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Design and Fabrication of Solar Based Portable Air Cooler

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Abstract

Mechanical Engineering without production and manufacturing is meaningless. Production and manufacturing process deals with conversion of raw materials inputs to finished products as per required dimensions, specification and efficiently using recent technology. The new developments and requirements inspired us to think of new improvements in air conditioning Engineering field. In our project, solar power is captured and stored in a battery. This power is used to run the air cooler whenever required. Solar energy means the radiation energy that reaches the earth from the sun. It provides daylight makes the earth hot and is the source of energy for plants to grow. Solar electric systems are suitable for plenty of sun and are ideal when there is no main electricity. Solar electricity is the technology of converting sunlight directly in to electricity. It is based on photo-voltaic or solar modules, which are very reliable and do not require any fuel. Our objective is to design and develop a solar electric system namely **"**Fabrication of Solar Air Cooler**".**

Keywords: Solar energy, Air Cooler, Battery, Cooling unit etc.

1. Introduction

An environmental control system utilizing solar energy would generally be more cost effective if it were used to provide both heating and cooling requirements in the building it serves. Various solar powered heating and cooling systems have been tested extensively, but solar powered air-Coolers have received little more than short-term demonstration attention. Solar cooling technologies collect the thermal energy from the sun and use this heat to provide cold air for residential, commercial, institutional and manufacturing buildings. These technologies displace the need to use electricity or natural gas. Today, Countries across the globe are at work manufacturing and installing solar heating and cooling systems that significantly reduce our dependence on imported fuels. We need smart policies to expand this fast growing, job producing sector.

It uses solar energy to produce cold or hot air. This technology can be used to reduce the energy consumption environmental impact of mechanical cooling system. A significant advantage of this system is, it has no moving parts consequently they are noiseless, noncorrosive, cheap to maintain, long lasting in addition to being environmentally friendly with zero ozone depletion as well as global warming potentials. The use of solar energy for cooling can be either to provide refrigeration for food preservation or to provide comfort cooling. There is less experience with solar cooling than solar heating. Several solar heated buildings have been designed, built, operated for extended periods but only a few short time experiments have been reported on solar cooling. However, research work is expected to close the gap between the two within few years.

2. Problem Definition

Human beings give off heat, around an average of 100 kcal per hour per person, due to what is known as 'metabolism'. The temperature mechanism within the human body maintains a body temperature of around 36.9^0 C (98.4^0 F). But the skin temperature varies according to the surrounding temperature and relative humidity. To dissipate the heat generated by metabolism in order to maintain the body temperature at the normal level, there must be a flow of heat from the skin to the surrounding air. If the surrounding temperature is slightly less than that of the body, there will be steady flow of heat from the skin. But is the surrounding temperature is very low, as on cold winter day the rate of heat flow from the body will be quite rapid, thus the person feels cold, on the other hand on a hot summer day, the surrounding temperature is higher than that of the body, and so there cannot be flow of heat from the skin to the surroundings, thus the person feels hot. In such a situation water from the body evaporates at the skin surface dissipating water from the body evaporates at the skin surface dissipating the heat due to metabolism. This helps in maintaining normal body temperature. But if the surrounding air is not only hot but highly humid as well, very little evaporation of water can take place from the skin surface, and so the person feels hot and uncomfortable.

3. 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.

4. Experimental Block Diagram

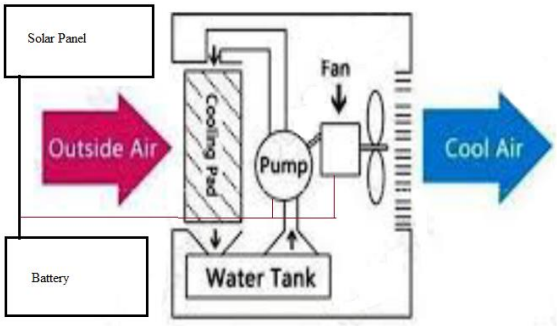


Fig.1. Block Diagram of system

5. Working

The solar panel is converting sun rays to the Electricity by "Photo-Voltaic Effect". This electrical power is stored in a 12 V battery. Battery D.C power is used to run the D.C motor and D.C water pump.

Block diagram, Photo-voltaic Effect and major components of our project are already discussed in the above chapters.

The D.C motor is coupled with impeller blades. The D.C motor runs when the air cooler button is ON, the impeller blades starts rotating. The water pump is used to circulate the water to the blower unit.

The forced air flows through the water which is sprayed by water pump, so that the cold air is produced. The switch control is used to ON/OFF the solar air cooler circuit and the heater circuit.

Sun radiation time:

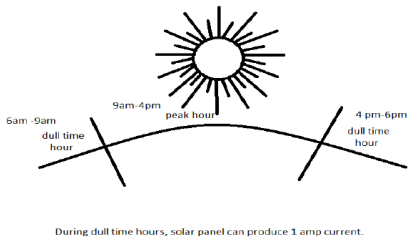


Figure 1 Sun radiation time

- Power produced from solar panel = 20 watts
- Battery storing capacity = 7 amps
- Motor capacity =1.4 amps
- Pump capacity =1.4 amps
- Average working time =5 hrs per day
- Voltmeter shows 16 volts in stationary condition.=20watts/16volts =1.25amps/hr.
- Formula :
  P=V X I
  Where P=power
  V=volts
  I=current
  P=16volts X1.25amps =20Watts per hour.

6. Results And Discussions

- **Analysis Of Solar Air Cooler**

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.

We conducted an analysis on the solar air cooler by placing the experimental setup under three conditions ,

1. Inside a well lit room.
2. Outside the room exposed to direct sunlight.
3. Outside the room under the shade.

We measured the current and voltage under the above conditions and determined the voltage and tabulated the readings shown in Table 1.The maximum power was obtained when the cooler was exposed to direct sunlight.

SL NO	CONDITIONS	VOLTAGE (V)	CURRENT (A)	POWER (W)
1	Inside a well lit room	5.96	0	0
2	Outside the room exposed to direct sunlight	20.1	0.044	0.8844
3	Outside the room under the shade	13.5	0.02	0.27

Table 1

SL NO	CONDITIONS	VOLTAGE (V)	CURRENT (I)	OUTLET AIR TEMPERATURE (°C)	INLET AIR TEMPERATURE (°C)	DIFF IN TEMP (°C)	COOLING EFFECT (W)	COP (%)
1	Water at 25°C	8.14	0.91	29	31.8	2.8	6.475	0.87
2	Water at 15.2°C	8.16	0.91	27.1	31.9	4.8	11.1	1.494

Table 2

We measured the outlet and inlet air temperatures of air under two conditions:

1. Cooling water at 25°C
2. Cooling water at 15.2°C

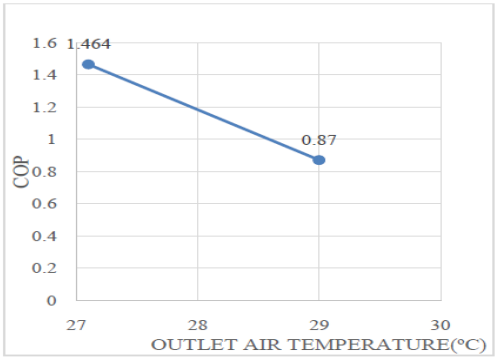
We determined the cooling effect and COP in both cases. Results show us that the values of COP and cooling effect almost doubled when the temperature was reduced by 9.8°C.

- **GRAPHS**

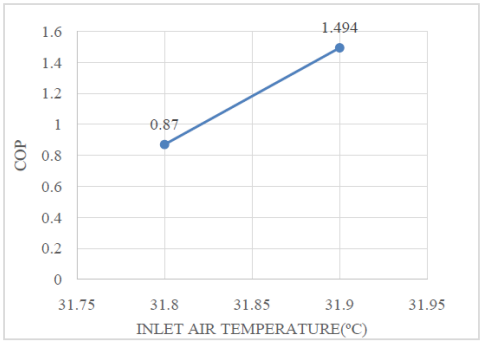
Using the values from table 2 we plot two graphs

1. COP vs Inlet Air Temperature
2. COP vs Outlet Air Temperature

In the Graph 1, value of COP increases with increase in Input Air Temperatures. And in Graph 2, the value of COP decreases with increase in Output Air Temperatures.



Graph 1: COP vs Inlet Air Temperature



Graph 2 : COP vs Inlet Air Temperature

So as comparing the cost of this product with the existing products in the market is, solar product appeals better and affordable by common people. This solar product perfectly suits for villages, schools and offices and thus prevention from the power cut problems. It comprises of many attractive features such as usage of solar energy, cooler and cooling cabin at lower cost. The above method is eco friendly and natural, electricity savers. Durability of our product is more thus minimizing the cost. No electricity is spent so this product saves the energy and saves environment from getting polluted.

Fig. 3. Project Model

7. Advantages

- This system is eco friendly in operation.
- It is portable, so it can be transferred easily from one place to other place.
- Non conversional source as fuel.
- Maintenance cost is low.
- More amount of energy is capture by auto tracking.

8. Disadvantage

- It does not purify air.
- Initial cost is high.
- Solar panel saves the energy during day only.

9. Applications Of Systems

The solar air cooler is used in

- Home
- Industries
- Meeting halls
- Seminar halls
- By adding control circuit, we can maintain the room temperature at required level,

10. Conclusion

By completing this project, we have achieved clear knowledge of comfort cooling system for humans by using non-

conventional energy. This project would be fruitful in both domestic and industrial backgrounds. The Solar Air Cooler 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.

We also learned about non-conventional energy sources and utilization. The project carried out by us made an impressing task in the field of Cost of generation of power is very less so the source of power is free and available in plenty and then is no power interruptions. This project has also reduced the cost involved in the concern. Project has been designed to perform the entire requirement task which has also been provided.

11. Future Scope

Comparing the cost of this product with the existing products in the market is solar product appeals better and affordable by common people. This solar product perfectly suits for villages, schools and offices and thus an alternate to the power cut problems. It comprises of many attractive features such as usage of solar energy, cooler and cooling cabin at lower cost. It is eco friendly and natural, electricity savers. Durability of the product is more thus minimizing the cost. No electricity is used so this product saves the energy and saves environment from getting polluted.

This project although fulfilling our requirement has further scope for improvements. Some of the improvements that could be made in this solar air cooler unit are listed.

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