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Solar Air Heater

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Abstract--Energy demand is one of the most threatening problems arising now days. This can be resolved by usage of renewable energy resources. Solar energy is an ultimate renewable energy resource that nature has offered. Solar energy is nothing but the heat energy, light energy and radiation coming from the Sun. This solar energy is used in numerous heating and electrical applications. In Solar heating applications the energy from the sun is mostly utilized in heating the fluids. Solar water heaters deal with heating water. Whereas our project deals with heating of air (atmospheric) which is nothing but solar air heating. Our project is titled as 'SOLAR AIR PRE-HEATER' or 'SOLAR DRYER'. This solar air heating reduces the fuel consumption to about 50%. This technique is capable of preheating the fresh air and it improves the indoor air quality. With the less installation and maintenance cost this offers high efficiency. Apart from everything, this technique reduces the emission of Co2 in the atmosphere.

Solar air heater is a solar thermal technology in which the radiation from the sun is captured by an absorbing medium and used to heat air. Solar air heating is a renewable energy heating technology used to heat or condition air for buildings or process heat applications. It is typically the most cost-effective out of all the solar technologies, especially in commercial and industrial applications. In our project, the heating efficiency of the collector is influenced by three important factors. One is the transmittance of the Glazing medium or material which absorbs the radiation (Light energy) from the sun. The second one is Black body absorption of the metal duct. Also, since we are going to heat up the air passing through the duct. Hence the geometry and the design is the third influence of the efficiency of the product (DRYER).

I. INTRODUCTION

Solar heat collectors are broadly classified into two types. They are Unglazed solar collectors and Glazed solar collectors.

A. Unglazed Solar Collectors

The term "Unglazed air collector" refers to a solar air heating system that consists of a metal absorber without any glass or glazing on the top. Unglazed_collectors have existed for over 20 years and were originally used in industrial applications, gradually broadening to other commercial and larger scale applications. **Unglazed Solar Collectors** are primarily used to heat ambient air and not building air. These only require one penetration into the building, or if existing fan inlets are used, then no additional penetrations are necessary. Heating ambient air allows solar energy to be utilized whenever the temperature in the collector is above ambient, not room temperature. This can provide twice the solar energy gain over space heating designs. The efficiency of a solar collector is highest when the temperature of the air entering the solar panel is equal ambient temperature. This occurs with solar heaters that draw outside air into the solar heater instead of room air. The air circulates through the building's conventional ventilation system deriving from the negative pressure under which it is drawn from the outside. There are two types of unglazed panels, perforated (transpired collector) and non perforated. It has been shown that unglazed systems can meet up to half of conventional heating load and that RET Screen is an accurate tool for predicting of system performance. There is no maintenance required over the technology's 30 years life span approximately. A hybrid variation exists by which transpired collectors are combined with solar PV. The unglazed system acts as the solar panel's mounting structure, removing the heat from the panel. This increases the performance of the PV system and makes use of otherwise wasted heat for heating purposes.

Unglazed collectors are usually made of black plastic that has been stabilized to withstand ultraviolet radiation form sun. Since it is made without glazing a large portion of sun's energy is absorbed. However it not insulated a large portion of heat is lost particularly when it is windy and not warm outside. They transfer heat so well into air (and from air) that they can actually capture heat during night when it is warm and windy outside.

B. Glazed Air Collector

In "Glazed air collector" an absorbing medium is used in addition to the metal. This absorber could be a polymer glass for absorbing the radiation from the sun. Through the use of an energy collecting surface to absorb the sun's radiation, and ducting air to come in contact with the heated up metal surface, a simple and effective collector can be made for a variety of air conditioning and process applications. In contrast to unglazed solar air collectors' functioning based on exterior air, "Glazed collectors" provide heat through the re-circulation of existing building air. There are three general types of glazed collectors, which differ in the way air is ducted: through-pass, front-pass, and back pass collectors (or a fourth alternative is a combination of front and back collectors).All types consist of an absorber material as the basis for heat transfer and the heated air is ducted to where it is needed.

A simple solar air collector consists of an absorber material, sometimes having a selective surface, to capture radiation from the sun which heats up the metal surface via radiation and transfers this thermal energy to air via convective heat transfer. This heated air is then ducted to the building space or to the process area where the heated air is used for space heating or process heating needs.

1) Types of Glazed Air Collectors: Flat plate collector, Evacuated tube collector

II. LITERATURE REVIEW

There is a lot of not so good information out there on what makes a good solar air heating collector design, so we thought we 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. 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/sq m, 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/sq m that arrive at the collector face, about 850 watts/sq m end up actually heating up the absorber. Most of this 850 w/sq m 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. It is very important to note that the heat output depends on both the Temperature Rise and the Airflow 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 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 the 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 warm enough to feel warm coming out of a heater vent. If the room temperature is 65F, then 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 sq ft 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 sq ft of absorbers seems to be a good compromise between efficiency and the other factors.

A. Classification of Evacuated Tube Collectors

According to the air flow path the Evacuated tube collectors can also be classified into several types as follows.

Through-pass collectors,
Front-pass,
Back pass,
Combination front and back pass collectors.

1) Through-Pass Air Collector: In the through-pass configuration, air ducted onto one side of the absorber passes through a perforated or fibrous type material and is heated from the conductive properties of the material and the convective properties of the moving air. Through-pass absorbers have the most surface area which enables relatively high conductive heat transfer rates, but significant pressure drop can require greater fan power, and deterioration of certain absorber material after many years of solar radiation exposure can additionally create problems with air quality and performance.

2) Back, Front, And Combination Passage Air Collector: In back-pass, front-pass, and combination type configurations the air is directed on either the back, the front, or on both sides of the absorber to be heated from the return to the supply ducting headers. Although passing the air on both sides of the absorber will provide a greater surface area for conductive heat transfer, issues with dust (fouling) can arise from passing air on the front side of the absorber which reduces absorber efficiency by limiting the amount of sunlight received.

III. REQUIREMENTS AND THE IMPORTANCE OF THE COMPONENTS USED

List of components:
Beverage cans
Plywood of required dimensions
CPU case cooler fan
Aerosol paint spray
Colorless Acrylic sheet for Glazing
Silicone sealant

A. Beverage Cans

These beverages cans are chosen for our product mainly because of the reason that these cans are made of Aluminium material. After iron, aluminium is now the second most widely used metal in the world. Some of the important properties of the Aluminium includes low density and therefore low weight, high strength, superior malleability, easy machining, excellent corrosion resistance and good thermal and electrical conductivity. Aluminium is also very easy to **recycle.** These cans are not only made of aluminium but the alloy containing 92.5% to 97% aluminium, 5.5% magnesium, 1.6% manganese, 0.15% chromium and some trace amounts of iron, silicon and copper according to MSDS from aluminium producer Alcoa. Also the dimension of the cans influence the heat transfer. The thickness of the beverage cans available are very small to about 0.11 mm to 0.76 mm which is very thin and allows more heat to transfer. These are cans are also very light in weight which is about 13.5 gms in average.

B. Plywood

We have used the plywood of thickness 13 mm. The plywood should not be too heavy as it is just the base or box which contains the air flow duct. And at the same time it should be of considerable size and weight to provide proper insulation and also protection for the cans from outside environment. The number of Plywood plates and their dimensions and also the holes needed to be drilled in those holes depends upon the collector design.

C. CPU Case Cooler Fan

CPU case cooler fan is one of the major components for the air collector. This fan is conventionally used in the case of the CPU of

computer for circulating air and maintains the case of the CPU cool because more heat will be generated inside the CPU case while working. This cooler fan is used in our collector at the inlet and the exhaust sides both for the suction of the atmospheric air inside the duct and also for the exhaustion of the air outside the collector which is nothing but our output. Some of the important requirements of the cooler fan include the high airflow rate, high maximum speed (rpm), minimum Power requirement and reduced noise and vibration. These requirements are fulfilled from the design of the fan as follows.
Ultra-thin yet rigid blades generate high airflows that reach up to better CFM. Steel threaded rubber pads absorb fan vibration and keep the noise down. Two silent mode adapters let us fix the fan speed for quietness and performance. POM (Polyoxymethylene) is an extremely rigid and abrasion resistant compound, which reduces vibrations, noise and results in an incredible life expectancy. This POM bearing material must be used in the cooler fan for high stiffness, low friction, long life and also dustproof. Cooler fan with above mentioned feature works incredibly with the optimum power from a DC battery. The specifications of the cooler fan we used is as follows.

D. Aerosol Paint Spray
Aerosol paint (also called spray paint) is a type of paint that comes in a sealed pressurized container and is released in a fine spray mist when depressing a valve button. A form of spray painting, aerosol paint leaves a smooth, evenly coated surface, unlike many rolled or brushed paints. Standard sized cans are portable, inexpensive and easy to store. Aerosol primer can be applied directly to bare metal and many plastics. Particularly this spray paint is used in the Air collector for the matt finish. It is to be ensured that the color is black because we are going to convert the Aluminium air duct in to a black body for radiation absorption which is essential for the solar air collector.

E. Acrylic Sheet for Glazing
Acrylic sheets are colorless polymer sheets made of PMMA (Poly methyl methacrylate). It is a crystal clear (with a transparency equal to optical glass), lightweight material having outstanding weatherability, high impact resistance, good chemical resistance, and excellent thermo-formability and machinability. The properties of this polymer sheet and its behavior of light transmittance plays a major role in the Solar air collectors.

F. Visible Light Transmittance
In colorless form, Plexiglas sheet is as transparent as the finest optical glass. Its total light transmittance is 92%, and haze measurement for colorless Plexiglas sheet averages only 1%. The wavelengths of visible light fall between approximately 400 and 700 nanometers in the electromagnetic spectrum. Electromagnetic energy reaching the earth from the sun is rich in these wavelengths, tapering off in the ultraviolet and infrared regions. When light energy strikes colorless Plexiglas sheet perpendicular to the surface (0 degree angle of incidence), most are transmitted, part is reflected at each surface, and a negligible fraction is absorbed. The theoretical maximum transmittance of a non-absorbing optical medium depends on its refractive index. Plexiglas sheet has a refractive index of 1.49. The calculated theoretical maximum light transmission for such a medium is 92.3%. Actual measurement shows that colorless Plexiglas sheet as thick as six millimeters (0.236") transmits 92% of perpendicular rays. This represents virtually all the light that could be transmitted by a perfect optical medium of this refractive index. Approximately 4% of the incident perpendicular rays are reflected on passage through each surface of colorless Plexiglas sheet, giving a total reflectance loss of approximately 8%. As the angle changes, reflectance increases and the transmittance decreases. In all ordinary thicknesses, the light absorbance of colorless Plexiglas sheet is not significant. Even at a thickness of one inch, absorbance is less than 0.5%.

G. Silicone Sealant
Silicone sealant is a special type of bonding material which made especially to avoid the leakage of air and heat dissipation. May be it is not very good at Gluing property so that we could use Fevicol for gluing. But in addition to that for sealing purpose it is essential to use the silicone sealant for like sealing the cans, closing the air gaps in the edges of the plywood box and for sealing any other gap in the setup. Initially it will be in gel like texture. After drying it changes to a rubber like texture which is rigid enough to seal the air (hot air) inside the setup. Particularly silicone sealants are chosen for its following properties. The main advantage of silicones over other materials is their long-term performanceThe adhesion will not weaken with exposure to either moisture or to UV irradiation. And the mechanical properties (elasticity, tensile strength, ultimate elongation and tear resistance) of silicone rubber do not change at low temperatures. They stay flexible even at -20°C or lower. Also some more properties such as chemical

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resistance, water resistance, transparency, durability, water and gas permeability helps us for perfect sealing of our air collector. The particular sealant we employed is ANABOND-RTV 666 (Appearance (uncured) : Clear/White/Black, Flow properties : Non-sag, Elongation % : ≥350 Hardness, Shore A : 22 – 30 Dielectric Strength Kv/mm : ≥22, Temperature resistance : -50°C to +250°C).

IV. BUILDING POP CAN COLLECTOR

The building of pop can collector involves the following steps.

A. Collecting the Cans

If we drink pop or beer, this is not really a problem for us but, we don't. We needed to find a source of intact cans. Recycling places are a place to start. Some civic organizations collect pop cans for recycling and happy that they let us to sort through for the intact ones and sold them to us.

B. Cleaning the Cans

The cans typically have some residue and need to be cleaned. Most people just use soapy water for this. The soap must be rinsed off.

C. Cutting out The Top of the Cans

This requires more skill and effort than it might seem at first. First, break the tabs off. To open the top up, we just used tin snips to make radial cuts in the top of the pop can. Each cut starts at the drinking hole and extends outward toward the can rim. I we bent the resulting pieces out toward can walls by first pushing the can down on a pipe, and then bending the pieces out with a gloved hand.

D. Cutting out The Bottom Of The Cans

First the bottom ends of the cans are drilled with the hand drilling machine. Then made a large hole at an eccentric point. Then with the use of tin snip we made a radial cut at the bottom of the can.

E. Painting the Cans

The cans are painted with the aerosol black spray paint. We ensured that it give matt finish for better absorption of radiation.

F. Gluing the Can Columns

To glue the cans into straight columns we needed some kind of form to place the cans in while the glue sets. We used a couple of boards nailed together to form a "V". First can is kept in the position with the top pointing up. A bead of glue is applied around the bottom of the 2nd can and presses it down onto the first can. This process is repeated until all the cans for one can column have been glued. For glue, we used silicone sealant. It is a good high temperature material that remains a bit flexible and does not stink or outgas after its initial cure. It should be ensured that the cans must not only be glued together but also be sealed together to avoid air leakage.

G. Building of plywood box

Initially a 13 mm thick plywood is chosen for the entire box. The base plate is of 1041*488.5 mm. Then two numbers of side plywood frames of dimension 1015*57.5 mm is taken. Two plywood frames of dimension 488.5*57.5 mm is taken for top and bottom frames. For inlet and outlet manifolds two numbers of plates with dimensions 145*57.5 mm and 132*57.5 mm is taken. The base plate is drilled to 80 mm diameter at diagonally opposite positions near the two corners for inlet and outlet passages. The top and bottom frames are drilled to 30 mm diameter at spacing according to the flow passages of air. All the frames are attached to the base plate according to the design. The dimensions of the plywood box purely depends on the dimension of the fan, dimension of the can and the number of cans being used. The dimension of the case cooler fan we have used is of (80*80*25). The beverage (Al) can which we have chosen is of 57.5mm outer diameter and 14.5 mm height.

H. Cooler Fan Attachment

Two cooler fans are nailed to the back side of the base plate in the drilled holes of inlet and outlet passage for the suction and

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exhaust of the air.

I. Fitting of Pipes

The pipes for the air flow passage are fitted and sealed to top and bottom frame of the plywood box in the holes according to the design.

J. Arranging the Can Columns

The sealed pop can columns are arranged in the box setup according to the design of air flow. Out of 5 columns there are 7 cans each in the middle three columns and there are 6 cans arranged in the end columns with the spacing provided for the attachment of cooler fan for the inlet and outlet. These cans are sealed perfectly to avoid leakage.

K. Glazing

A PMMA (Poly methyl methacrylate) commonly known as Acrylic sheet which is transparent for absorption of solar radiation of base plate dimension is sealed at the top of the setup.

L. Mounting with A Proper Angle

With a proper support the Solar Air Collector is mounted with proper angle of inclination to horizontal which is calculated for the latitude of the particular region to utilize the solar radiation the whole year.

V. DESIGN IMPROVEMENT

Among the above discussed types of the Solar Air collectors our project (Solar Air Dryer) falls under the category of Glazed type evacuated tube collector. To obtain the required heat output and improve the efficiency that too to obtain the same within the limited cost estimated we have modified and improved the basic design of the Solar Air Collector.

A. Design of Airflow Path

As we know that not only the temperature but also the airflow is important to obtain the required output we have installed two fans. One at the inlet and the other at the outlet. These fans are installed is such a ways that air from the inlet till the outlet is forced in the same direction without any distraction.

B. Design of Air Duct Arrangement

As in conventional model we haven't imposed the common inlet and common outlet for a number of duct columns. In our model we have installed the duct (series of cans) for the air flow in a snake like model or it can also be mentioned as a Zig-zag model where the Air enters the inlet of the duct which is at the one end (top end) of the collector box and travels through the Zig-zag path of the air flow duct and leaves the outlet of the duct which is at the other end (bottom end) of the collector box.

C. Imposing Turbulence in the Flow

When the Zig zag arrangement of cans in series came into picture a question may arise that why couldn't we simply use the flexible Aluminium pipe for such (Snake) arrangement. But to improve the heat outlet and efficiency of the air one of the useful key technique that can be imposed is TURBULENCE. Creating Turbulence in the airflow path can be well implemented in the cans rather than in single flexible pipes. Because at the beginning and the end of each can in series there will be a change in cross-section. And also by imparting different shapes while removing the material of the can at bottom and top the turbulence can easily be created in the air flow.

D. Mounting Angle

The next thing to be decided is the installation of the collector. This installation not only mean installation with respect to the working area but also with respect to the effective sun rays as our project is truly dependent on solar radiation.

First we will discuss on the installation with respect to the effective sun rays that we have imposed.

Solar panels should always face true south if you are in the northern hemisphere, or true north if you are in the southern hemisphere.

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True north is not the same as magnetic north. If you are using a compass to orient your panels, you need to correct for the difference, which varies from place to place. The next question is, at what angle from horizontal should the panels be tilted? Books and articles on solar energy often give the advice that the tilt should be equal to your latitude, plus 15 degrees in winter, or minus 15 degrees in summer. It turns out that you can do better than this - about 4% better. If your latitude is below 25°, use the latitude times 0.87.
After the perfect installation of the air collector and giving supply to the case cooler fans they rotate and tend to trap the atmospheric air into the collector box. As mentioned earlier the fans both at the inlet and exit are fixed in such a way that air is forced in the same direction from the inlet till the exhaust. After the air is trapped inside it starts passing through the air flow duct made by combining a number of Aluminium cans. At the same time since our collector is exposed to sunlight the sun's energy (light or radiation) is being absorbed by the Glazing made of acrylic sheet which is the top for the collector box. And then this radiation energy is being absorbed by the collector duct surface as it is coated with black (matt finish) paint. So it is very clear that a very important radiation phenomenon BLACK BODY ABSORPTION is taking place in here. Now it is essential to discuss about the black body absorption.

E. Black Body Absorption

Heat transfer through radiation takes place in form of electromagnetic waves mainly in the infrared region. Radiation emitted by a body is a consequence of thermal agitation of its composing molecules. Radiation heat transfer can be described by a reference so-called 'black body'**.**

VI. THERMAL ANALYSIS

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. Measuring the absolute performance of a collector is difficult. A collector's performance depends on its design, but is also influenced by solar intensity, ambient temperature, wind and collector orientation all the things that vary quite a bit from day to day and even minute to minute. It is needed to measure the inlet and outlet temperatures of each collector and the airflow through each collector. Changes that increase the product of the airflow times the temperature rise improve the heat output of the collector.

A. Measurement for Testing

Thus for testing the performance of the collector the following parameters need to be measured:
Temperature measurements
Air flow measurements
Power supply from Battery

For measuring and testing the performance of the collector first we let the Air Heater to operate in a perfect whether suitable for testing process for sometime say one hour. Then the temperature at the inlet and the exhaust are measured with the Thermometer. And then the air flow measurement is taken with the help of an anemometer. After these measurements are taken the testing of performance is carried out based on the Heat output. The heat output can be calculated with the formula as follows.

HEAT OUTLET = (T raise) (Flow rate) (Density of air) (Sp. Heat)

[Unit: J/s (or) W]

Where,

Flow rate = Flow velocity (m/s) * Area of duct (m^2)

[Unit: m^3/s]

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T raise – Temperature raise in Kelvin

Density of air is in Kg/m^3 [(1.2013) Kg/m^3 for Avg temperature of air]

Specific heat of air is constant [(1004.64) J/kg.K]

VII. APPLICATIONS OF SOLAR HEATER

In this session we are going to discuss about the various areas where this Thermal air collector are being used and could be used.

A. Room Heating Applications

This is the ultimate application of the Thermal air collector. The solar air heater installed either on the walls or roof of the house or a building circulates hot air inside the building and maintains the warm environment. This application is mostly used in houses in cold regions.

B. Moulding Sand Dryers In Foundaries

Generally moulding sand after usage will have the moisture content of additives which are added for the processing of the sand. After the sand has been used for moulding this sand can be reused only if it is dried. Conventionally high power rotary type dryers which works on electricity is being used. So we suggest that this Solar Air Heater which produces very low power compared to these Rotary dryers can be used for drying the moulding sand in small scale industries. This saves more amount of electrical energy as the source is solar energy.

C. Tea Dryers

In Tea industries before processing, the leaves has to be dried to remove the moisture content. So similar to the Sand dryers rotary type dryers are being used in tea industries which consumes more power (electricity). So we suggest these Tea dryers can also be replaced with the Solar Air Dryers for drying the tea leaves in small scale production.

D. Laundry Applications

In laundries after washing the clothes they are being dried in electric dryers. We suggest with a proper equipment design the Solar Air Heater can be used as a source of hot air in these cloth dryers.

E. Sterile Environment

This application is similar to that of the room heating application. Some typical chemical products are required to be maintained in a warm sterile environment to avoid the changing of physical and chemical properties of some peculiar chemical products which are used for selective applications.

F. Grain Drying Applications

Grain drying is process of drying grain to prevent spoilage during storage. And also some of the grains, pulses and nuts can be used commercially only after they are dried. In large industries machines which work on electricity are used. Whereas in small scale industries large amount of wood are burnt as a source for heating and drying. Thus we suggest that for this process also Solar Air Dryer can be used as the source of drying.

VIII. CONCLUSION

After discussing a lot of information about the Solar Air Heater we came to the following conclusions. This technology works purely on solar radiation which is a renewable source of energy. This technique is completely eco-friendly. A large amount of fuel and electrical energy can be saved by fully utilizing this technology. Better timing of solar heat with usage of thermal wall. When there is no sunshine heat is released from the wall. This reduces the wastage of energy. In comparison with water collectors no chemicals for antifreeze are needed and in case of damage they do not cause any loss for the environment. They can cooperate with HVAC systems, for example for preheating air. One of the advantages of the pop can collector is that solar radiation striking the front of the can is transferred through the can walls around to the back of the can, and this provides more heat transfer area for the can to heat the air flowing through it. But, this is only true if the heat is actually transferred around to the back of the can. This technique is cost effective in both installation and in maintenance. It is very complicated and tedious to install the Solar Air Heater in a perfect place. This requires more skill. For higher power requirement more space is needed for large surface area of the set-up. Less heat output is obtained in comparison with the Solar Water Heater.

Thus apart from any pros and cons this Solar technology will surely survive as an eco friendly system which enables the energy consumption.

REFERENCES

[1] *Hollick, J. C (2009) "Commercial scale solar drying" published in International Journal of Engineering Trends and Technology (IJETT).*

[2] *L. H. Gunnewiek, E. B., K. G. T. Hollands (1996) "Flow distribution in glazed transpired plate solar air heaters of large area".*

[3] *L. H. Gunnewiek, K. G. T. H., E. Brundrett (2001) "Effect of wind on flow distribution in glazed transpired-plate collectors".*

[4] *Sadegh Motahar, A. A. A. (2010) "An Analysis of glazed Transpired Solar Collectors Based on Exergetic Performance Criteria".*

[5] *Summers, D. N. (1995) "Thermal simulation and economic assessment of glazed transpired collector systems".*

[6] *Choudhury C, Andersen SL and Rakstad T (1988) "A solar air heater for low temperature applications".*