# REVIEW PAPER ON: Design, Fabrication & Analysis of Solar Air Cooler cum Heater

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**Abstract:** *The natural increase or decrease in the temperature of the surroundings makes human uncomfortable. So for human comfort the invention of air-conditioner, cooler, heater took place. The present cooling and heating methods require large amount of electricity, which results in excess depletion of Non–renewable resources. Depending completely on electric source for cooling and heating effect is risky as there might be a power short circuit which would in return lead to damage of the device. But completely stopping the use of cooling or heating devices is not feasible. The room occupants also add heat to room since normal body temperature is much higher than Room temperature. So there's need to use such a source which is abundantly available in nature (here solar energy). Solar energy is never ending source as long as there's sun in nature. The effective use of same device for cooling as well as heating is done. This project reviews the solar powered cooler cum heater at domestic level.*

**Keywords: Solar energy, Axial Flow Fan, Heating coils, Wires, Solar Panel, Battery,Indicator.**

## 1. Introduction:

This paper reveals the comfort conditions achieved by the device for the human body. In summer, the 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 gained (hot surfaces) or radiant heat loss (cold surfaces) are also important factors for thermal comfort. Relative humidity (RH) is a measure of the moisture in the air, compared to the potential saturation level. Warmer air can hold more 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 of such a source which is abundantly available in nature, which does not impose any bad effects on earth[1]. That is the emissions of Chloro-Fluro-Carbon into atmosphere leads to depletion of ozone layer. There is only one thing which can come up with these all problems solution is solar energy.

### 1.1 Working of Solar Air Cooler And Heater:

First start the pump which sucks water from bottom tank which was already filled with water. Water goes on stationery pad which are placed on backside of two side door, through delivery pip .After that, the exhaust fan starts & sucks the atmospheric air, which is passed through wet pad(jute or grass). In this process cooling is achieved by direct contact of water particles & moving air stream. In complete contact process the air would become saturated at WBT of entering air. In other words sensible heat of air is carried by water in the form of latent heat, when it is brought intimate contact with water. After some time air may be sufficiently cooled by evaporative process, which results in considerable increase of humidity. For better effect add ice cube or chilled water in bottom tank. For heating purpose the supply of water is stopped by pump and the heating coil is in ON condition. As the coil goes on heating the air stream temperature also increases. The convection process is said to occur due to which the hot air comes out.

### 1.2 Problems Regarding to cooling and heating(Air-conditioner and heater) :

1. Fossil fuels contain radioactive materials, mainly uranium and thorium which are released into the atmosphere which in return increases the smog and acidic rain , emission of carbon di oxide.
2. Longer power cuts problem during summer condition in rural areas.
3. High Cost of Cooling and Heating Products.
4. Mechanical Wear and Tear.
5. Unusual motor noises.
6. Water leaks.

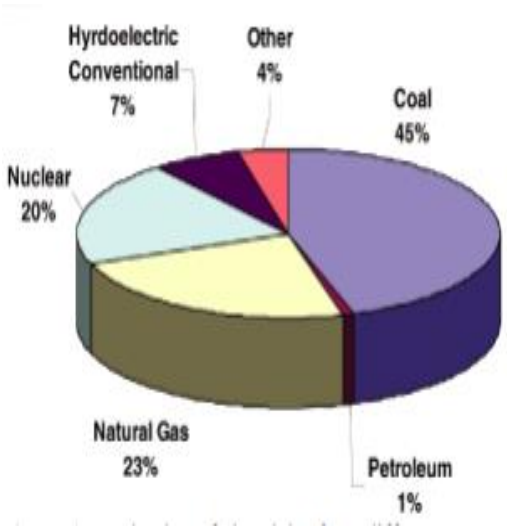


FIG 1.2: Production of electricity from different sources

### 1.3 Solar energy Conversion :

Solar energy conversion requires battery, inverter and charge controller. Whenever solar light falls on panel it has large amount of photon energy which is controlled by charge controller. The charge controller charges the battery. The battery is directly connected to the inverter. Inverter is needed only when there is use of AC loads type instruments.

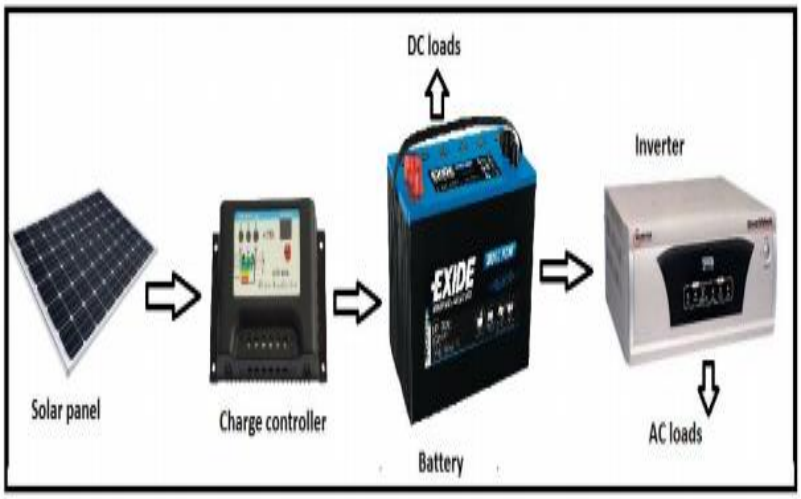


FIG1.3: Solar Energy Conversion Process

## 2. Literature Review :

Adarsh Mohan Dixit, Arjit Raj Sahu (student) (2013)," Water Cooler Double purpose: To produce hot and cold water simultaneously". Evaporator & condenser are used in this simultaneously. Evaporator in the water cooler is not used when condenser is removed and it is replaced by another exchanger. Heat is released on the level of condenser is 3 to 4 times the electric power used by the compressor. Hence in this project they coupled the water cooler to the water heater in order to rise its temperature to an acceptable threshold. During cool weather condition the water cannot be heated sufficiently. Hence we recourse to electric supplement but it also cannot satisfy 90% of our annual needs. In this device the outgoing gas from the compressor will transfer its heat to the water of cumulus to a place that doesn't have ambient air. Then the hot gas goes towards the pressure reducer which is followed by an evaporator and at the end it returns to the compressor to start a new cycle. From this project the refrigeration COP is 3 and the thermal COP is 4 so they deduce that the total COP of the system is 7.They concluded that adding the regenerator of heat on the level of condenser and evaporator will result in increased performance. [5]

Akhilesh Yadav, Rajatkumar Bachan, Dattaprasad Tendolkar, Sankesh Torashkar (2018),"Design & Fabrication of 360 Cooler Cum Heater " As we are in need of heating and cooling simultaneously in many of the rural area in India. This paper helps us to understand the process of evaporative cooling. In this they have created a 360o simple evaporative air cooler in which cooling is achieved by direct contact between the water particles and air stream. In which the minimum outdoor temperature required for successful $360^{o}$ evaporative cooling is about $35^{o}$ C and even lower than that. The $360^{o}$ evaporative cooler depends on the outdoor temperature as well as relative humidity, dry bulb temperature and low wet bulb temperature. This can't be used where relative humidity is high. This system doesn't dehumidify the air but on contrary further humidify air. The working of this system can be explained as followed:

1. Initially we start the pump which sucks the water from the bottom tank then this water is then passed on the stationary pads/grass of the two side door through various delivery pipes. Now due to capillary action this water is passed to the neighbouring grass/pads.

2. Now we turn on the exhaust fan which is a centrifugal fan which sucks the air from these wet pads/grass and throws on the opposite side due to which there is a convective heat transfer between air and water and thus temperature of the air which is thrown by the centrifugal fan is reduced. Hence in this order by direct contact between the air and water particle cooling is achieved.[2]

Vijay Kumar Kalwa, R Prakash , 2012, "Design & development of solar power air cooler". This research paper gives the information about the problems faced by the excess usage of the non-renewable resources. Room occupants also add the heat to the room since the normal body temperature is much higher than the room temperature. Hence the solution to the problem can be solved by the requirement of the sources which are abundantly available in nature that's Solar Energy.

They provided information, Calculations, Analysis on Solar Energy conversion. Components Used are:

- Solar Panel
- Battery
- Charge Controller
- Inverter
- Blower
- Ceramics Slabs

The converted Energy is used to run the Centrifugal Fan. Blower is surrounded by cooling pads through which continuous water supply is provided. When Blower is switched ON it sucks atmospheric air into cabin through cooling pads, so that the cooling effect is introduced into the room. They selected Solar panel of 40W & Battery of 40Ah. [1]

Maneesh Bhardwaj (2012), "Solar Air Cooling", They stated the major disadvantages of the solar cooler that is ; High cost of manufacturing , low conversion efficiencies & need for continual streams of photons to produce power. The peak output from solar panel can be obtained during Noon hours. [4]

S.A.Abdalla, Kamal N. (2016), "A radiant air-conditioning system using solar driven liquid desiccant evaporative water cooler". They described that the solar driven liquid "desiccant" evaporative cooling system & method used for investigating it's performance is providing cold water for radiant air-conditioning system in Khartoum. For more than decades, Air-conditioning is considered as the reliable & efficient source due the popularity gained by the Vapour Compression Machines. But the air-conditioners produces harmful effects on the ozone layer due to presence of Halogenated Hydrocarbons. In liquid Desiccant Evaporative Cooling process, air is used, dehumidified by desiccant solution to cool water by direct evaporative cooling. It's considered to be modified version of the direct evaporative cooling that can cater for different climatic conditions. They concluded that the system is environmental friendly as it requires low high grade input & improves indoor air quality substantially in energy efficient manner radiant air-conditioning.[3]

R.Sai.Lavanya, Dr. B.S.R.Murthy (2008), "Design of solar using aqua-ammonia absorption refrigeration system", The system invented here works on Ammonia Absorption System which provides refrigeration effect by using two fluids & some quantity of heat input, rather than electrical input as in more familiar vapour compression cycle. In Absorption system, Secondary fluid is used to circulate refrigerant because temperature requirement for cycle falls into low to moderate temperature range. Usage of Absorbent depends on the temperature:

- Above $32^0$ F - Lithium Bromide as absorbent & water as refrigerant.
- Below $32^0$ F – Ammonium as refrigerant & water as absorbent. [6]

## 3. Problem Definition:

Today we are dealing various problems in air cooling and heating

- Extreme weather conditions

  In desert areas where temperature changes during night time as well as day time the need of air conditioning is more requirement than a luxury. The increase in the relative humidity makes the air too humid and uncomfortable for human sustainability.

- Shortage of Electricity

  In some areas there is no power supply and longer power cut problems can ultimately relate to breakdown conditions. The people can't use basic devices.

- Low Refrigerant

  The leaks in the refrigerant line results in the low efficiency of air cooling due to which the temperature of air required is not achieved.

- Condenser problems

  Sometimes the condenser gets dirty, sooty which makes it grimy and result in the interference of heat transfer due to with the whole system needs to work harder and wears it out faster. This consumes excess power units.

- Refrigerants

  The working fluid sometimes have negative impact on the environment. Some contribute to global warming and also result in the depletion of ozone layer.

## 4. Objectives :

The specific objectives of our project are as follows

- To develop a simple, cheap and portable cooling and heating system which does not require much maintenance and can be easily carried wherever necessary.
- To find out the system applicability, depending on climate which helps heating in winter and cooling in summer.
- To minimize investments in the system costs so it can be cost effective.
- To reduce the energy requirement and also use renewable resources to run the system as maximum energy gets into dehumidifying the air.

- To reduce the use of refrigerants that are harmful and non-eco-friendly. These refrigerants can contribute to global warming and also result in the depletion of ozone layer.

## 5. Methodology :

This project mainly consist of two sections:

i. Solar Energy Conversion

ii. Cool air generated by Axial Flow fan

i. Solar Energy Conversion:

Solar energy conversion is done by using battery, inverter and charge controller. As sun light falls on solar panel, which converts into electrical energy by photoelectric effect. This electrical energy stored in battery in the form of chemical energy. Charge controller is employed in between solar panel and battery which prevents overcharging Figure 2: Solar energy conversion process and may protect against overvoltage, which can reduce battery performance or lifespan, and may pose a safety risk. The stored energy directly can use for DC loads or else need to be converted AC (alternate current) by the help of inverter.

ii. Cool air generation by Axial Flow fan

The converted energy is used to run the Axial Flow fan. This fan covered with cooling pads, through which water is passed at a specific rate. As the fan sucks the hot air through cooling pads, heat transfer occur between air and water thus generated cool air enters into the room.

- Working Model of the Project:

This concept is driven by solar energy. Components involved in this concept are solar panel, battery, charge controller, battery, inverter, blower, ceramic slabs and cooling pads. Solar panel is employed to convert sun light into electrical energy by means of photovoltaic effect. The generated electrical energy is supplied to the battery for storage purpose through charge controller which prevents from power fluctuations. As AC blower is used for cooler, so need to convert DC load from the battery to AC load by the help of inverter. Inverter converts DC load to AC. Load, now AC power can be supplied to the blower. This blower is surrounded by cooling pads through which continuous water supply is provided. When the blower is switched ON, blower sucks atmospheric air into the cabin through the cooling pads, mean time heat transfer occur between water and air, so the cool air enters into the room thus providing required thermal comfort conditions.

## 6. Conclusions :

We would conclude that, The Solar Air Cooler Cum Heater is a model of minimum investment providing both heating and cooling effect as required. The easy displacement of the model can be achieved. The use of renewable resources like solar energy helps in maintaining eco-friendly atmosphere.

## 7. References :

[1] Vijay Kumar Kalwa, R Prakash, 2012, "Design and development of solar power air cooler", International Journal of Science and research (IJSR), ISSN: 2319-2064.

[2] Akhilesh Yadav, Rajatkumar Bachan, Dattaprasad Tendolkar, Sankesh Toraskar, "Design and fabrication of 360 cooler cum Heater'', International Research Journal of Engineering and Technology (IRJET) 2018.

[3] S. A. ABDALLA, KAMAL N. ABDALLA "A radiant air-conditioning system using solar driven liquid desiccant evaporative water cooler." (Journal of Engineering Science and research-2016).

[4] Maneesh Bhardwaj, "SOLAR AIR COOLING", International Research Journal of Engineering and Technology (IRJET) 2012.

[5] Adarsh Mohan Dixit, Arjit Raj Sahu Students, Malwa Institute of Technology Indore , "Water cooler double purpose: to produce cold and hot water simultaneously."(IJEH-International Journal of Engineering and Humanities.)

[6] R Sai Lavanya, Dr.B.S.R.Murthy, "DESIGN OF SOLAR WATER COOLER USING AQUA-AMMONIA ABSORPTION REFRIGERATION SYSTEM"(International Journal of Advanced Engineering Research and Studies.)