. DESIGN AND FABRICATION OF SOLAR AIR COOLER

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

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ABSTRACT

Mechanical Engineering without production and manufacturing is meaningless. Production and manufacturing process deal with conversion of raw materials inputs to finished products as per required dimensions, specifications and efficiently using recent technology. The new developments and inspired us to think of new improvements in air conditioning field. In our project, solar power is harvested and stored in a battery. This power is used to run the air conditioner 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 the electricity. It is based on photo-voltaic or solar molecules, which are very reliable and do not require any fuel. Our objective is to design and develop a solar electric system.

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CHAPTER 1

INTRODUCTION

1.1 AIR COOLER

A unit for cooling the supplied to a building or for dissipating the heat from machinery, furnaces, and other types of heat-producing equipment. Air conditioning systems for industrial, public and residential buildings, as well as in cooling systems for electric generators, computers and radio and chemical equipment. Air coolers may be of the surface, trickle or combination type.

In recuperative surface air coolers, the air reduces the temperature by transferring heat through smooth or finned (plane or tubular) surfaces that are washed on the opposite side by a coolant (ammonia or brines). In regenerative rotatory or stationary air coolers the air dissipates the heat periodically to cooled layers made of metal to plastic sheets or grids, stone chips or porcelain rings. In trickle coolers the air is c0ooled by water or brine sprayed from atomisers. The principles of the first two types of units mentioned above are incorporated in the design of the combination air cooler.

There are two types of air coolers available in the market. They are

- Personal air cooler
- Desert air cooler

1.1.1 PERSONAL AIR COOLER

Personal air cooler is known as an Evaporative cooler. It is a device that cools air through the evaporation of water. Evaporative cooling differs from typical air conditioning systems, which use vapor-compression or absorption refrigeration cycles. Evaporative cooling uses the fact that water will absorb a relatively large amount of heat in order to evaporate (that is, it has a large enthalpy of vaporization). The temperature of dry air can be dropped significantly through the phase transition of liquid water to water vapour (evaporation). This can cool air using much less energy than refrigeration. In extremely dry climates, evaporative cooling of air has the added benefit of conditioning the air with more moisture for the comfort of building occupants.

The cooling potential for evaporative cooling is dependent on the wet-bulb depression, the difference between dry-bulb temperature. In arid climates, evaporative cooling can reduce energy consumption and total equipment for conditioning as an alternative to compressor-based cooling. In climate not considered arid, indirect evaporative cooling process without increasing humidity. Passive evaporative cooling strategies can offer the same benefits of mechanical evaporative cooling systems without the complexity of equipment and ductwork.

Our aim in this project is to design a non-conventional energy source to run an evaporative cooler. Which will be more convenient and eco-friendlier to the environment.

This paper reveals the comfort conditions achieved by the device for the human body. In summer (hot) and humid conditions we 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 (RH) is a measure of the moisture in the air, compared to the potential saturation level. Warmer air can hold more 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. There is only one thing which can come up with these all problems is solar energy.

CHAPTER 2

2.METHODOLOGY

2.1 UTILIZATION OF SOLAR ENENRY

The solar energy can be utilized by means of “PHOTO VOLTAIC METHOD”. The most useful way of harnessing solar energy is by directly converting it into electricity by means of solar photo-voltaic cells, when sun rays is incident on Solar cells, in this system of energy conversion that is direct conversion of solar radiation into electricity. In the stage of conversion into thermodynamic form is absent. The photo-voltaic effect is defined as the generation of an electromotive force as a result of the absorption of ionizing radiation. Energy conversion devices, which are used to convert sunlight to electricity by use of the photo-voltaic effect, are called solar cells.

2.2 PHOTOVOLTAIC PRINCIPLES

The photo-voltaic effect can be observed in nature in a variety of materials that have shown that the best performance in sunlight is the semiconductors as stated above. When photons from the sun are absorbed in a semiconductor, that create free electrons with higher energies than the created there must be an electric field to induce these higher energy electrons to flow out of the semi-conductor to do useful work. A junction of materials, which have different electrical properties, provides the electric field in most solar cells.

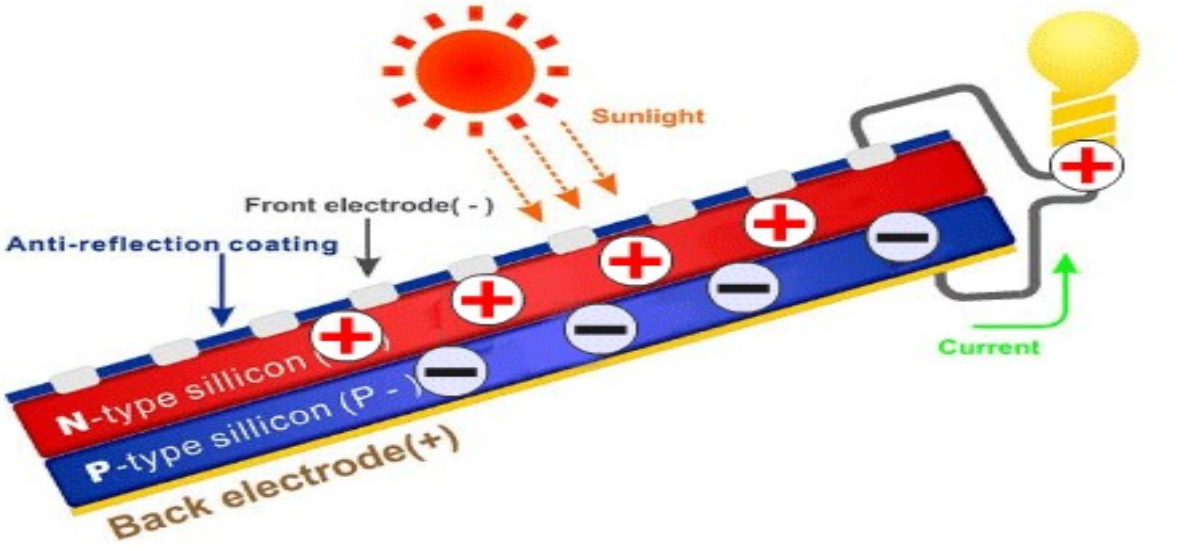

Figure 2.1 Photo-voltaic cell

To obtain a useful power output from photon interaction in a semiconductor, there processes are required.

1) The photon has to be absorbed in the active part of the material and result in electrons being excited to a higher energy potential.

2) The electrons hole charge carries created by the absorption must be physically separated and moved to the edge of the cell.

3) The charge carries must be removed from the cell and delivered to useful load before they lose extra potential.

For completing the above processes, a solar cell consists of: -

a) Semi-conductor in which electron hole pairs are created by absorption of solar radiation.
b) Region containing a drift field for charge separation
c) Charge collecting fronts and back electrons.

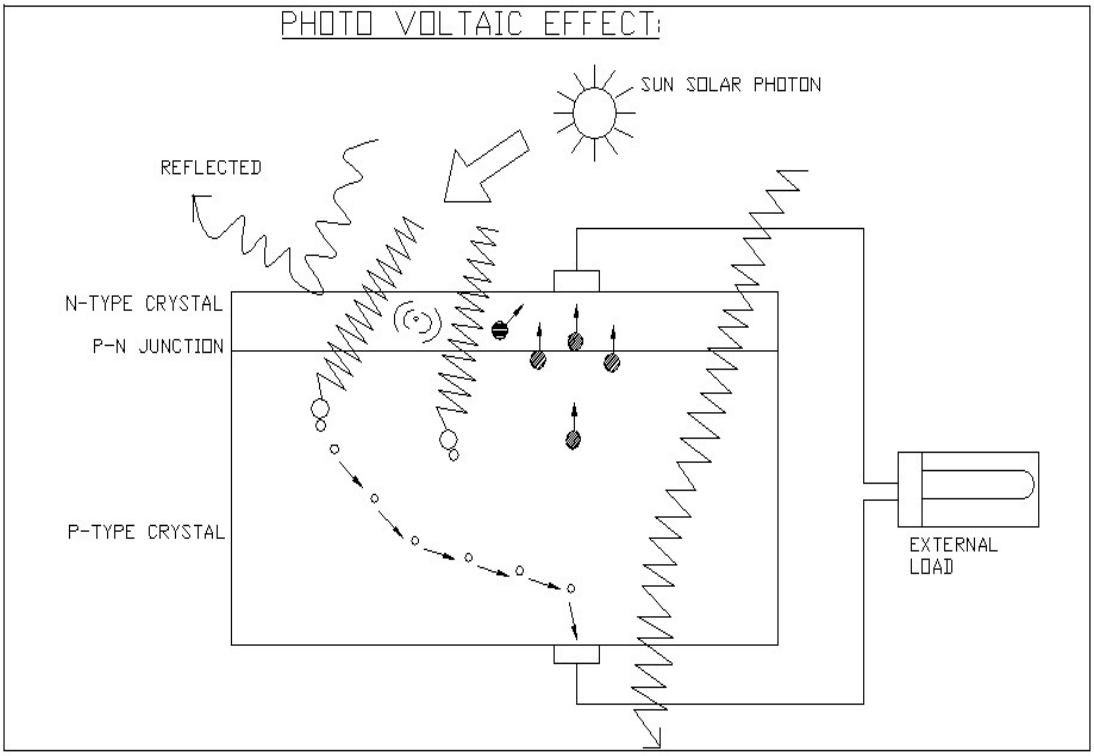

Figure 2.2 Photo-voltaic effect

2.3 COMMISSIONING

During the day time the battery gets charged and when the intensity of light decreases, the LDR makes the light to get ON and the light glows by using the stored charge in the battery.

2.4 COOLER PRINCIPLE

Evaporative coolers lower the temperature of air using the principle of evaporative cooling of absorption refrigeration. Evaporative cooling is the conversion of liquid water into vapor using the thermal energy in the air, resulting in a lower air temperature. The energy needed to evaporate the water is taken from the air in the form of sensible heat, which affects the temperature of the air, and converted into latent heat, the energy present in the water vapor component of the air, whilst the air remains at a constant enthalpy value. This conversion of sensible heat to latent heat is known as an isenthalpic process because it occurs at a constant enthalpy value. Evaporative cooling therefore causes a drop in the temperature of air proportional to the sensible heat drop and an increase in humidity proportional to the latent heat gain. Evaporative cooling can be visualized using a psychometric chart by finding the initial air condition and moving along a line of constant enthalpy toward a state of higher humidity.

Vapor-compression refrigeration uses evaporative cooling, but the evaporated vapor is within a sealed system, and is then compressed ready to evaporate again, using energy to do so. A simple evaporative cooler's water is evaporated into the environment, and not recovered. In an interior space cooling unit, the evaporated water is introduced into the space along with the now-cooled air; in an evaporative tower the evaporated water is carried off in the airflow exhaust.

CHAPTER 3

3.EQUIPMENTS AND DESCRIPTION

The physical setup of this project is given below and it is been explained as follows:

1. Solar panel
2. Battery
3. Dc motor
4. Water pump

3.1 SOLAR PANEL

A solar cell works on the principle of photo-voltaic principle, the photo-voltaic solar energy conversion is one of the most attractive non-conventional energy sources of reliability from the micro to the Megawatt level.

Figure 3.1 Solar panel

Solar Panel (Fig 3.1) consists of a base plate made of either steel or aluminum and carries a layer of metallic selenium, which is light sensitive. An electrically conducting layer of cadmium oxide is applied by sputtering over the silicon layer. The layer is sufficiently thin to allow light to reach the selenium and is electrically continuous as it acts as the negative pole. The negative contact is formed of a strip of woods metal sprayed on to the edge of the top surface. The base plate forms the positive contact. A transparent varnish protects the front surface of the cell. When light falls on the upper surface of the selenium, electrons are released from the surface, a flow of current through the external circuit passes between the positive and negative contacts.

SPECIFICATIONS OF SOLAR PANEL

Rated maximum power (Pm)	5W
Voltage at Pmax (Vmp)	12V
Current at Pmax (Imp)	0.417A
Open-circuit voltage (Voc)	13.5V
Short-circuit current (Isc)	0.53A
Normal operating cell temp (NOCT)	$47^{O}C$
Maximum series fuse rating	10A
Operating temperature	$-40^{O}C$ to $+85^{O}C$
Application class	Class A
Cell technology	Poly-S
Dimension (mm)	306*148*15mm

Table 3.1

3.2 BATTERY

Batteries seem to be the only technically and economically available storage means. Since both the photo voltaic system and batteries are high in capital costs, it is necessary that the overall system be optimized with respect to available energy and local demand pattern. So, we use lead acid battery for storing the electrical energy from the solar panel.

3.2.1 LEAD ACID WET CELL

The lead-acid cell is the type most commonly used, where high values of load current are necessary. The electrolyte is a dilute solution of sulfuric acid (H_2SO_4). In the application of battery power to start the engine in an automobile, for example, the load current to the starter motor is typically 200A to 400A. One cell has a nominal output of 2.1V, but lead acid cells are often used in a series combination of three for a 6V battery and six for a 12V battery.

The lead acid cell type is a secondary cell or storage cell, which can be recharged. The charge and discharge cycle can be repeated many times to restore the output voltage, as long as the cell is in good physical condition. However, heat with excessive charge and discharge currents shortens the useful life to about 3 to 5 years for an automobile battery. Of the different types of secondary cells, the lead acid type has the highest output voltage, which allows fewer cells for a specified battery voltage.

Inside a lead acid battery (Fig 3.2) shows the systematic diagram, the positive and negative electrodes consist of a group of plates welded to a connecting strap. The plates are immersed in the electrolyte, consisting of 8 parts of water to 3 parts of concentrated sulfuric acid. Each plate is a grid or framework, made of a lead-antimony alloy. This construction enables the active material, which is lead oxide, to be pasted into the grid. In manufacture of the cell, a forming charge produces the positive and negative electrodes. In the forming process, the active material in the positive plate is changed to lead peroxide (pbo_2). The negative electrode is spongy lead (Pb).

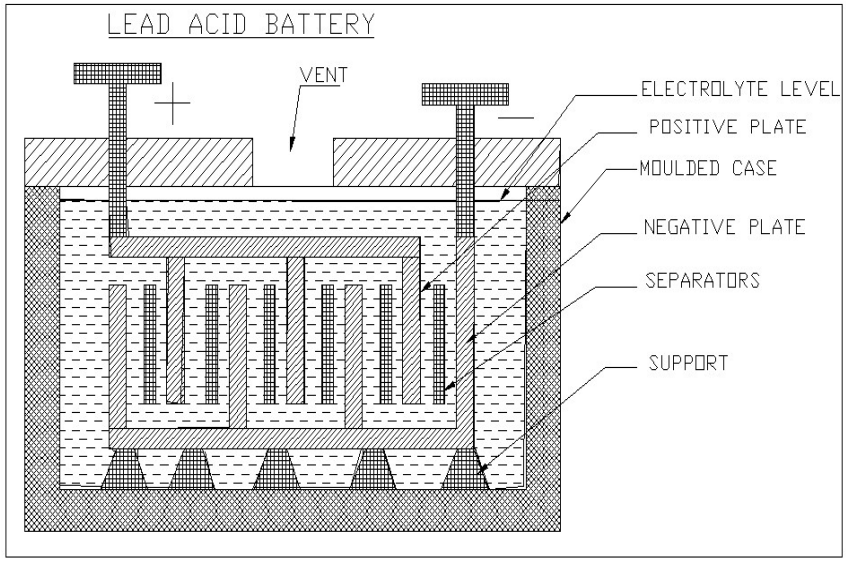

Figure 3.2 Lead acid battery

SPECIFICATIONS OF BATTERY

Voltage	12V
Current	7AH
Voltage Regulation	14.2-14.5 V ($25^{O}C$)
Initial Current	1.4A Max

Table 3.2

3.3 DC GEAR MOTOR

A dc motor (Fig 3.3) is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic field. It is of vital importance for the industry today and is equally important for engineers to look into the working principle of dc motor in details that we have discussed in the article to understand the operating principle of dc motor we need to first look into its constructional feature.

The very basic construction of a dc motor contains a current carrying armature which is connected to the supply end through commutator segments and brushes. The armature is placed between north south pole of a permanent (or)an electromagnet as shown in diagram. As soon as we supply direct current in the armature, a mechanical force acts on it due to the electromagnet effect of the magnet. Now to go into the details of operating principle of dc motor it's important that we have a clear understanding of Fleming's left-hand rule to determine the direction of force acting on the armature conductors of dc motors.

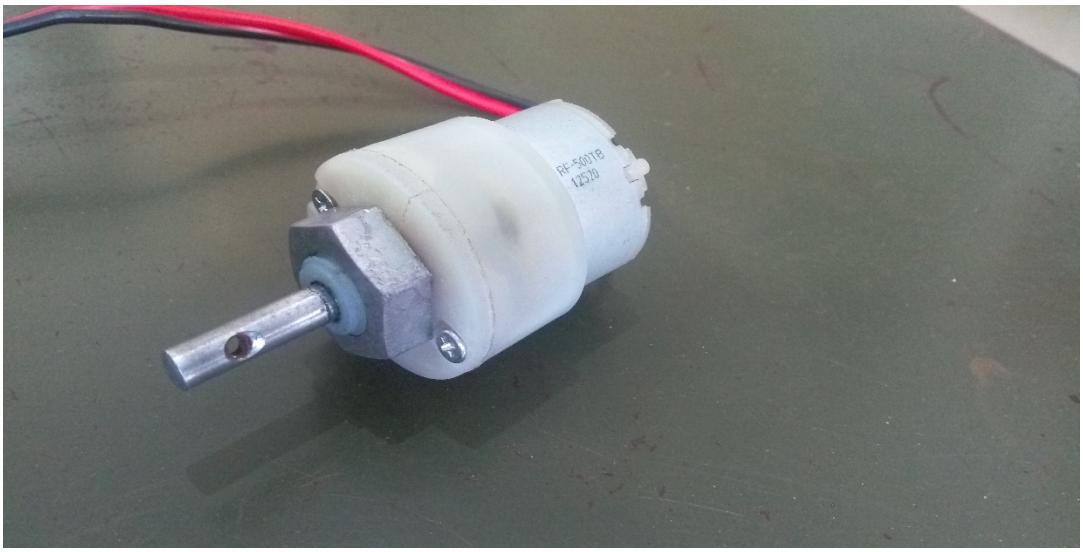

Figure 3.3 DC Gear motor

3.4 WATER PUMP

Water pump (Fig 3.4) is used to circulate the water. In our project, the **"AC 220-240V"** water pump is used. The water pump is directly connected to the power supply, so that A.C water pump runs directly.

Figure 3.4 Water pump

CHAPTER 4

4.COST ESTIMATION

The cost spent for completion of the project is tabled below (Table 4.1). The major cost is shared by the solar panel and the 12V battery, which are cost high in production. The DC gear motor, water pump and the sheet metal are the major materials used in the fabrication of the project.

S.NO	MATERIAL	QUANTITY	COST
1.	SOLAR PANEL	1	750
2.	BATTERY (12V)	1	820
3.	SHEET METAL	90*90cm	300
4.	DC GEAR MOTOR	1	220
5.	WATER PUMP	1	200
6.	L-ANGLED FRAMES	3	40
7.	CONNECTING WIRES	FEW	10
8.	METAL PASTER	1	30
9.	ARALDITE	1	50
10.	WOODEN STRIPS	FEW	10
	TOTAL		2,430

Table 4.1

CHAPTER 5

5. FABRICATION

The air cooler body is made up of the sheet metal of thickness(0.25mm) and of dimensions(90*90cm) which covers the whole body of the air conditioner. The DC motor is placed inside the metal body supported by a long rod from the base. The conditioner body consists of several openings which are covered by the wooden strips. The wooden strips are made wet by circulating the water through the water pump and also used to maintain the air at moisture condition. The DC motor is powered by the battery (12V) through the connecting wires. The solar energy harvested from the solar panels are stored in rechargeable battery. (Fig 5.1) shows the systematic diagram of solar air cooler body.

CHAPTER 6

6. 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. 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. (Fig 6.1) shows the working process of the solar air cooler.

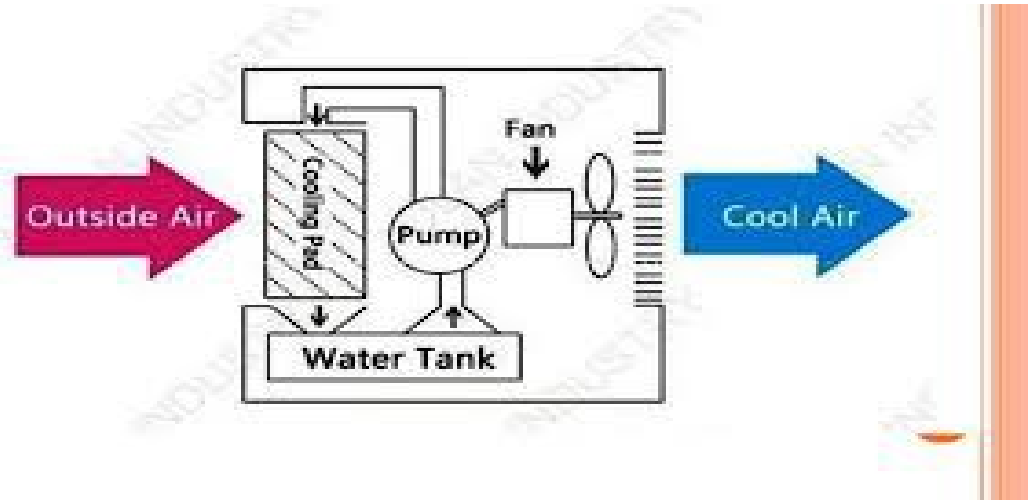

Figure 6.1 Function of air cooler

The process involved in cooling of solar air cooler is Indirect cooling. Indirect evaporative cooling (closed circuit) is a cooling process that uses direct

evaporative cooling in addition to some type of heat exchanger to transfer the cool energy to the supply air.

The cooled moist air from the direct evaporative cooling process never comes in direct contact with the conditioned supply air. The moist air stream is released outside or used to cool other external devices such as solar cells which are more efficient if kept cool. One indirect cooler manufacturer uses the so-called Maisotsenko cycle which employs an iterative (multi-step) heat exchanger that can reduce the temperature of product air to below the wet-bulb temperature, and can an approach the dew point. While no moisture is added to the incoming air the relative humidity (RH) does rise a little according to the Temperature-RH formula. Still, the relatively dry air resulting from indirect evaporative cooling allows inhabitants' perspiration to evaporate more easily, increasing the relative effectiveness of this technique. Indirect Cooling is an effective strategy for hot-humid climates that cannot afford to increase the moisture content of the supply air due to indoor air quality and human thermal comfort concerns. The following graphs (Fig 6.2) describe the process of direct and indirect evaporative cooling with the changes in temperature, moisture content and relative humidity of the air.

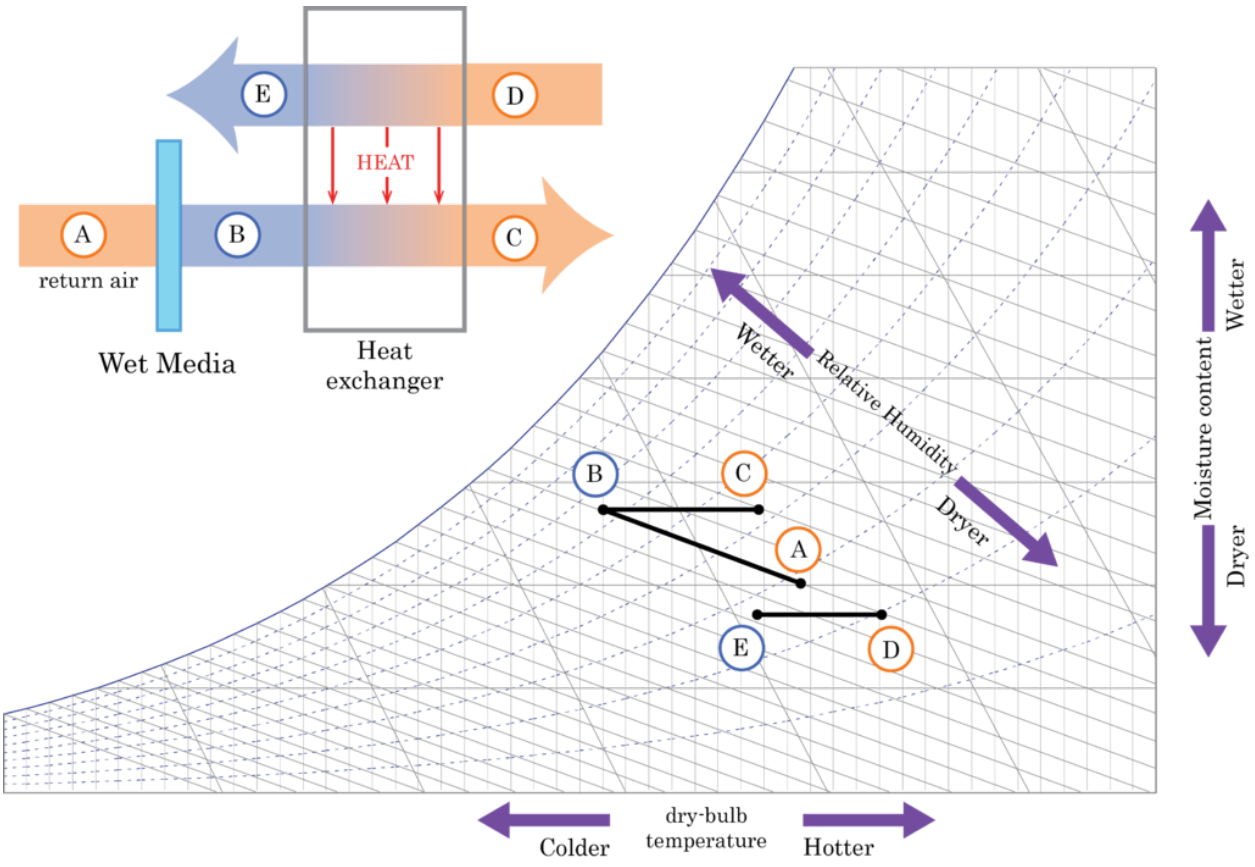

Figure 6.2 Indirect cooling process

CHAPTER 7

7.APPLICATIONS

- Solar air conditioner is used in schools, offices, meeting halls and seminar halls.
- It can be used in rural areas where power cut is problem.
- We can maintain the room temperature at the required level.

8.ADVANTAGES

- This system is eco-friendly in operation.
- It is portable, so it can be transferred easily from one place to another place.
- Non-conventional source as fuel.
- Maintenance cost is low.

9.DISADVANTAGES

- Initial cost is high.
- Solar panel saves energy during day only.

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. 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.

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.