International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622
International Conference On Emerging Trends in Mechanical and Electrical Engineering
(ICETMEE- 13th-14th March 2014)

RESEARCH ARTICLE OPEN ACCESS

A Review of Experiment study & analysis of solar air heater.

Nishant sharma
ME (Heat Power) student ,Jabalpur Engg.College Jabalpur, (M.P.)
Email id:nishant_24aug@rediffmail.com

ABSTRACT
A new technique was developed to enhance the heat transfer more than with fully developed turbulent flow set rectangular plate fins are used in heat exchangers. They alternate with the periodically interruptions. The fluid homogenization depends on the length of interruption and new velocity and thermal boundary layers were developed at each encountered ,set fin located downstream of interruption. Many years since the enhancement of the thermal heat transfer in different systems. When the air systems are employed for the needs of heating or drying ,inexpensive materials are used and one does not fear the inopportune leaks of circuit ,like that encountered by using the water.
Key word; - Air inlet ,Air outlet , Aluminum plate ,Temperature

I. Introduction

Solar air heating collectors are one of the better solar projects. They are easy to build, cheap to build, and offer a very quick payback on the cost of the materials to build them. They also offer a huge saving over equivalent commercially made collectors.

Two of the more popular designs are the pop can collector and screen absorber collector. The pop can collector uses columns of ordinary aluminum soda pop cans with the ends cut out. The sun shines on the black painted pop cans heating them, and air flowing through the inside of the can columns picks up the heat and delivers it to the room. The screen collector uses 2 or 3 layers of ordinary black window insect screen as the absorber. The sun shines on the screen and heats it, and the air flowing through the screen picks up the heat and delivers it to the room.

II. Literature review

By research paper, The system productivity is increased up to 8% by using a double-pass solar air heater compared to a singlepass solar air heater and decreased about 30% without double-pass solar air heater under the same operating conditions. Significant development on the productivity of the system is achieved by increasing the humidifier inlet water and air mass flow rates. At a constant water mass flow rate, however, the productivity of the unit increases with the increasing of air mass flow rate to an optimum value and decreases after that value. In addition, theoretical results indicate that there is a significant improvement on the system performance as the inital water temperature and water mass in the storage tank is increased. Moreover, increasing the cooling water mass flow rate and decreasing its temperature lead to appreciable improvement on the unit productivity

III. Collector Basics

There is a lot of not so good information out there on what makes a good solar air heating collector design, so I thought I would include a little info on solar air collector physics, what makes for a good design, and how one can measure and compare collectors accurately. If you are an old hand at this stuff, just skip this section.

On just about all solar thermal collectors, the sun shines through the glazing, and hits the collector absorber heating it. The air flows through the inlet and over or inside or through the absorber picking up heat as it goes. This heated air then flows out the collector outlet and into the room being heated. The main differences between air heating collector designs have to do with how the air flows over the absorber.

In full sun, the incoming solar energy is about 1000 watts per square meter of collector area. Of this 1000 watts/sm, about 10% is absorbed or reflected by the glazing and never gets to the absorber. Of the remaining solar energy, about 95% is absorbed by the absorber. So, for the 1000 watts/sm that arrive at the collector face, about 850 watts/sm end up actually heating up the absorber.
Most of this 850 w/sm that made it into the absorber end up going down one of two paths:: one part is picked up by the air flowing through the collector and ends up heating the room, and the other part ends up being lost out the glazing. The

job of the collector designer is to maximize the first part and minimize the 2nd part.

IV. The heat output the collector can be calculated as:

Heat Output = (Temperature Rise)(Airflow)(air density)(specific heat of air)

Temperature rise is the increase in air temperature from the inlet to the outlet of the collector -- often around 50 to 60F for well designed collectors. For example, air might enter at 65F and exit at 120F.

Airflow is the volume of air flowing through the collector expressed in cubic ft per minute (cfm) -- often around 3 cfm/sqft of collector area for well designed collectors.

Air density and Specific Heat are physical properties of air that you don't really have any control over -- air density is 0.075 lbs per cubic foot under standard conditions, and the Specific Heat of air is about 0.24 BTU per lb per degree F.

Its very important to note that the heat output depends on BOTH the Temperature Rise and the Airflow. Many of the videos out there talk only about temperature rise as though that is all that mattered, when it fact its only half the story. It is quite common for a collector to have a very high temperature rise and have a low heat output because the airflow is much to low.

There is a tendency to think that things that increase the collector temperature rise will improve the efficiency of the collector, but, in general, the most efficient collectors will have a temperature rise that is just enough to be used for space heating and an airflow that is relatively large. The reason for this goes back to that portion of the heat that the absorber takes in that ends of being lost out the collector glazing. You want to minimize those glazing losses, and an important way to do that is to keep the absorber temperature as low as possible -- the cooler the absorber runs, the less heat will be lost out the glazing. A way to keep the absorber cooler while extracting the same amount of energy from it is more airflow.

On solar air heating collectors, it is relatively easy to get most of the suns energy into the collector absorber. The difficult part of air collector design is getting the heat transferred from the absorber into the air. Air is a low density material with a low specific heat, and that makes the heat transfer from absorber to air difficult. The things that tend to help in the transfer of heat from the absorber to the air stream are a high volume of airflow, a lot of absorber area, and good and even airflow of high velocity air over the full surface of the absorber. All of these things help to efficiently pick up heat from the absorber, and to keep the absorber at a cooler temperature so that losses out the glazing are minimized.

The good characteristics of the pop can collector from an efficiency point of view are that it has a lot of absorber area (about Pi times what a flat plate would have), and it has a mixed flow of relatively high velocity air through he can columns. The good characteristics of the screen collector are that the thousands of strands of screen wire provide a lot of screen to air heat transfer area, and that the inlet and exit vents are arranged such that the airflow is required to pass through the screen to get from the inlet to the outlet.

While there are no hard and fast rules, a temperature rise through the collector of about 50 to 60F works well in that is is warm enough to feel warm coming out of a heater vent. If the room temperature is 65F, than the collector outlet temperature will be about 120F. Moving air that is much cooler than this will not feel warm. Going for a temperature rise greater than 60F usually means a hotter collector absorber and increased heat loss out the glazing.

Airflow through the collector of around 3 cfm per sqft of collector area for a collector with a well designed absorber is about right. More airflow would make the collector more efficient, but it also increases noise and fan power, and may lower the temperature rise to the point where the air does not feel warm to people for space heating. The about 3 cfm per sqft of absorbers seems to be a good compromise between efficiency and the other factors.

V. Measuring Performance

Even though solar air heating collectors have been around a long time, it seems there are still significant design improvements that can be made to both performance and cost/labor of construction. This seems like a very interesting and worthwhile area to work on.

If you do want to work on an improved air collector design you must have a way to measure performance so you know if the changes you are making actually improve efficiency or not. Its fine to speculate on what might help, but if you don't measure the actual performance carefully, you really don't know if a change helps or hurts performance. Right now, when you look across Youtube etc., it seems like we have a lot of speculation and not a lot of careful measurement going on. Its not that difficult or expensive to do side by side tests of collector designs and to measure the performance.

Measuring the absolute performance of a collector is difficult. A collectors performance depends on its design, but is also influenced by solar intensity, ambient temperature, wind and collector orientation -- all things that vary quite a bit from day to day and even minute to minute. One way to get around most of the variations is to test a baseline or reference collector side by side with the collector you are making changes to. If the two collectors are side by side, then they see the same ambient temperature, the same solar intensity and the same wind. If you make a change to your test collector and it performs better relative to the reference collector, than you can be sure the change you made was a good one.

VI. Materials

There are two common methods used to create a solar air heater. The first is a pop can design and the other directs the air through a channel in a "snake" pattern. Both methods use similar materials and tools with only a few exceptions.

Both designs require the following materials: [3] [4]

- Plywood
- Wood - 2"x4"
- Glass or plexiglass
- Sealant
- Insulation
- Black paint
- Aluminum "L" trim
- Screws
- Drill

To build a "snake" design, a piece of sheet metal for the base would help increase thermal mass and improve heat transfer to the passing air. Also, sand paper may be required.

Alternatively, building the pop can design requires a large number of pop cans and either a mortar or glue to connect the cans.

VII. Three basic forms of solar air heaters Pop Can Design

1. Determine the dimensions of the unit and build a box for the number of rows of cans and to include insulation along the walls.
2. Build the box to act as a base structure for the air heater. It can be built using 2" x 4" beams and plywood can act as the bottom
3. Drill a hole at the top of the unit and at the bottom, make an equal number of holes as rows of cans (In the 2" by 4") to act as the inlet and outlet streams for the air. The holes should be the same size as the opening of the cans
4. The box should be sealed along all edges to prevent air leaking out of the system
5. Insulation can be added to reduce the amount of heat leaving the unit. The insulation is placed along the inner walls and a second application of sealant can be applied along the edges
6. Wash the aluminum cans and then drill holes into the bottom of the aluminum cans or the tops and bottoms can be cut off
7. Paint the box and cans black with a matt coating.
8. Connect the cans in a row using glue (Tops connected to bottoms usually fits best)
9. Attach the rows of cans to their respective positions in the box and add sealant around the air intake holes
10. Place the sheet of glass or plexiglass on the top of the unit to complete the box and enclose the system. Fasten the material using the aluminum "L" trim.

VIII. Conclusion

heat transfer between the absorber plate and the air stream reduces sensibly the temperature of the absorber and in same time the heat losses are reduced. collector the double glazing gives lower thermal performance than the triple glazing this is due to the heat losses towards the surroundings.

Reference

[1] J.A. Duffie and W.A. Beckman, Solar Thermal Engineering, Wiley Interscience, New York, 1991
[2] E. Chafik, A new seawater desalination process using solar energy. Desalination, 153 (2002) 25–37
[3] H.E.S. Fath and A. Ghazy, Solar desalination using humidification-dehumidification technology. Desalination, 142 (2002) 119–133.
[4] A.S. Nafey, H.E.S. Fath, S.O. El-Helaby and A.M. Soliman, Solar desalination using humidification-dehumidification processes. Part I. A numerical investigation. Energy Conversion and Management, 45 (2004) 1243–1261.
[5] A.A. Mohamad, High efficiency solar air heater. Solar Energy, 60 (1997) 71–76.
[6] A. Ghoneyem and A. _Ileri, Software to analyze solar stills and an experimental study on the effects of the cover. Desalination, 114 (1997) 37–44.
[7] H.–M. Yeh, C.–D. Ho and J.–Z. Hou, Collector efficiency of double-flow solar air heaters with fins attached. Energy, 27 (2002) 715–727.