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Solar Operated Multi-Utility Cooler

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Abstract

The present air cooling methods are evaporative coolers, air conditioning, fans and dehumidifiers. But running these products need a source called electricity. The generation of electricity is ultimately responsible for hot and humid conditions i.e. global warming. In hot and humid conditions the need to feel relaxed and comfortable has become one of few needs and for this purpose utilization of systems like airconditioning and refrigeration has increased rapidly. These systems are most of the time not suitable for villages due to longer power cut durations and high cost of products. Solar power systems being considered as one of the paths towards more sustainable energy systems, considering solar-cooling systems in villages would comprise of many attractive features. This technology can efficiently serve large latent loads and greatly improve indoor air quality by allowing more ventilation while tightly controlling humidity. Despite increasing performance and mandatory energy efficiency requirements, peak electricity demand is growing and there is currently no prevalent solar air cooling technology suited to residential applications especially for villages, schools and offices. This project reviews solar powered air coolers for residential and industrial applications .

Keywords: Solar panel, Battery, Charging system, cooler body, PM DC Motor, wires , automation in product , air cooler , water cooler;

1. Introduction

This paper reveals the comfort conditions achieved by the device for the human body. In summer (hot) and humid conditions feel uncomfortable because of hot weather and heavy humidity. So it is necessary to maintain thermal comfort conditions. Thermal comfort is determined by the room's temperature, humidity and air speed. Radiant heat(hot surfaces) or radiant heat loss (cold surfaces) are also important factors for thermal comfort. Relative humidity and moisture. When you approach 100% humidity, the air moisture condenses – this is called the dew point. The temperature in a building is based on the outside temperature and sun loading plus whatever heating or cooling is added by the HVAC or other heating and cooling sources. Room occupants also add heat to the room since the normal body temperature is much higher than the room temperature. Need which does not impose any bad effects on earth. There is only one thing which can come up with all these problems is solar energy. Our project "Solar Cooler" is based on the concept of harvesting solar energy. The solar energy is harvested and stored in a battery. This battery is in turn connected to the solar cooler for the power source. The concept of solar cooler sounds good and economical

hence almost every class of our society can bear its expenses. The best part is that it can be used even in rural areas where there will be no supply of electricity.

2. Layout analysis

Solar Panel

Solar panel being incorporated is a polycrystalline solar panel with Max power 5 W.

Technical specifications

RATED MAXIMUM POWER 5 W
OPEN CIRCUIT VOLTAGE 21 V
SHORT CIRCUIT CURRENT 0.6 A
RATED VOLTAGE 16.85 V
RATED CURRENT 0.30 A

Figure 1. solar panel

Solar Panel Output

= Solar panel watts x average hours of sunlight x 75% = daily watt-hours =5 watts x 5 hours x .75 = 18.75 daily watt hours.

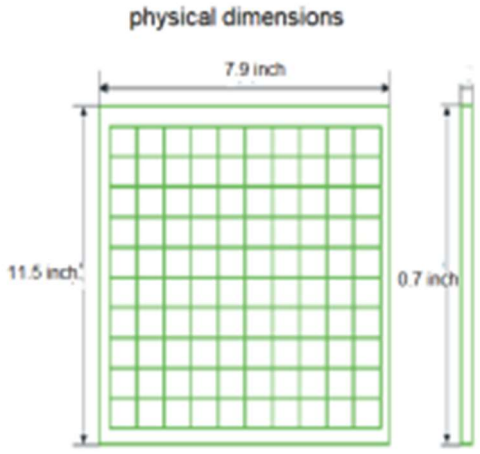

Figure 2 Polycrystalline or MultiCrystalline solar panels are solar panels that consist of

several crystals of silicon in a single PV cell. Several fragments of silicon are melted together to form the wafers of polycrystalline solar panels. In the case of polycrystalline solar panels, the vat of molten silicon used to produce the cells is allowed to cool on the panel itself. These solar panels have a surface that looks like a mosaic. These solar panels are square in shape and they have a shining blue hue as they are made up of several crystals of silicon. As there are multiple silicon crystals in each cell, polycrystalline solar panels allow little movement of electrons inside the cells. These solar panels absorb energy from the sun and convert it into electricity.

Features of Polycrystalline Solar Panels

- Polycrystalline solar panels are more eco-friendly than monocrystalline solar panels as they do not require individual shaping and placement of each crystal and most of the silicon is utilized during production. So, very less waste is produced.
- The acceptable maximum temperature of polycrystalline solar panels is 85 °C while the acceptable minimum temperature is -40 °C.
- Polycrystalline solar panels have lower heat tolerance than monocrystalline panels. So, at higher temperatures, these solar panels have lower efficiency than others.
- Polycrystalline solar panels have a higher temperature coefficient than monocrystalline panels.
- These panels have a high-power density.

Full Wave Rectifier

- A full wave rectifier is defined as a type of rectifier that converts both halves of each cycle of an alternating wave (AC signal) into a pulsating DC signal. Full-wave rectifiers are used to convert AC voltage to DC voltage, requiring multiple diodes to construct. Full wave rectification is the process of converting an AC signal to a DC signal.
- Our full wave rectifier being used is Full Wave Bridge Rectifier.

Figure 3

Construction of Full Wave Bridge Rectifier

A full wave bridge rectifier system consists of

1. Four Diodes
2. Resistive Load

We use the diodes, namely A, B, C and D, which form a bridge circuit. The circuit diagram is as follows.

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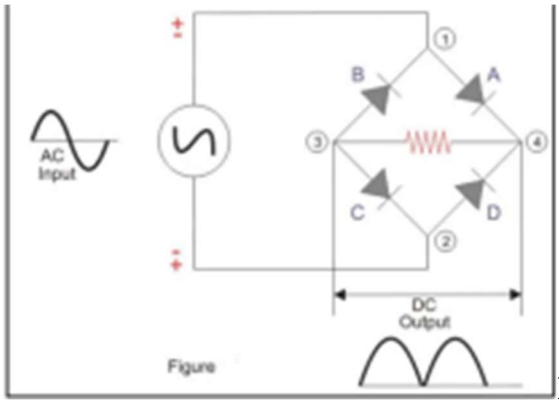

Figure 4

Principle of Full Wave Bridge Rectifier

We apply an AC across the bridge. During the positive half-cycle, terminal 1 becomes positive, and terminal 2 becomes negative.

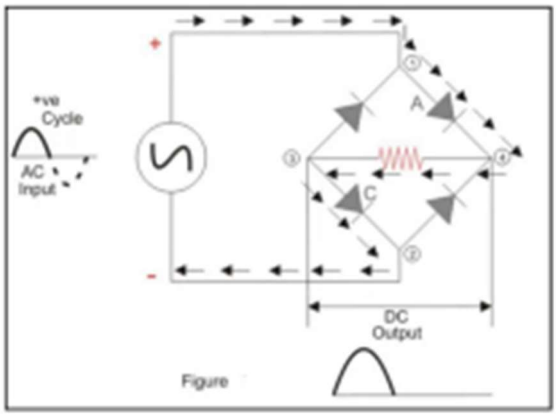

Figure 5 This will cause the diodes A and C to become forward-biased, and the current will flow through it. Meanwhile, diodes B and D will become reverse-biased and block current through them. The current will flow from 1 to 4 to 3 to 2.

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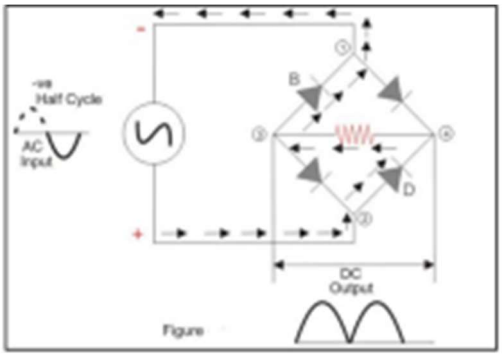

Figure 6

Battery Specification: -

Lead Acid Battery: A lead acid battery consists of a negative electrode made of spongy or porous lead. The lead is porous to facilitate the formation and dissolution

of lead. The positive electrode consists of lead oxide. Both electrodes are immersed in an electrolytic solution of sulfuric acid and water.

Figure. 7

In solar air coolers a secondary type battery has been used. This battery has specifications of current rating up to 7 Ah and the voltage rating 12 Volt, constant voltage charge of battery is 15-35 degree centigrade .The basic purpose behind using the battery is to provide smooth operation to the solar air cooler because PV panel does not provide fixed range of current and voltage due to variation in solar radiation. This battery is connected to a transformer so it can be charged both ways from a solar panel as well as direct through electricity. This battery will charge within 1.5 hrs when we charge through the electricity and when we connect it to the solar panel it will take 0.5 ampere per hour
That means it takes approximately 14 hours to fully charge.

Half Wave Rectifier Diode: A half wave rectifier is defined as a type of rectifier that allows only one-half cycle of an AC voltage waveform to pass while blocking the other half cycle.

The battery we used has a half wave rectifier diode. The use of the diode is when the DC current comes from the panel and goes through the diode to the battery. Diode makes sure that this process is unidirectional. Current does not flow from the battery to the panel and this is the main work of the diode. A rectifier is defined as a type of rectifier that allows only one-half cycle of an AC voltage waveform to pass while blocking the other half cycle.

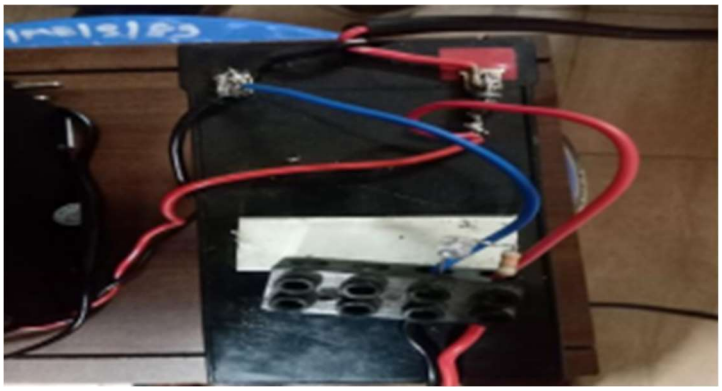

Figure. 8

IR sensor temperature control unit :-

The electronic unit which is the main control unit for automation and remote controller in the project is situated in this electronic box the box contains IR sensor Coma thermostats display a and trip switch (killer switch) .The unit consists of different components with different functionality such as ; The IR sensor (infrared sensor/eye) Is responsible for the remote access of the complete system. Due to the IR situated in the board using any remote control For example TV remote AC remote and etc . can be used to switch on and off the

complete system.

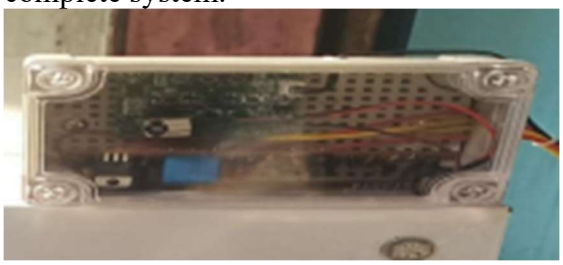

Figure 10 The next component in the box is thermostat and trips which year we get the result in form of automation comma with the input from difference thermostat located near the the fan as well as near the water cooler the temperature of air and drinkable water can be displayed on the display screen situated in the the electronic box.

These thermostat readings are then transferred to the different components in the motherboard which controls The Killer switch when the temperature drops down to the lower set limit The Killers which is activated and the complete system is switched off , i.e the pumps and the motor. And likewise when the temperature reaches above the upper set limit the system is switched on again using the killer switch. This is how the IR sensor temperature control box operates full stop since the thermostat readings are directly displayed on the display screen on this unit which can check whether/ when The automation is carried out. since the zero error is off ± 1 Ċ(Degree Celsius) therefore if we set the lower and upper set limit for automation as (25Ċ , 30Ċ) close the system will switch off at 25Ċ degree and restart again at 30-31 Ċ .

Air cooling principle law uses Air cooling as a method of dissipating heat. It works by expanding the surface area or increasing the flow of air over the object to be cooled, or both. Here **,**it is done by using a fan blowing air into or onto the object one wants to cool. The addition of fins to a heat sink increases its total surface area, resulting in greater cooling effectiveness. There are two types of cooling pads are used in air cooling one is a honeycomb and another one is

In all cases, the air has to be cooler than the object or surface from which it is expected to remove heat. This is due to the second law of thermodynamics, which states that heat will only move spontaneously from a hot reservoir (the heat sink) to a cold reservoir (the air).An air cooler works on the principle of evaporative cooling wherein evaporation of water is used to cool the air. A simple example of evaporative cooling is sweating in humans. As sweat starts to evaporate, it extracts the extra heat absorbed in it from the skin in the form of gas thus resulting in a cooling effect.

The cooling potential for evaporative cooling is dependent on the wet-bulb depression, the difference between dry-bulb temperature and wet-bulb temperature (see relative humidity). In arid climates, evaporative cooling can reduce energy consumption and total equipment for conditioning as an alternative to compressor-based cooling. Honeycomb cooling pad has water retention compartments, much similar to beehives, which elevates the water retention capacity, and hence the hot outside air transforms into cool humid air very quickly. These pads offer efficient cooling for a sustainable and longer period. When the warm air is drawn into an Air Cooler, it passes through a wet Honeycomb Cooling Media. As it passes through the honeycomb pad, water flowing over the honeycomb pad absorbs heat from the air causing the water to evaporate. This results in cooler, moisturized air.

Drinking Water cooling In Air cooler: In our project we also add one feature that is, to cool the drinking water with help of cooler cool water which was stored in Cooler tank.
Below, we discuss How **Drinking Water Cools in an Air Cooler** ?
We have fitted a box inside the cooler and inside this box we have fitted a pump(shown

in fig). There we will store Drinking Water and the Temperature of this water will be slightly higher. The Copper Condenser Coil is fitted at the bottom of this Box shown in fig.

Figure 11

In pharmaceutical industries many types of equipments are used for transfer of heat, they can be classified as follows,

1.**Heat Exchangers.**

2.Heat Interchangers.

1.Heat Exchangers:

These devices are used for transferring heat from a fluid (Hot Gas or Steam) to another fluid (Liquid) through a metal wall.

2.**Heat Interchangers**:

These devices are used for transferring heat from a One liquid to another liquid or one gas to another gas through a metal wall. In our Project We use a concept of Heat Interchangers because We transfer heat from one liquid to another liquid.

- Direct transfer type:

The hot and cold fluids are separated by a metal wall through which the heat is transferred from hot fluid to cold fluid . E.g. shell and tube heater(Copper Condenser Coil).

Copper Condenser Coil:

The Copper condenser coil consists of Shell And Tube Heat Exchanger. A Heat exchanger is a device to transfer heat from one fluid (Liquid/Gas) to another. There are various types of heat exchangers used in process piping but we use shell and tube Heat exchangers. Shell and tube heat exchanger is the most widely used heat exchanger and are among the most effective means of heat exchange. Shell and tube heat exchanger is a device where two working fluids exchange heats by thermal contact using tubes housed within a closed shell. The fluid temperature inside the shell and tube are different and this temperature difference is the driving force for temperature exchange. Used for wide temperature and pressure range, Shell and tube heat exchangers are compact in design, easy in construction and maintenance and provide excellent heat exchange.

Construction of shell And tube Condenser Coil:

- It consists of a bundle of parallel tubes, which are relatively thin-walled. The ends of these tubes are fitted to two tube-sheets First tube is Inlet Tube(B1) and Exit tube(B2).
- The Inlet Tube is directly connected to the Pump Which is in the Inside the Drinking Water Box situated in the Inside the Air cooler.
- The Exit Tube is connected to Tap. When tap is on then drinking Water will come out And When tap is off then water will again go to the drinking water box.
- The bundles of parallel tubes are enclosed in a shell or casing to which the tube-sheets (B1 and B2) are fitted.

Working Principle of Drinking Water cooling In Air cooler:

We have stored drinking water inside the cooler and the Temperature of this water will be slightly higher and there is also a pump inside it.The help of this water pump we will pump the water to the copper condenser coil.
The Copper Condenser coil is situated in the air cooler water tank, The temperature of air cooler water tank is less because of Air cooler .Drinking Water is introduced through the pump in inlet of Condenser into the space surrounding the parallel tubes .According to Heat Interchangers, Heat is transferred to the hot liquid (Drinking Water) inside the tubes to water which is in the tank because of this temperature of drinking water will decrease . Exit copper tube is connected to the rubber tube that is also called exit tube and Exit Tube is connected to Tap, When tap is on then drinking Water will come out And When tap is off then water will again go to the drinking water box.

3. Results and Discussion

Time(min)	15	30	45	60	75	90

Temperature (air)	38	36	33	31	30	28
Temperature (drinking water)	25	24.3	23.6	22.8	21.5	21

The table shows the temperature of the Cabin(room) for every 15 min till 90.
We can see that the temperature is decreasing with time .The temperature of the cabin without using the cooler was 38 degrees and that of drinking water was 25 degrees (at 0 min). After 90 min of using a cooler , the temperature of the cabin was found to be 21 degrees .

4. Conclusions

By completing this project, we would achieve clear knowledge of comfort cooling systems for humans by using non-conventional energy. This project would be fruitful in both domestic and industrial backgrounds. We also learned about non-conventional energy sources and utilization.

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