EXPERIMENTAL STUDY OF SOLAR AIR HEATER
WITH AND WITHOUT POROUS MATERIAL

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Abstract - In this examination, tests were led on single and two-fold pass sun oriented air Heaters with baffles and sixteen wire network layers embedded between the baffles. The baffles and cross section layers were embedded in the arrangement and tried to notice their impacts on the heat transfer of the SAHs (Solar Air Heaters). Three instances of single-and two fold pass Solar Air Heaters were considered with bed structures of 3, 5, and 7.5 cm. The diverse bed structures were considered to work on the heat productivity, efficiency and outlet temperature. For all cases, the wind current rate was fluctuated between 0.011 and 0.032 kg/s, and the structure of the upper channel for the two-fold pass SAH was fixed at 2.5 cm. The impacts of the wind current rate and number of baffles in each case on the heat transfer rate and outlet temperature of the Solar Air Heaters were tentatively explored.

Keywords: Solar Air Heaters, Porous, Baffles

I. INTRODUCTION
Sun powered air heaters are straightforward gadgets that use occurrence sun oriented radiation to get clean energy for a wide use. The sun oriented air heater gadget captures sunlight based radiation, changes this radiation over to the warmth in air and conveys the air for use.

The principle parts of a sun based air heater is a absorber plate, at least one channels for the streaming air, protection for the base and parallel sides of the sun powered device and at least one straight forward covers. The utilization of a blower is discretionary for the air supply. Definite data is given underneath.

Sun oriented air heater might be isolated into two principle classes. The main class is identified with the air channel stream arrangement. To expand the framework effectiveness different air channel stream setups will be developed. The different arrangements might be communicated in four captions under this classification. The sub-classes are; single stream single pass, twofold stream single pass, single stream twofold pass and single stream reused twofold pass. The subsequent classification is identified with the air channel plan. The air channel plan influences the framework proficiency essentially. Thus extraordinary plan designs can be utilized in sun based collector. The subsequent classification can likewise be communicated in three sub-classes, for example, flat plate, broadened surface helped, permeable media helped. All primary and sub classifications are clarified underneath. Different investigations exist that can't be clarified under any of these classes. These contemplates are classified as exceptional plans.

II. METHODOLOGY
The surrounding temperature Tin was recorded by using two mercury thermometers that hung under the bed. A calibration test affirmed a precision of ±0.5 °C. Nine T-type thermocouples were conveyed in three group of three thermocouples each to record the temperatures at three areas. A calibration test affirmed an exactness of ±0.15 °C. The first bunch was utilized to quantify the normal outlet air temperatures Tout (Tout1, Tout2, and Tout3) and was fixed 5 cm before the orifice meter. The second bunch was utilized to record the normal bed temperature Tbed (Tbed1, Tbed2, and Tbed3) and was mounted inside the wire network. The last gathering was utilized to record the normal glass temperature Tg (Tg1, Tg2, and Tg3) and was fixed on the lower side of the glass by silicon paste and sticky tape inside the channel at three better place. Tg was the mean temperature of the air extremely near the second glass. All of the deliberate temperatures may acquire by utilizing computerized thermometers (OMEGASAYS) with an exactness of ±0.5 °C.

The sun powered radiation was controlled by utilizing a pyranometer found adjoining the bed (Eppeley Radiometer Pyranometer, PSP model HHM1A computerized, ±0.5% precision over a scope of 0–2800 W/m2). This is clarified exhaustively in Section 3.4.3. The sunlight based heater collecting system was situated pointing toward the south and shifted at a point of 35° with deference to the flat. The channel temperature Tin (surrounding temperature), normal outlet temperature Tout= (Tout1+ Tout2+ Tout3)/3, normal bed temperature Tbed= (Tbed1+ Tbed2+ Tbed3)/3 (temperature of air passing inside the
bed at three positions), normal glass temperature $T_g = (T_{g1} + T_{g2} + T_{g3})/3$ (temperature of air passing extremely near the glass), wind speed, relative humidity ratio, and solar radiation. I were recorded each 60 min. All information were recorded from 8:00 am to 5:00 pm. The gadget was worked under consistent state conditions; the air was flowed for 30 min before the period in which the information were taken.

Although the absorber plate is one of the significant parts of the SAH, expanding the absorbing region that certainly expands the heat transfer rate of the collector. In this study, the absorber plate was replaced with wire network layers and baffles, which are a lot less expensive than a metal absorber plate and are easily accessible in market. The utilization of wire network layers will in general significantly increment the surface area per unit volume proportion and increase the heat transfer rate of a SAH.

III. EXPERIMENTAL SETUP

SAHs are the most essential factor of a photo voltaic electricity utilization system, as discussed in previous chapters. The air path, glass cover, and absorber plate are the important parts of a typical SAH. Active photo voltaic heating techniques use an air fan to enhance the air flow and heat transfer. In the present study, some modifications had been made to a conventional air heater. The direction of the air flowing inner side of the channel was once increased, and the outcomes of the second pass height and quantity of baffles on the thermal performance of the photo voltaic collector had been studied. This chapter provides the development and experimental setup of air heaters with distinctive numbers of baffles, various bed heights, and with wire mesh layers as the absorber plate. The chapter also offers an uncertainty analysis for the mass flow rate and thermal efficiency.

An open air test arrangement was created to test SAHs (single- and double pass with 16 wire network layers and confounds just as various bed statures and quantities of baffles). The distinctive SAH arrangements. The fundamental parts in every arrangement were the quantities of baffle, ducts, and glass or double glass cover.

![Figure 1: Pictorial view of the experimental set up of SAH.](image)

The flat plate SAH was built in Kurukshetra, Haryana for the heat effectiveness tests. A wooden structure was utilized with measurements of 1.47 m × 1 m (Figure 3.2) and channel with depth of 0.03, 0.05, or 0.075 m. There was a rectangular opening on top with measurements of 0.36 m × 0.03 m to go about as the wind stream entrance. Table 1 presents the plan and working boundaries

<table>
<thead>
<tr>
<th>Location of collector</th>
<th>Kurukshetra, Haryana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector slope</td>
<td>35° degree</td>
</tr>
<tr>
<td>Collector orientation</td>
<td>South</td>
</tr>
<tr>
<td>Experiment Period</td>
<td>April, May, June 2021</td>
</tr>
<tr>
<td>Length of collector</td>
<td>1.47 m</td>
</tr>
<tr>
<td>Width of collector</td>
<td>1 m</td>
</tr>
<tr>
<td>Air channel depths</td>
<td>0.03m, 0.05m, 0.075m</td>
</tr>
<tr>
<td>Absorber</td>
<td>16 wire mesh layers</td>
</tr>
<tr>
<td>Number of glazing</td>
<td>1 or 2</td>
</tr>
<tr>
<td>Glass thickness</td>
<td>4 mm</td>
</tr>
<tr>
<td>Glass covers space</td>
<td>25 mm</td>
</tr>
<tr>
<td>Blower power</td>
<td>0.62 kW centrifugal fan</td>
</tr>
<tr>
<td>Mesh layer</td>
<td>Absorptivity of 0.96</td>
</tr>
<tr>
<td>Emissivity of</td>
<td>0.87</td>
</tr>
</tbody>
</table>

Table 1: Parameters Value
The wooden bed base and edges were shaded dark to retain the sun based radiation furthermore, work on the effectiveness. All sides of the bed were thermally protected with Styrofoam (thickness of 20 mm) with the exception of the top of the channel. Simple sheets of glass with a thickness of 4 mm were utilized as the cover for the single-and double pass beds. The space between the upper glass and lower glass for the double pass system was 0.025 m. The single-pass air collecting system was created basically by eliminating the primary glass on top of the collector. Sixteen wire network layers with square voids of 1.81 mm × 1.81 mm were utilized in three type of system found 5 mm separated. The first and second sets each contained six wire network layers fixed to the lower part of the channel and set corresponding to the glass cover. The third collecting system comprised of four wire network layers found 5 mm over the initial two system. For complete study of the layers, which compared to a general porosity of 0.98, were painted dark before establishment.

Aluminium baffles were situated along the channel to separate the bed into many equivalent parts. These baffles were painted dark before addition in the bed. These baffles were 27, 47, or 72 mm high and 3 mm thick. Some were 0.8 m long, while the others were 0.45 m long. A dark elastic band that was 5 mm wide and 3mm thick was utilized to keep the baffles from contacting the glass and keep air from passing above them. As such, the air streamed along the design and acquired heat as it went through the channel. For the double pass collecting system, the stream initially entered from over the exit of the lower channel and gone through the upper channel. The stream then, at that point reverse around in the lower channel before diverting to move from the top side to the base side through a 0.36 m × 0.04 m opening in the top of the second glass sheet. The adjusted orifice meter used to gauge the wind stream rate followed Holman's plan (Holman, 1989). Stream straighteners were set prior and then afterward the orifice meter to make a uniform move through it. These straighteners were plastic straw cylinders with a width of 4.6 mm and length of 20 mm. A 0.62 kW blower was joined to the release side, this is clarified exhaustively in next Section. An alcohol manometer tube set at a point of 15° and had a fluid thickness of 803 kg/m3, was utilized to quantify the pressure distinction across the opening. Three wind current readings were acquired between wind streams of wind current rate 0.011, 0.022 and 0.032 kg/s. A speed regulator, which was associated with the fan, was changed to control the speed of the fan. Two openings were made one at the channel, one at the power source to quantify the pressure drop across the solar collector. The pressure drop across the collecting system is recorded by utilizing the slanted alcohol manometer tube for the different stream rates.

IV. RESULTS AND DISCUSSIONS

As a rule, the solar power intensity followed a same pattern for the entirety of the times of the tests. The sun powered intensity expanded from morning until early afternoon, at which point it arrived at the maximum value, and afterward slowly decreased until sunset. The scopes of the sun powered force for each test were near one another. The hourly variety in the deliberate sun powered force for the single and double pass SAHs with air flow rates of 0.011, 0.022 and 0.032 kg/s. The peak value of the solar intensity somewhere in the range of 12:00 and 1:00 pm was 1081 W/m² for the single pass SAH and 1005 W/m² for the Double pass SAH. In any case, the sun based radiation and inlet temperature arrived at their greatest values around early afternoon. The maximum value of inlet temperature Tin somewhere in the range of 12:00 and 1:00 pm was 37 and 36.9 °C for the single and double pass SAHs, individually. The inlet temperature depended upon the natural state. The variances during some days were brought about by the air velocity. The air velocity was a significant factor that influenced the inlet temperature, humidity ratio.

![Figure 2: Solar intensity versus time of the day for single pass SAH, during testing of the SAHs having (a) 3 baffles (b) 5 baffles](image-url)
Temperatures difference ($\Delta T$) is (normal outlet temperature - inlet temperature) for single and Double pass solar air heater with a bed height of 3 cm and air flow rate of 0.011–0.032 kg/s with the hour of day. For all air flow rates, the temperature difference ($\Delta T = T_{out} - T_{in}$) expanded from the morning to reach at its maximum temperature difference around early afternoon and afterward slowly decreased from 1:00 pm to the last limit of the day at 5:00 pm in same manner as the sunlight based radiation. For all curves, $\Delta T$ expanded to arrive at its greatest value around early afternoon and afterward decreased toward the finish of day (comparative way as the sun oriented radiation). In addition, $\Delta T$ was more for the Double pass SAH than for the single pass SAH at a similar air flow rate. On account of the Double pass SAH, the inlet air was preheated in the upper channel before to entering the bed, which made $\Delta T$ increment. Figure show the temperature difference ($\Delta T = T_{in} - T_{out}$) with the hour of day for various air flow rates of the SAHs with a bed height of 5 cm. The greatest upsides of $\Delta T$ with three and five baffles were 39 and 39.8°C individually, for the single pass SAH and 45 and 48.3°C, individually, for the Double pass SAH.
V. CONCLUSION AND FUTURE WORK

The thermal performance of single and double pass SAHs with various numbers of cross over baffles and steel wire network (wire mesh) layers going about as absorber plate were researched tentatively under the climate conditions at Kurukshetra, Haryana. The impacts of air mass stream of 0.011-0.032 kg/s on the power source temperature and thermal efficiency were studied. The bed structures of the lower channel were shifted somewhere in the range of 3 and 7.5 cm. The upper channel of the double pass SAH was fixed to a depth of 2.5 cm for all cases. As a general rule, the expense of the SAH was decreased by the wire network layers rather than the absorber plate. The outcomes showed that the productivity increases with the air mass stream rate at the same bed structure and a fixed number of baffles. At a similar wind current rate and a fixed channel and number of baffles, the double pass SAH was discovered to be 7% more proficient than the single-pass SAH. Likewise, the efficiencies of the single pass SAH, double pass SAHs expanded with the quantity of baffles for a similar air mass stream rate and bed structure. The greatest efficiencies for the single and double pass SAHs with five baffles and bed structure of 3 cm were 64.3% and 69.3%. Separately, for an air mass stream pace of 0.032 kg/s. The warm productivity Diminished when the principal pass of the single and double pass SAHs was increased. The immediate and normal efficiency were higher with a 3 cm Channel structure than with channel structures of 5 and 7.5 cm for a similar air mass stream Rate and a fixed number of baffles. For both the single and double pass SAHs, the temperature distinction between the Outlet stream and surrounding decreases as the air mass stream rate expanded for similar Channel structure and number of baffles. The temperature rise expanded with the Number of baffles for a similar channel structure and air mass stream rate. The Temperature rise was higher with five baffles than three baffles. Diminishing the channel structure of the primary pass expanded the temperature rise at the same air mass stream rate and number of baffles. The most extreme temperature rise got in this work for the single and double pass SAHs were 45.6 and 54.6 °C, respectively. At the base wind current pace of 0.011 kg/s with five baffles and a Channel tallness of 3 cm. The temperature changes with a channel tallness of 5 cm Were 44.7 and 50.1 °C, individually. With a 7.5 cm channel tallness, they were 36.3 Also, 49.8 °C, separately. As study, the temperature rise expanded with an increment in the quantity of baffles or reduction in the lower channel structure at a similar air mass stream rate. The present study showed that the proposed SAH configuration gives enhancements compared with a traditional SAH. These enhancements are expected to the utilization of stuffed wire layers and cross over baffles as an option in contrast to the absorber Sheet and the low bed structure (3 cm). The thermal efficiencies for the single and double pass SAHs in the current work showed an improvement contrasted with the conventional SAHs. The outcomes that the proposed configuration created significant, enhancements in the thermal efficiency and outlet air temperature.

Future Work

For future investigations, the plan should be performed on software program prior any trial work to recognize the weak spots and streamline the plan to Decrease the costs and time. Additionally, the hypothetical work can likewise measure up with the trial work. The efficiency lost due to the coating face of the arrangement can be diminished by expanding the space between the principal network layer of the mesh and the coating cover. More investigation is required for the new course of action of cross section layers to decide the impact on the power source temperature, heat transfer rate, and efficiency. Analyses can likewise be led with various quantities of cross section layers to acquire the best plan with the least cross section layers to diminish the pressure Drop and improve the results.
REFERENCES