating the rate of product drying, increasing the system's intake of heat can increases the crop drying rate. Preventing corrosion of the material used in solar air heater.to increases the material lifespan. To reduce the cost of solar air heater without reducing the material quality.

1.4 PRINCIPLE

A flat plate collector with an absorber plate is the basic structure of a typical solar air heater. It has insulation on the bottom and sides and a clear cover system at the top. An enclosed container made of sheet metal houses the whole assembly. Fan within the house draws cold air into duct that is covered by solar collector. The air in the duct warms up as a result of the solar collector's transmission of heat. Since warm air has a lower density than cold air, it tends to move upward, creating a natural convection current. Since the heat convection coefficient of air is poor, a blower is utilized to increase velocity.

1.5 HEATING

Home heating is the main purpose of a solar air heating system. Due to the heat's high energy efficiency, there are a number of noteworthy advantages:

- Increased comfort
- Decreased energy costs
- Less carbon emissions

Australia's home energy use is made up of 23% of hot water and 38% of space heating, with certain states like Victoria reaching 55%. Despite varying outcomes, case studies have indicated that some households may cut the heating portion of their yearly energy expenses by around 50%, translating to an annual household savings of about 20%. The following variables affect the amount of savings:

- The size and configuration of the installed solar air heating system.
- The current conventional heater's dimensions and kind.
- The residents' customs (e.g., thermostat setting).
- The home's thermal characteristics (e.g., insulation, draught sealing, size).

1.6 COOLING

Many solar air heating systems may also be used to assist cool dwellings by either:

Bringing cold outside air inside during the summer, especially after dawn, or exhausting hot air from the roof cavity to lessen the transmission of heat from the ceiling to the inside air.

It's common to compare the cooling impact to a cool evening wind that blows in after sunset. You can move air using one of the aforementioned techniques using the same fan that is used to bring warm air into the house for heating. It is possible to manage the cooling system with the same ducting and thermostat that are used for the heating system, sometimes with no or very little additional hardware.

1.6.1 MERITS

1. The expense of erecting "collectors" and other equipment needed to transform solar energy into electricity or hot water offsets the fact that solar energy is free.
2. There is no pollution as a result of solar energy. On the other hand, manufacturers that make solar
3. Remote locations where it would be too expensive to extend the electrical system could benefit from using solar energy.
4. Solar energy may be used successfully to power many commonplace products like calculators and other low-power users.
5. The world's oil reserves are predicted to last for 30 to 40 years. Solar energy, on the other hand, never runs out (forever).

G.Murali, et al (2020) [1] The experiments of solar air heater by using Aluminium can with and without sensible heat material have been performed for two mass flow rate. Thus, the efficiency is increased by using SHM than that of without SHM, because Aluminium a good thermal conductivity and heat absorption .

Rahul Khatri, et al (2020) [2] The experiments conducted suggested that the thermal performance at a fluid flow velocity of 5 m/s was better than the other two flow velocities considered in this study i.e. 3 m/s and 9 m/s. Three different arrangements were considered for the comparative study on the newly designed solar air heater and it can be concluded that the thermal performance of arched wavy plate with fins was better than the other two The range of temperature difference between inlet fluid temperature and outlet fluid temperature achieved with arched wavy plate with fins was 55–70 ℃.

Jardine Jongpluempiti, et al (2017 [3] The installation of a solar air heater into a spray dryer uses 130.08 units of electricity over 8 hours. The solar heater experimented with various inclination degrees of 12, 13, 14, 15, 23.5, 30, 31, 32, and 33 degrees, showing that 15 degrees angle is the best inclination angle.

Binguang jia,et al (2021) [4] The profiles of velocity proved that the channel with both right angle turnings and rectangular holes contributed to decreasing
the pressure loss by depressing the intensity and scale of the separated vortex and corner vortex.

Ho-Ming Yeh,et al (2012) [5] Considerable improvement in collector efficiency is obtainable if the operation is carried out with an external recycle. The enhancement increases with increasing reflux ratio, especially for operating at lower air flow rate with higher inlet air temperature. It is shown that the desirable effect of increasing the fluid velocity by recycle operation overcomes the undesirable effect of decreasing driving force (temperature difference) for heat transfer due to the remixing at the inlet.

Ho- Ming Yeh,et al (2009) [6] It is found that the desirable effect of increasing the fluid velocity by recycle operation compensates for the undesirable effect of decreasing driving force. The results show that more than 100 % of improvement in collector efficiency is achieved by the internal- recycle operation.

Brij Bhushan, et al (2010) [7] The purpose of the article is to present the heat transmission and friction properties of the intentionally roughened solar air heater duct. The artificial roughness methodology and experimental tests conducted by different researchers have been covered in depth. It has been shown that adding artificial roughness is an effective way to increase the thermal efficiency of solar air heaters.

Ranjit Singh, et al (2012) [8] In the current work, a mathematical model has been used to examine the thermal and thermohydraulic performance of smooth and roughened solar air heaters. The absorber plate of a solar air heater is thought to have developed protrusions and been roughened. Thermal and thermohydraulic performance of solar air heaters have been assessed using parameters such as thermal efficiency and effective efficiency. The ideal value of each roughness geometry parameter has been found based on the roughened solar air heater's maximum thermal and effective efficiency

.**A.A. El-Sebaii, et al (2011) [9]** The double pass flat and V-corrugated plate solar air heaters are both theoretically and experimentally examined in this paper. There are provided analytical models for the air heater with flat and V-corrugated plates. According to the theoretical predictions, there is some agreement between the measured performance and the performance. The output power and total heat losses of the flat and V-corrugated plate solar air heaters are also compared, as well as the observed outlet temperatures of flowing air. The double pass V-corrugated plate solar air heater is 14 % more efficient than the double pass flat plate solar air heater, according to the data.

Sami Kooli, et al (2015) [10] In this study, the effectiveness of the nocturnal shutter at night to preserve night time temperature is assessed using two similar insulate greenhouses. According to the experimental findings, the night time temperature variance inside the greenhouse with the shutter is 2 °C higher than the night time temperature variation without the shutter. To determine the amount of energy that was absorbed, used, stored, and lost within the greenhouse with or without a night time shutter, a thermal energy analysis was also used.

Dilip Jain, et al (2004) [11] A transient analytical model for an inclined multi-pass solar air For deep- bed drying applications, a performance study of a tilting multi-pass solar air heater with built-in thermal storage has been conducted. The grain temperature rises as the collector's length, width, and tilt angle increase until they reach their usual values. For agricultural drying applications, the thermal energy storage effect during the hours without sunlight is crucial. In order to assess the thermal efficiency of a flat plate solar air heater for the purposes of grain drying, the presented mathematical model is helpful. Predicting the moisture content, grain temperature, humidity of the drying air, and drying rate is also helpful heater with built-in thermal storage and a connected deep-bed drier is presented in this study.

A.J. Mahmood, et al (2015)[12] This project aims to build and test four transverse fin single-pass and double-pass solar air heaters. These fins were transversely positioned and painted a deep black with four evenly spaced parts. In place of an absorber plate, sixteen layers of steel wire mesh with internal diameters of0.02 cm and a cross-sectional area of 0.18 cm * 0.18 cm were positioned between these fins. According to the experimental data, for air flow rates between (0.011 and 0.032 kg/s), thermal efficiency rises as air flow rate increases. At an air flow rate of0.032 kg/s, the greatest efficiency attained using the 7.5 cm height collector was 62.50% for the double-pass solar air heater and55 % for the single-pass solar air heater.

Abhishek Priyam, et al (2016) [13] The analytical investigation of the finned absorber solar air heater's performance analysis has been done in this study. Two transversely positioned wavy fins attached to the absorber plate, with the bottom side thermally insulated and the top surface of the absorber exposed to uniform heat flow, create the fluid channel. The influence of mass flow rate and fin count on the thermal and thermohydraulic performance is discussed in this work. analytically examined for both the wavy fin absorber solar air heater and the aircraft. Thermal effectiveness, Thermal efficiency has been assessed using effective efficiency and the solar air heater's thermohydraulic performance.

Sanjay Yadav, et al (2014)[14] In this study, an effort has been made to assess the energetic efficiency of a roughened solar air heater duct that includes protrusions above the absorber plate that are arranged in an arc pattern. Analytical calculations were used to determine a solar air heater's energetic efficiency, and the findings were compared to those of a solar air heater with a smooth flat plate. To help the designer create this kind of roughened solar air heater inside the examined range of system and operational parameters, design plots were also generated.

Mohamed, et al (2020) [15] In this study, several turbulence generators are used to assess the thermal-hydraulic performance of flat-plate solar air heaters with roughened ducting. Based on the availability of experimental F-factor and Nusselt number data, about 220 roughened ducts have been chosen from the literature. Rectangular/square ribs, arc/wavy ribs, V- shaped ribs, wedge-shaped ribs, protrusions, and metal mesh are examples of roughness elements. Collector efficiency (as a function of usable energy and pumping power) and entropy production are assessed to evaluate the performance of various solar air heaters.

Tingting Zhu, et al (2021) [16] In this research, anoptimization study for a solar air heater based on micro-heat pipe arrays was conducted with the goal of determining the best operational conditions and geometrical parameters for the solar air heater. Based on the actual physical processes of heat transmission in the solar air heater, a 3-D CFD model was created and verified using the experimental findings.

Hamdy Hassan, et al (2019) [17] In this study, the Experimental research is being done on the effectiveness of a novel type of solar air heater (SAH) called a tubular solar heater (TSAH). The adjacent tubes in this design replace the flat absorber plate of the flat solar air heater (FSAH) in the same direction as the airflow through the SAH. For the purpose of comparing their performance at various airflow rates through the SAHs, two SAHs (FSAH and TSAH) with identical dimensions and construction materials other than their absorbers are built. The results show that when compared to the FSAH, the TSAH has greater efficiency, output power, outlet air temperature, and reduced top heat loss.

Ramadan ElGamal, et al (2020) [18] This study's major objective was to create an integrated solar-tracking system to increase the effectiveness of solar heaters made from recycled Aluminium (RAC) for the best possible drying of apple slices. The findings showed that at all tested air flow rates, the thermal efficiency of the solar air heater integrated with a tracking unit was dramatically increased by roughly 45 % when compared to the standard fixed heaters.

Ebrahim Rahmani, et al (2021)[19] In this study, A 3D numerical simulation of a solar air heater with wavy and raccoon-shaped fins in a turbulent fluid flow was conducted. The thermo-physical characteristics of air were thought to depend on temperature. Two Reynolds numbers of 12,000 and 24,000, as well as two fin heights of 0.25 and 0.5 times the height of the channel, were taken into consideration. Comparisons were made between the solar air heater with and without fins. The fins may result in improved mixing, increased turbulent kinetic energy, and more equal temperature distribution on the absorber plate and outlet flow. In terms of the aforementioned factors, it was discovered that the cases with higher height fins were more effective.

FABRICATION OF FINS

Figure.1.1 Fin Arrangement

In the above figure 1.1,the five main fins are arranged in the solar air heater and the small fins with the angle of 120 degree is attached with the main fins, this is the best angle for reducing the velocity of air.

Figure.1.2 Inlet And Out Let Pipe

The inlet and outlet pipe is attached with the solar air heater, the top is used as inlet of air and the bottom pipe is used as outlet of air.

MASS FLOW RATE CALCULATION

Mass Flow Rate = Density ×Area×
Velocity From HMT data book page no. 34
Density of air at temperature 40°C =
1.128/ m^3

VELOCITY

Velocity is measured at the outlet of the blower by using ANEMOMETER
Velocity value = 2 m/s

CROSS SECTION AREA

THERMAL EFFICIENCY

Thermal efficiency = Qout/Qin
Qin =I×A
I =incidentradiation A=area of SAH
Qout =m×Cp×ΔT Area of SAH = L×B
= 0.94×0.64
=0.4125m^2
Solar radiation =1011W/m^2 Room temperature =36°C Outlet temperature = 60°C

ΔT=To-Ti
= 60-36
ΔT = 24°C Thermal efficiency =Qout/Qin
η=0.0176×1005× 24/1011×0.4125
=424.512/417.30
=1.0179×100
η =101.79%

II. RESULT AND DISCUSSION

While taking the readings the SAH is placed in the solar radiation falling area with an ideal period of 6 hours from 10.00 to 4.00 PM on the following days (20,21,22,23 of march 2023) with different mass flow rates (2 m/s, 3 m/s, 4 m/s). The mass flow rate was found by using calculations which were shown in chapter5. During that period, the blower was kept in ON condition; from every hour, the readings are taken from 10.00 AM to 04.00 PM.

The absorber plate is the hottest part in the solar air heater and it reached 72°C while the glass and sensible heat storage material reached the maximum temperature of 58°C and 60°C respectively at the noon time. The outlet air temperatures reached a maximum value of 60°C around noon. Only after 1. AM, there was an appreciable rise in all temperatures and after 04.00 PM all temperatures reached the low value. It is observed that, the efficiency of the SAH with energy storage and packed bed was better during day time. The following graphs were plotted based on our readings

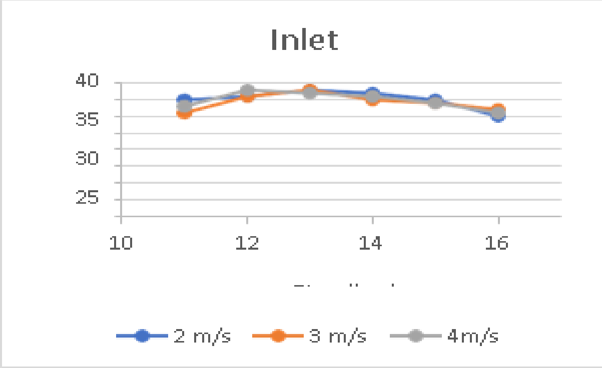

Figure.1.3 Inlet temperature

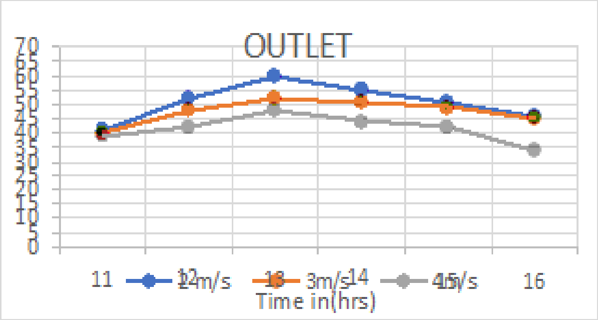

Figure.1.4 Outlet temperature

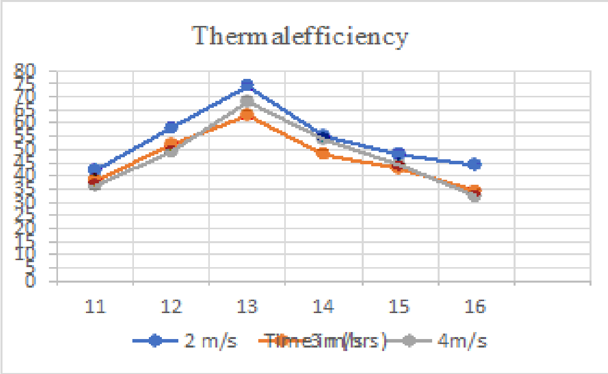

Figure.1.5 Thermal efficiency

III. CONCLUSION

A detailed experimental study was conducted to evaluate the performance of the solar air heater with aluminium fins as a sensible heat storage medium under the metrological conditions.

The two variables used in this project for the solar air heater are velocity and temperature. In this experiment, which is carried out with the help of sunlight during the day, In this experiment, work took readings for a whole week, beginning on the first day at 10:00 AM and ending at 4:00 PM. There is little solar exposure before 10:00 AM and after 4:00 PM in the morning. In this experiment, the velocity flow was changed daily, and readings were taken hourly.

In this experiment, flow rates ranging from 2 m/s to 4 m/s were employed. A 2 m/s flow velocity causes a higher temperature. When maintaining an intake temperature of 32 °C, the experiment's maximum output temperature is 60 °C. Lastly, by reducing the velocity with the help of angular fins and aluminum scrabs, the temperature of the solar air heater rises.

PHOTOGRAPHY

Figure.1.6 Solar Air Heater

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