Volume : 4 | Issue : 10 | Special Issue Oct- 2015 • ISSN No 2277 - 8179

Working Model of Solar Heat Pump

Engineering

KEYWORDS: Solar energy, solar collectors i.e. glazed solar collector, ventilation, heat transfer, selective surface, anti-reflectioncoating, and PV cells.

Bableet Dogra	Faculty – Mechanical Engg. Deptt., Chitkara University,Punjab India
Rupesh Gupta	Faculty - Mechanical Engg. Deptt., Chitkara University,Punjab India
Himanshu Jindal	Faculty - Mechanical Engg. Deptt., Chitkara University,Punjab India
Rajeev Kumar Dang	Assistant Professor, University Institute of Engineering & Technology, Panjab University SSG Regional Centre, Hoshiarpur

ABSTRACT

- In winter seasons, we felt cold. We need hotness for comfortable feeling. To obtain hotness we use electric heater, electric heat pump etc. it consumed large amount of electricity. Now days, electricity is very costly and production of electricity is very costly. Thermal plants use coal for production of electricity. Coal after burning, produce smoke and ash, which pollute the environment. In order to produce process heat for heating of buildings and re-generating dehumidify agent, solar energy is one of the promising heat sources for meeting energy demand without putting adverse impact of environment. So in our project we use renewable thermal energy i.e. solar energy which is pollution free, free of cost energy. Our project works as heat transfer device. It includes glazed solar thermal collector, recirculation fan, and duct. Solar collector collects sun radiations, it produce hotness in solar collector, in solar collector air flow through it and get heat up with thin boundary layer then it will duct in to space where hotness is required. Whenever temperature reached at desired condition it automatically break circuit of circulatory fan. Air is clean by filter providing at suction line. It is feasible, it is simpler in construction, it cheapest in use, it has long life durability. It aids in reduce of 50% heat load of electric heat pump when it use in industrial purposes. It is applicable in laundries, industries, hotels, schools & colleges where space heating required.

INTRODUCTION:

A Solar heat pump is a device that provides heat energy from a source of heat to a destination called a "heat sink". Solar Heat pumps are designed to transfer thermal energy by absorbing heat from Solar Radiations and release it to a colder one, and vice-versaA heat pump uses some amount of external power to accomplish the work of transferring energy from the heat source to the heat sink.

While air conditioners and freezers are familiar examples of heat pumps, the term "heat pump" is more general and applies to many HVAC devices used for space heating or space cooling. When a heat pump is used for heating, it employs the same basic refrigeration-type cycle used by an air conditioner or a refrigerator, but in the opposite direction - releasing heat into the air-conditioned space rather than the surrounding environment. In this use, heat pumps generally draw heat from the cooler external air or from the ground.

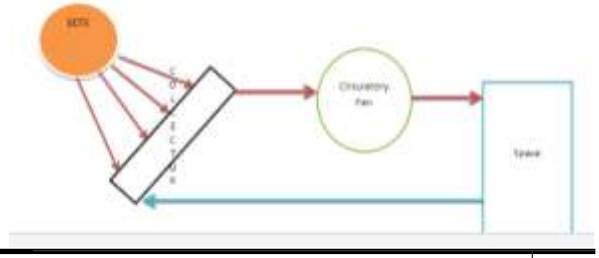
In heating, ventilation and air conditioning (HVAC) applications, the term solar heat pump usually refers to easily heat transfer devices optimized for high efficiency in both directions of thermal energy transfer. Heat spontaneously flows from warmer places to colder spaces. A soar heat pump can absorb heat from solar radiations and release it to a colder one, and vice-versa. "Heat" is not conserved in this process, which requires some amount of heat energy, such as solar energy. Solar air heating is a solar thermal technology in which the energy from the sun, solar insolation, 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, and it addresses the largest usage of building energy in heating climates, which is space heating and industrial process heating.

Solar air collectors can be commonly divided into two categories:
1. Unglazed Air Collectors or Transpired Solar Collector (used primarily to heat ambient air in commercial, industrial, agriculture and process applications)

2. Glazed Solar Collectors (recirculating types that are usually used for space heating) Adjustable stair climbing robot is one of the most attractive performances of robot in legged and wheeled. Developments have been made on various kinds of stair climbers, considering how to make its climbing ability higher and its mechanical complexity reasonable and practical. The research includes realizing a large step negotiating. Reducing body weight and energy consumption is also the important matter of developing. We introduce some solutions to realize stair climbing machines that we developed. Each of them has good performance as in a category of their kind, e.g. various numbers of wheeled shapes. Then, we discuss a development of adjustable high-grip mover, which we think one of the best solutions as the stair climber .A mechanism is a combination of rigid or restraining bodies so shaped and connected that they move upon each other with definite relative motion. A machine is a collection of mechanisms which transmits force from the source of power to the load to be overcome, and thus perform useful mechanical work. Robotics is the area of automation which integrates the technology in variegated fields like mechanisms, sensors & electronic control systems, artificial intelligence and embedded systems. The synthesis of mechanisms is the very first step in any robot design depending upon its application.

Working:

Schematic diagram shows the methodology for solar heat pump. Its method is simple. Solar energy is available in abundance. Sun radiation when incident on solar collector, it absorb radiation, these radiation gives hotness on absorber material in the collector then these heat conduct through absorber material. Air is passing through this absorber material; through convection it makes a thin thermal boundary layer with it. Air gets heat up and ducted into space.



Methodology:-

We can find many of the necessary materials lying about our home. We shall save money, recycle some aluminum tubes, warm up a room and keep our environment a little greener. This is great for winter days that are both sunny and cold, and, caulked, painted and under Plexiglas, it looks like a high-tech appliance, not a recycled project.

Step 1 -Collect Aluminum tubes

Depending on your rate of beverage consumption, this could be the most time consuming part of the project. We need 10 Aluminum tubes having length of 90cm. we are going to make 10 rows of aluminum tubes. These aluminum tubes act as the absorbing plate for our solar heat pump.

Fig 5.1

Step 2 – Make a Box

Now make a box using plywood for the back and 1x4 lumbers for the sides. The size of the box is dictated by the number of Aluminum tubes. An Aluminum tube is 1-inche high, 2-inches wide and 36 inches across length. Add 2 inches to the height of the box for air to circulate. So the box needs to be 7 inches high by 48inches across.

Cut the plywood to that size. Cut the 1x4s to fit the sides and top and bottom of the box. Glue 1x4s to the

plywood and then screw them in place. You're using glue and screws because you want it to be both secure and air tight.

Fig 5.2

Step 3 - Caulk and Stack

After assembling the box, apply adhesive caulk to all the joints to keep air from escaping. Make sure to use a caulk rated for high heat. Fit the aluminum tubes in the box, caulking them together as you go. Allow the adhesive to dry before proceeding to paint them.

Fig 5.3

Step 4 - Drill Holes and Add Hose

At the top of the box, drill a hole to fit the vacuum hose you will insert here. These hoses are usually 4 inches in diameter, so make the hole the size you need for your hose. The hose will disperse the heated air from the absorption plate. Make sure the hose is caulked and anchored to the of the box. In the bottom of the box, drill a hole through the base, matching up with the bottom of each stack. These will draw cool air into the box.

Step 5 - Paint Everything Black

Once the adhesive dries paint the aluminum tubes and exposed surfaces of the interior of the box with black spray paint. Again, use a product rated for high heat. This helps absorb the sun's energy. Paint the outside of the box too, to protect it from the elements.

Fig 5.4

Step 6 - Apply Plexiglass

Cut a piece of plexiglass to the dimensions of the box to make a cover. Set the plexy over the open side of the

box and caulk and screw it into place. Make sure it's air tight.

Volume : 4 | Issue : 10 | Special Issue Oct- 2015 • ISSN No 2277 - 8179

Step 7 - Aim It at the Sun

Now that the solar Heat pump is complete, set it in a place where it will capture the most sunlight. Keep the base off the ground to let cool air in. As the air rises through the stacks, it heats up. The warm air gathers in the gap at the top of the stacks and exits through the hose. Set the hose where you want to feel the warmth. The heat from the box radiates from the hose to warm your space. You may need to experiment with angling your new solar furnace to discover the best spot to capture the sun's rays. Having it mobile allows it to be set in the best position to capture the sun's light that, in turn can help heat a portion of the home or possibly a small work space in a garage or shed.

Assumed Data:

- Outside/Inside Conditions = 10° c, 60%RH
- Inside Conditions to be maintained = 25°c & 60%RH
- Vol. of Space room = 10*10*10= 1000 cu.ft
- Mass of Air circulation = 28.3166cu.m/hour.
- Enthalpies are = 20 KJ/Kg & 53 KJ/Kg

Heat Required, Q=Ma*H = [28.31*(53-20)] =934.89KJ/h
= 0.259KW Where, Ma is mass of air7

h is total enthalpy

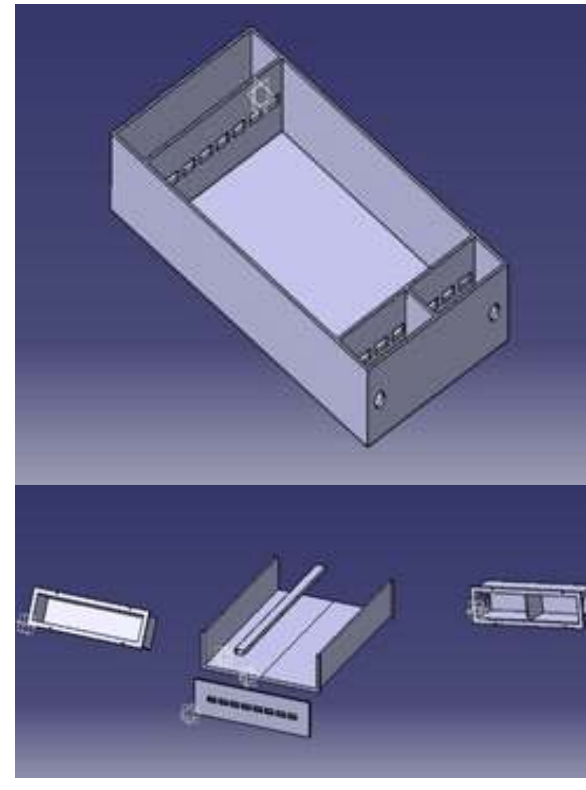
But our Design on 0.25*2 = 0.5KW or 0.15 Ton

Design Of solar collector

Solar Energy reaching the earth=782.77 w/sq.m
Diffused radiations=0.22*782.77=172.21 w/sq.m
Total radiations on collector= 782.77+172.21=955w/sq.m
Procted area= 0.8*.9*cos23=0.662 sq. m
Energy received by collector=955*0.662=632 watts or 0.632 KW
Hence it is applicable for 10 cu. Ft space

Software approach:

Our project is firstly made on CATIA software, where 3D model is made on it



Drawings:

Drawings are attached with it

Experimentation:

Experimental data: On 15 April 2014

Space 10ft*10ft*10 ft.

Time	Surface temp.(°c)	Temp. of Recirculate air(°c)		Ambient Temp. (°c)	Flow Rate of air M^3/h	Incident solar heat(W/m^2)
		Inlet	Outlet			
11:30am	75	28	40	32	28	650
11:35am	75	30	40	32.5	28	650
11:40am	76	32	43	32	28	660
11:45am	77	35	45	32	28	690
11:50am	77	36	45	32	28	680

Experimental investigation is conducted to study the performance of solar heat pump. The analysis includes development of correlations for the Solar Heat Pump and the Electric heaters for space heating. The Solar Heat pump includes Aluminum tubes solar thermal collector, re-circulatory fan, PV cells. The system is designed to allow for operation of a Space heating. The analysis is performed as a function of the Air-to-Air mass flow rate ratio and Sun Radiations. Also, comparison is made between the performance of the Solar Glazed thermal collector and same device as an Unglazed Solar thermal collector. Analysis of the collected data shows that the system efficiency increases at lower air to air ratios and higher Sun Radiation temperatures. The system efficiency for various configurations for the Glazed Solar thermal collector varies between 40% and 45%. Lower efficiencies are obtained for the Unglazed Solar Thermal Collector, with values between 20% and 30%. The highest efficiency is found for the solar heat pump followed by Glazed solar thermal collector.

Conclusion

By using solar heat pump for space heating we can reduce half electricity load from it by use during day time. Fan of solar heat pump consume only 11 watts/hour of electricity as comparatively electric heater consume 2 Kwh for heating element and 100 watts/hour of circulatory fan capacity, But our project consume only 11 Watts/hour for same heating capacity. Solar energy is renewable and free of cost energy. We can also reduce electricity cost of 11 watts by making system Hybrid. Photo voltaic cells convert solar thermal energy into electrical which directly used for running of fan. This will make system fully free of cost. It is maintenance free system and has a life up to 20 years for solar thermal collector and 7 years for PV cells.

Following suggestion can increase efficiency of system

- By makes System hybrid using Photo Voltaic Cells, it save energy by converting solar energy into electrical energy, these electrical energy can used to drive fan.

- By using selective surface of collector which is coating by combination of materials i.e. material is black copper oxide, black chromed copper, nickel coated copper and Multi layered PVD (physical vapour deposition) coating on absorber material.

Although ordinary black paint has high solar absorption, it also has high thermal emissivity, and thus it is not a selective surface.

- By using Anti-reflection coating on glass sheet, which is of dielectric material can increase efficiency of solar heat pump.

REFERENCE

www.wikipedia.com|http://www.doityourself.com|http://asmedigitalcollection.asme.org/journals.aspx|http://newsoffice.mit.edu/engineering|http://en.wikipedia.org/wiki/Heat_pump|http://en.wikipedia.org/wiki/HVAC|http://en.wikipedia.org/wiki/List_of_solar-powered_products|http://en.wikipedia.org/wiki/Talk:Solar_thermal_collector|http://techportal.eere.energy.gov/lab/NREL|www.solarwalls.com|Pan war NL, Kaushik SC, Kothari S. Role of renewable energy sources in environmental protection: a review. Renewable and Sustainable Energy Reviews 2011; 15:1513–24.|Thirugnanasambandam M, Iniyan S, Goic R. A review of solar thermal technologies. Renewable and Sustainable Energy Reviews 2010;14:312–22.