

Eco-Friendly Solar Air Temperature Regulation System Using Modern Technology

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Abstract:

Paper outlines the implementation of photovoltaic driven air cooling cum heating system powered from solar panels with a battery bank. Different from conventional refrigeration systems, thermoelectric refrigeration, based on the Peltier effect, does not require any compressor, expansion valves, absorbers, condensers or solution pumps. Moreover, it does not require working fluids or any moving parts, which is friendly to the environment and results in an increase in reliability. It simply uses electrons rather than refrigerants as a heat carrier. Nowadays, Thermo electric refrigeration devices have a distinct place in medical applications, electronic applications, scientific equipment and other applications, where a high-precision temperature control is essential.

THE SOLAR PELTIER COOLER CUM HEATER successfully demonstrates how renewable energy and thermo electric technology can be combined to create an efficient, eco-friendly temperature control system. It provides both cooling and heating functions using solar energy, reducing dependency on conventional power sources. This proves that sustainable and compact system can play a vital role in achieving energy efficiency, environmental conservation, and comfort in modern living and working spaces.

Keywords: photovoltaic, Peltier effect, Thermo electric refrigeration, renewable energy, solar energy.

INTRODUCTION

“Faster, mightier & smaller” is still the keyword for every invention and development. In day-to-day world we concentrate on the compactness and efficiency of every product. Keeping this in our thought we have designed and fabricated an economical and reliable unit known as “Solar air conditioner”.

“Human comfort is that condition of mind, which expresses itself with the thermal environment”. In our project two rival properties of cool water and cool air are obtained. This system can be used continuously. By using our system there is no need of going for a separate air conditioner or air cooler.

REVIEW OF LITERATURE

THERMAL EXCHANGE IN HUMAN BODY

The human body works best at certain temperatures like other machines, but it cannot tolerate with range of variations. The human body maintains its thermal equilibrium by three modes of heat transfer i.e. evaporation, radiation and convection.

A human body feels comfortable when the heat produced by metabolism of human body is equal to the sum of heat dissipated to the surroundings. The normal temperature of the human body is 37 degree centigrade or 98.6 degree Fahrenheit. But, if this level goes below 36.5 degree centigrade or 98 degree

Fahrenheit and exceeds 40.5 degree centigrade or 105 degree Fahrenheit, the conditions become dangerous for human existence.

USUAL CONDITIONS ACCORDING TO THE METEOROLOGICAL DEPARTMENT ARE

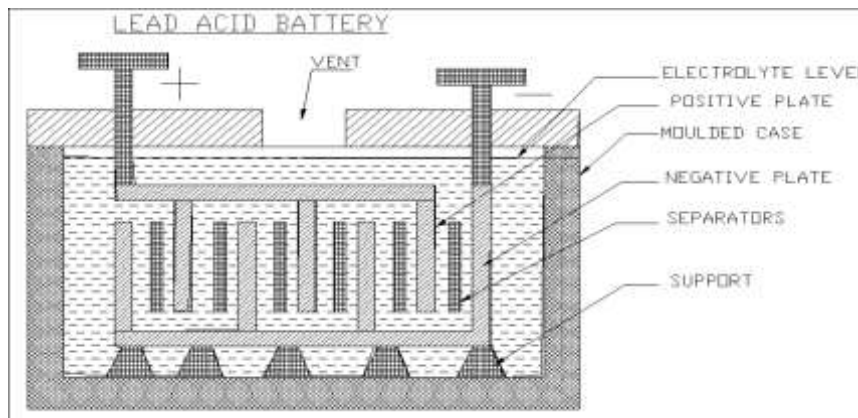
S. No.	CONTENTS	COIMBATORE	CHENNAI
1.	DBT	34.7 [^] C	36.3 [^] C
2.	WBT	27.5 [^] C	28.5 [^] C
3.	RH	58%	72%
4.	ET	30 [^] C	32 [^] C

BATTERY

In isolated systems away from the grid, batteries are used for storage of excess solar energy converted into electrical energy. The only exceptions are isolated sunshine load such as irrigation pumps or drinking water supplies for storage. In fact for small units with output less than one kilowatt. 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. To be economically attractive the storage of solar electricity requires a battery with a particular combination of properties: Low cost, long life, High reliability, High overall efficiency, Low discharge, Minimum maintenance, Ampere hour efficiency, Watt hour efficiency, We use lead acid battery for storing the electrical energy from the solar panel for lighting the street and so about the lead acid cells are explained below.

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



CONSTRUCTION:

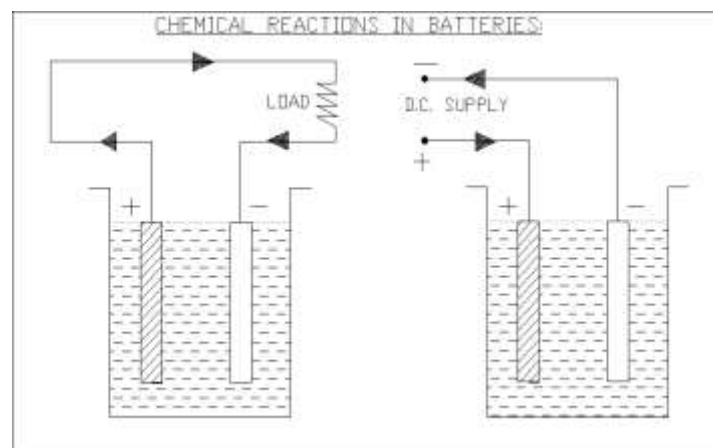
Inside a lead-acid battery, the positive and negative electrodes consist of a group of plates welded to a connecting strap. The plates are immersed in the electrolyte, consisting of 8 parts of water to 3 parts of concentrated sulfuric acid. Each plate is a grid or framework, made of a lead-antimony alloy. 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).

Automobile batteries are usually shipped dry from the manufacturer. The electrolyte is put in at the time of installation, and then the battery is charged to form the plates. With maintenance-free batteries, little or no water need be added in normal service. Some types are sealed, except for a pressure vent, without provision for adding water. The construction parts of battery are shown in above figure.

CHEMICAL ACTION:

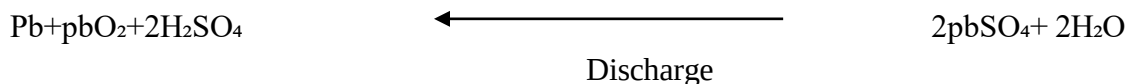
Sulfuric acid is a combination of hydrogen and sulfate ions. When the cell discharges, lead peroxide from the positive electrode combines with hydrogen ions to form water and with sulfate ions to form lead sulfate. Combining lead on the negative plate with sulfate ions also produces the sulfate. Therefore, the net result of discharge is to produce more water, which dilutes the electrolyte, and to form lead sulfate on the plates.

As the discharge continues, the sulfate fills the pores of the grids; retarding circulation of acid in the active material. Lead sulfate is the powder often seen on the outside terminals of old batteries. When the combination of weak electrolyte and sulfating on the plate lowers the output of the battery, charging is necessary.



At the same time, charging enables the lead sulfate on the negative plate to react with hydrogen ions; this also forms sulfuric acid while reforming lead on the negative plate to react with hydrogen ions; this also forms currents can restore the cell to full output, with lead peroxide on the positive plates, spongy lead on the negative plate, and the required concentration of sulfuric acid in the electrolyte. The chemical equation

Charge



On discharge, the pb and pbo₂ combine with the SO₄ ions at the left side of the equation to form lead sulfate (pbSO₄) and water (H₂O) at the right side of the equation. One battery consists of 6 cell, each have an output voltage of 2.1V, which are connected in series to get an voltage of 12V and the same 12V battery is connected in series, to get an 24 V battery. They are placed in the water proof iron casing box.

CURRENT RATINGS:

Lead-acid batteries are generally rated in terms of how much discharge currents they can supply for a specified period of time; the output voltage must be maintained above a minimum level, which is 1.5 to 1.8V per cell. A common rating is ampere-hours (A.h.) based on a specific discharge time, which is often 8h. Typical values for automobile batteries are 100 to 300 A.h.

As an example, a 200 A.h battery can supply a load current of 200/8 or 25A, used on 8h discharge. The battery can supply less current for a longer time or more current for a shorter time. Automobile batteries may be rated for “cold cranking power”, which is related to the job of starting the engine. A typical rating is 450A for 30s at a temperature of 0 degree F. Note that the ampere-hour unit specifies coulombs of charge. For instance, 200 A.h. corresponds to 200A*3600s (1h=3600s). This equals 720,000A.S, or coulombs.

SPECIFIC GRAVITY: Measuring the specific gravity of the electrolyte generally checks the state of discharge for a lead-acid cell. Specific gravity is a ratio comparing the weight of a substance with the weight of a substance with the weight of water. For instance, concentrated sulfuric acid is 1.835 times as heavy as water for the same volume. Therefore, its specific gravity equals 1.835. The specific gravity of water is 1, since it is the reference.

In a fully charged automotive cell, mixture of sulfuric acid and water results in a specific gravity of 1.280 at room temperatures of 70 to 80°F. as the cell discharges, more water is formed, lowering the specific gravity. When it is down to about 1.150, the cell is completely discharged.

CHARGING THE LEAD-ACID BATTERY: An external D.C. voltage source is necessary to produce current in one direction. Also, the charging voltage must be more than the battery e.m.f. Approximately 2.5 per cell are enough to over the cell e.m.f. so that the charging voltage can produce current opposite to the direction of discharge current.

Note that the reversal of current is obtained just by connecting the battery VB and charging source VG with + to + and – to –, as shown in figure. The charging current is reversed because the battery effectively becomes a load resistance for VG when it higher than VB. In this example, the net voltage available to produce charging currents is 15-12=3V.

A commercial charger for automobile batteries is essentially a D.C. power supply, rectifying input from the AC power line to provide D.C. output for charging batteries.

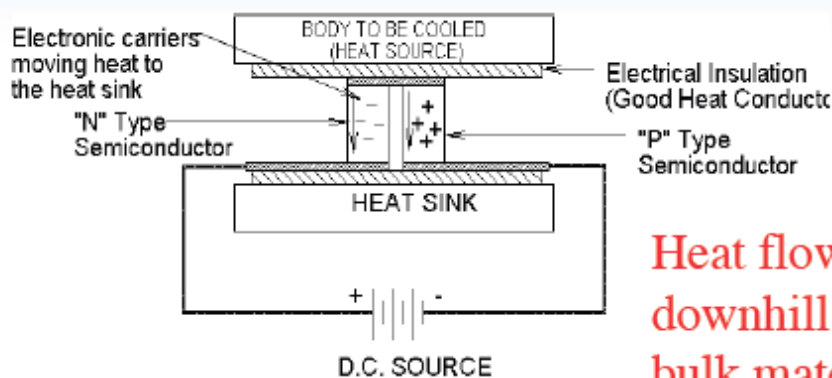
Float charging refers to a method in which the charger and the battery are always connected to each other for supplying current to the load. In figure the charger provides current for the load and the current necessary to keep the battery fully charged. The battery here is an auxiliary source for D.C. power.

It may be of interest to note that an automobile battery is in a floating-charge circuit. The battery charger is an AC generator or alternator with rectifier diodes, driven by a belt from the engine. When you start the car, the battery supplies the cranking power. Once the engine is running, the alternator charges the

battery. It is not necessary for the car to be moving. A voltage regulator is used in this system to maintain the output at approximately 13 to 15 V.

THERMO ELECTRIC ZIP COOLER:

The classic vacuum diode is on the top left. Used in vacuum tubes, television screens and numerous scientific instruments and tools, the vacuum diode is a highly mature technology. The Thermionic Converter is in the middle. Conceived at the beginning of the 20th century, the thermionic converter was proven to work in the 1950s, but largely abandoned by the early 1970s. The thermionic converter harnesses a thermal differential to create electrical output power. The Cool Chip is the Power Chipin reverse. Instead of creating power from a thermal difference, the Cool Chip creates a thermal difference (cooling) from electrical power.

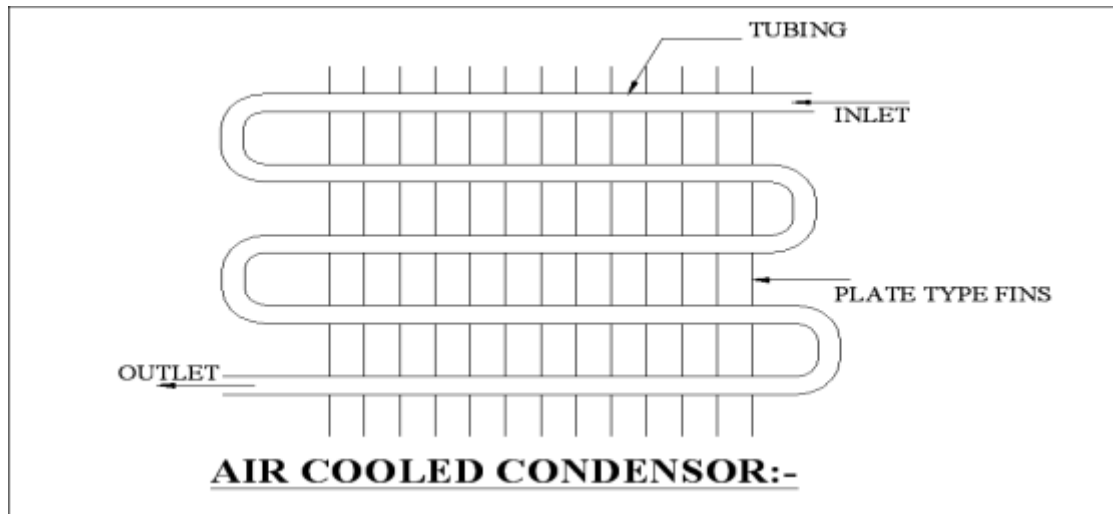


Heat flows downhill through bulk material - regardless of electrical flow

Thermo electrics also has a long pedigree. Using a combination of the Seebeck, Thomson and Peltier effects, cooling occurs when electricity flows through materials and specific junctions. Classic thermoelectric work, but with very low efficiency. The reason is simple. Heat will flow through any material, and does not require electrons to do so. So as soon as one side becomes colder than the other, then natural conduction will seek to equilibrate the two sides. As a result, efficiencies, expressed as a percentage of the Carnot-defined maximum, do not exceed 5-8%. For decades, researchers have hunted for the ideal material which would make thermoelectric efficient.

CONDENSER:

The condenser is an important device, used in the high pressure side of a refrigeration system. Its function is to remove heat of the vapour refrigerant discharged from the compressor. The hot vapour refrigerant consists of the heat absorbed by the evaporator and the heat of compression added by the mechanical energy of the compressor motor. The heat from the hot vapour refrigerant in a condenser is removed first by transferring it to walls of the condenser tubes and then from the tubes to the condensing or cooling medium.



FIN AND TUBE CONDENSER: The fin and tube condenser is one in which the removal of heat is done by air. It consists of steel or copper tubing through which the refrigerant flows. The size of tube usually ranges from 6mm to 18mm outside diameter, depending upon of the size of the condenser. Generally copper tubes are used because of its excellent heat transfer ability. The tubes are usually provided with plate type fins to increase the surface area for heat transfer. The fins are usually made from aluminums because of its light weight.

The condensers with the single row of tubing provide the most efficient heat transfer. This is because the air temperature rises as it passes through each row of tubing. The temperature difference between the air and the vapour refrigerant decreases in each row of tubing and therefore each row becomes low effective. However single row condensers required more space than multi row condensers.

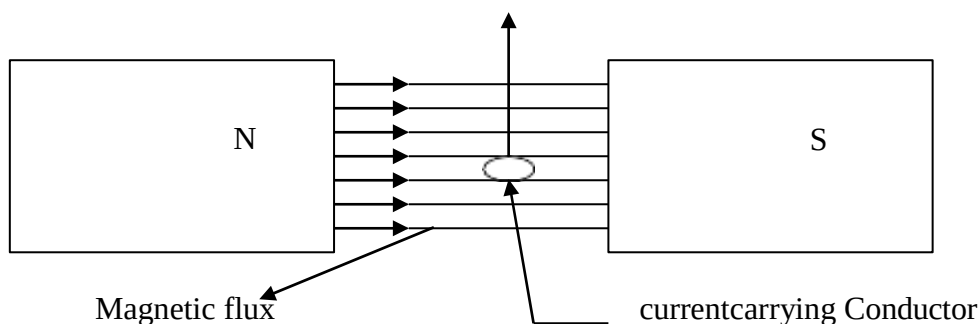
D.C BLOWER

The fan (impeller) rotates inside the shell. The shell is so designed that the air is rushed out force. The blower consists of two main parts. They are

PRINCIPLE OF OPERATION:

The basic principle of motor action lies in a simple sketch. The working principle tells that, when a current carrying conductor is placed in a magnetic field, a force is produced to move the conductor away from the magnetic field.

Movement of Conductor



The force given by the equation,
 $F = BIL$ Newton's

Where, B = Flux density in $Wb/sq.m$. I = Current through the conductor L = Length of the conductor

Let us consider a single turn coil. The coil side A will be forced to move downward, whereas the coil side B will be forced to move upward. Due to this movement now the coil is made to rotate. Since the coil is arranged in the armature when it rotates in emf is induced in the coil and that emf which is induced in the coil is in opposite to supply emf. Therefore we can call the emf induced as back emf ($B\text{-emf}$). Hence when motor runs normally the supply emf (V) is equal to $B\text{-emf}$.

Therefore $V = V_b + V_a$ (or) $V = V_b + I_a R_a$ (Since $V = IR$) Multiplying both sides by I_a ,

Therefore $V I_a = V_b I_a + (I_a \times I_a) R_a$

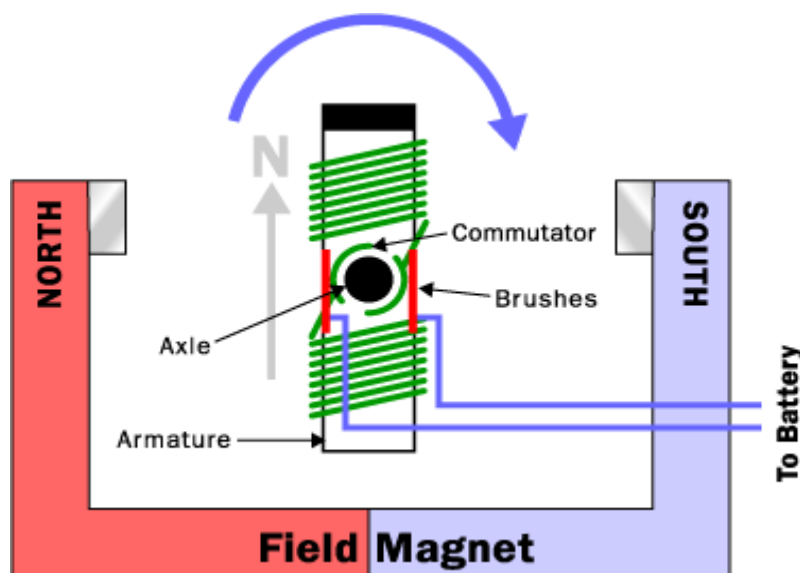
Where $V I_a$ is the electrical equivalent of the mechanical power developed in the motor and $(I_a \times I_a) R_a$ is armature drop.

This process that motor converts electrical energy mechanical energy where $(I_a \times I_a) R_a$ is the copper loss which is to be neglected.

Now consider a single turn coil carrying a current as shown in the above figure. In view of the reasons given above, the coil side A will be forced to move downwards, whereas the coil side B will be forced to move upwards. The forces acting on the coil sides A and B will be of same magnitude. But their direction is opposite to one another. As the coil is wound on the armature core which is supported by the bearings, the armature will now rotate. The commutator periodically reverses the direction of current flow through the armature. Therefore the armature will have a continuous rotation.

A simplified model of such a motor is shown in figure VI. The conductors are wound over a soft iron core. DC supply is given to the field poles for producing flux. The conductors are connected to the DC supply through brushes.

Let's start by looking at the overall plan of a simple 2-pole DC electric motor.



An electric motor is all about magnets and magnetism: a motor uses magnets to create motion. If you have ever played with magnets you know about the fundamental law of all magnets: Opposites attract and likes repel.

In the diagram above and below you can see two magnets in the motor, the armature (or rotor) is an

electromagnet, while the field magnet is a permanent magnet (the field magnet could be an electromagnet as well, but in most small motors it is not to save power).

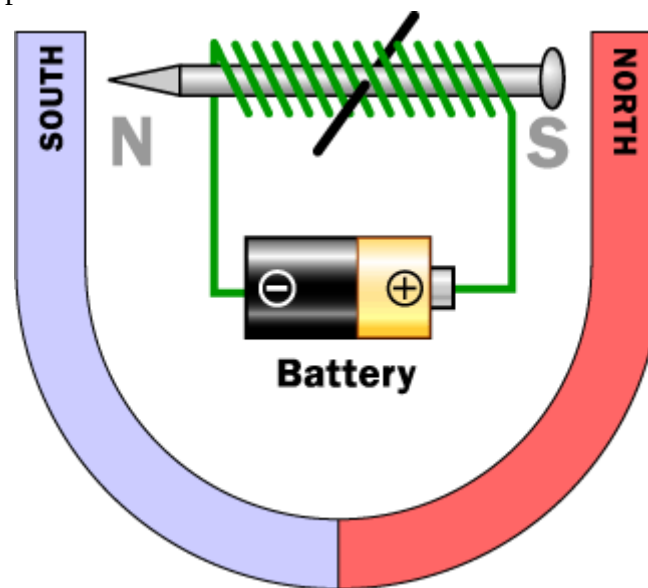
Electro magnets and Motors:

To understand how an electric motor works, the key is to understand how the electromagnet works. An electromagnet is the basis of an electric motor. You can understand how things work in the motor by imagining the following scenario. Say that you created a simple electromagnet by wrapping 100 loops of wire around a nail and connecting it to a battery. The nail would become a magnet and have a North and South pole while the battery is connected.

Now say that you take your nail electromagnet, run an axle through the middle of it, and you suspended it in the middle of a horseshoe magnet as shown in the figure below.

If you were to attach a battery to the electromagnet so that the North end of the nail appeared as shown, the basic law of magnetism tells you what would happen: The North end of the electromagnet would be repelled from the north end of the horseshoe magnet and attracted to the south end of the horseshoe magnet.

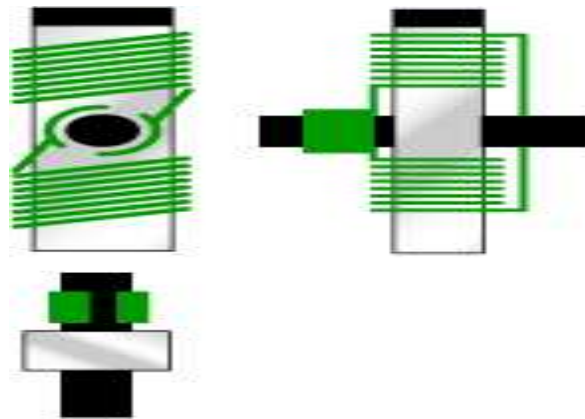
The South end of the electromagnet would be repelled in a similar way. The nail would move about half a turn and then stop in the position shown.



You flip the magnetic field simply by changing the direction of the electrons flowing in the wire (you do that by flipping the battery over). If the field of the electromagnet flipped at just the right moment at the end of each half-turn of motion, the electric motor would spin freely.

The Armature:

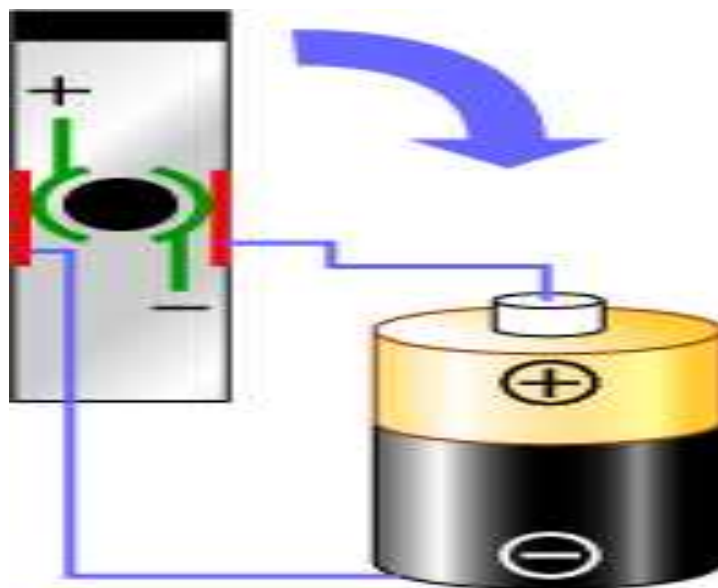
The armature takes the place of the nail in an electric motor. The armature is an electromagnet made by coiling thin wire around two or more poles of a metal core. The armature has an axle, and the commutator is attached to the axle.



In the diagram above you can see three different views of the same armature: front, side and end-on. In the end-on view the winding is eliminated to make the commutator more obvious. You can see that the commutator is simply a pair of plates attached to the axle. These plates provide the two connections for the coil of the electromagnet.

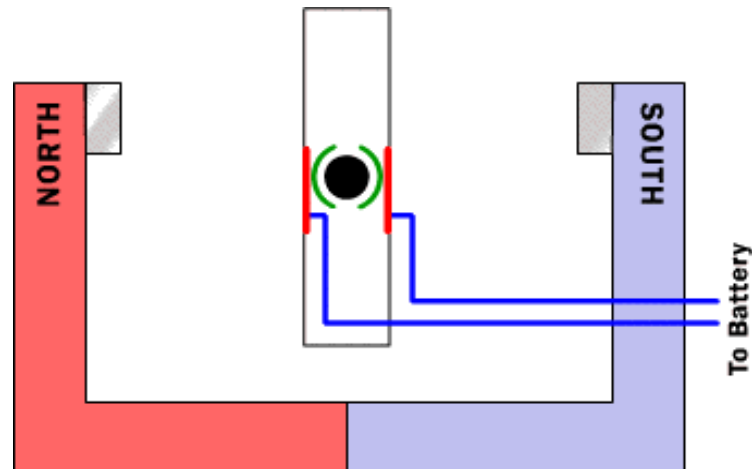
Commutator and brushes:

The "flipping the electric field" part of an electric motor is accomplished by two parts: the **commutator** and the **brushes**. The diagram at the right shows how the commutator and brushes work together to let current flow to the electromagnet, and also to flip the direction that the electrons are flowing at just the right moment.



The contacts of the commutator are attached to the axle of the electromagnet, so they spin with the magnet. The brushes are just two pieces of springy metal or carbon that make contact with the contacts of the commutator.

Putting It All Together:



In this figure, the armature winding has been left out so that it is easier to see the commutator in action. The key thing to notice is that as the armature passes through the horizontal position, the poles of the electromagnet flip. Because of the flip, the North Pole of the electromagnet is always above the axle so it can repel the field magnet's North Pole and attract the field magnet's South Pole. If you ever take apart an electric motor you will find that it contains the same pieces described above: two small permanent magnets, a commutator, two brushes and an electromagnet made by winding wire around a piece of metal.

Almost always, however, the rotor will have three poles rather than the two poles as shown in this article. There are two good reasons for a motor to have three poles:

IMPELLER: Impeller consists of more number of blades. The number of blade increases the cold air rushed out forcibly. The impeller blades are slightly bended, so that the cold air forcibly transmitted to the outside.

SOLAR PANEL: METHODS OF UTILISATION OF SOLAR ENERGY

1. DIRECT METHOD

- Photo Voltaic Method
- Thermal Method

2. INDIRECT METHOD

- Water Power Method
- Wind Power Method
- Bio Mass Method
- Wave Energy Method
- Ocean Power Method

DIRECT METHOD OF UTILIZATION OF SOLAR ENERGY:

The most useful way of harnessing solar energy is by directly converting it into electricity by means of solar photo-voltaic cells. Sunshine 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.

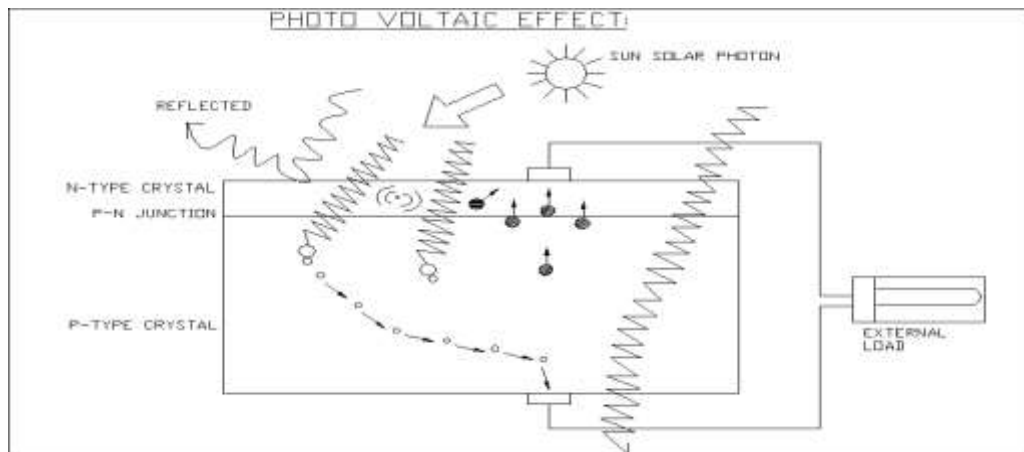
In recent years photo-voltaic power generation has been receiving considerable attention as one of the more promising energy alternatives. The reason for this rising interest lie in PV's direct conversion of sunlight to electricity, the non polluting nature of the PV widespread are of PV generation has been hampered by economic factors. Here to force, the low cost of conventional energy sunlight has obviated the development of a broad-based PV technology. At the present time, PV generation can be justified only for special situations mostly for remote sites where utility lines on other conventional means of furnishing energy may be prohibitively expensive and is one of the most attractive non-conventional energy sources of proven reliability from the micro to the Mega-watt level.

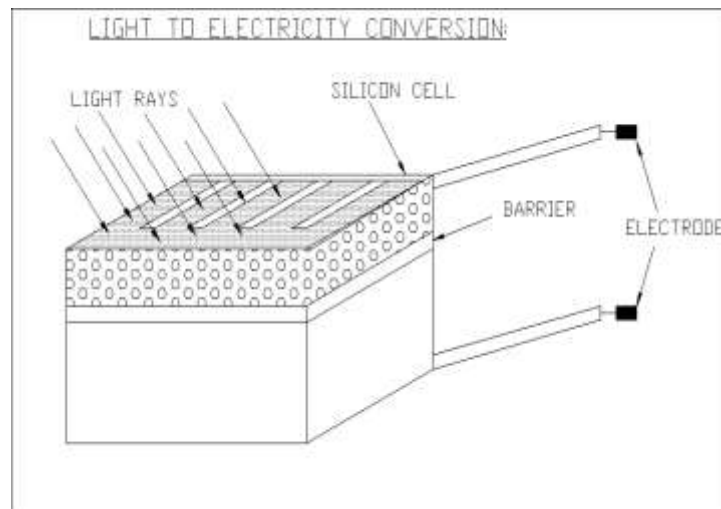
Like other energy system this system also has some disadvantages

- Distributed nature of solar energy,
- Absence of energy storage,
- Relatively high capital cost.

PHOTO VOLTAIC METHOD & PRINCIPLE:

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. To obtain a useful power output from photon interaction in a semiconductor, three processes are required. The photon has to be absorbed in the active part of the material and resulting electrons being excited to a higher energy potential.





1. The electron hole charge carriers created by the absorption must be physically separated and moved to the edge of the cell.
2. The charge carriers 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:-

- Semi-conductor in which electron hole pairs are created by absorption of incident solar radiation.
- Region containing a drift field for charge separation

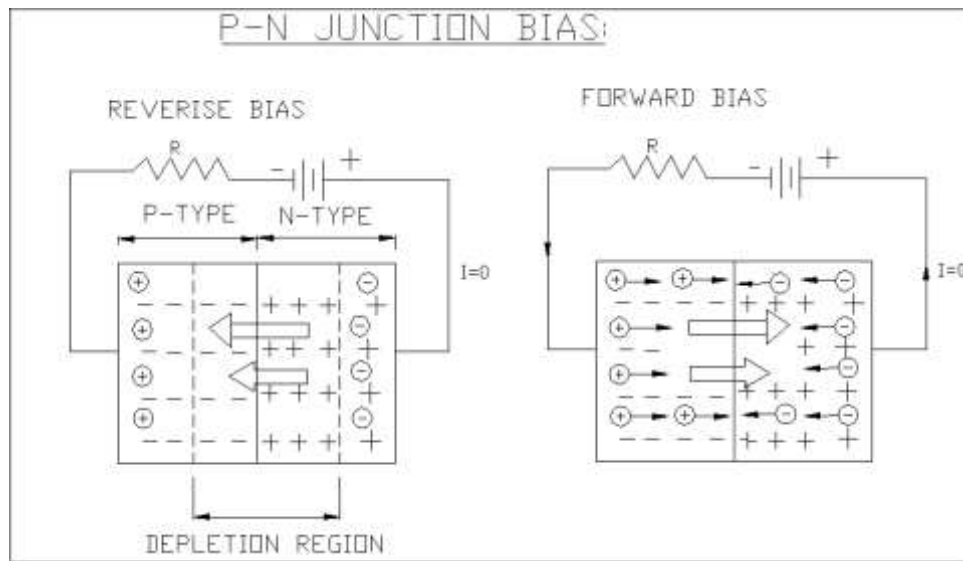
Charge collecting fronts and back electrodes.

The photo-voltaic effect can be described easily for p-n junction in a semi-conductor. In an intrinsic semi-conductor such as silicon, each one of the four valence electrons of the material atomized in a chemical bond, and there are no free electrons at absolute zero. If a piece of such a material is doped on one side by a five valence electron material, such as arsenic or phosphorus, there will be an excess of electrons in that side, becoming an n-type semi-conductor.

The excess electrons will be practically free to move in the semi-conductor lattice. When a three valence electron material, such as boron dopes the other side of the same piece, there will be deficiency of electrons leading to a p-type semi-conductor. This deficiency is expressed in terms of excess of holes free to move in the lattice. Such a piece of semi-conductor with one side of the p-type and the other, of the n-type is called p-n junction. In this junction after the photons are absorbed, the free electrons of the n-side will tend to flow to the p-side, and the holes of the p-side will tend to flow to the n-region to compensate for their respective deficiencies. This diffusion will create an electric field from the n-region to the p-region. This field will increase until it reaches equilibrium for V , the sum of the diffusion potentials for holes and electrons.

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.

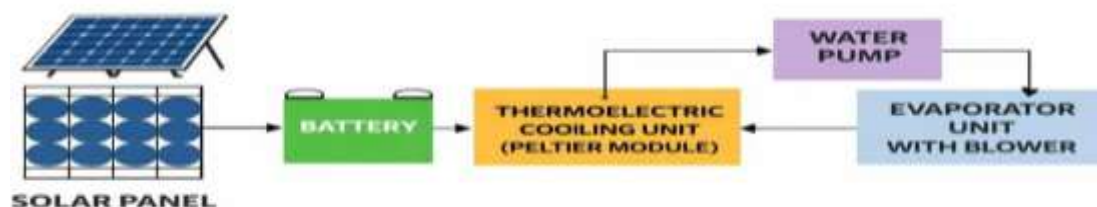


If electrical contacts are made with the two semiconductor materials and the contacts are connected through an external electrical conductor, the free electrons will flow from the n-type material through the conductor to the p-type material (figure). Here the free electrons will enter the holes and become bound electrons; thus both free electrons and holes will be removed. The flow of electrons through the external conductor constitutes an electric current, which will continue as long as free electrons and holes are being formed by the solar radiation. This is the basis of photo-voltaic conversion, that is, the conversion of solar energy into electrical energy. The combination of n-type and p-type semiconductors thus constitutes a photo-voltaic cell or solar cell. All such cells can, at some rate, convert direct current into alternating current if desired.

The photo-voltaic effect can be observed in almost any junction of material that has different electrical characteristics, but the best performance to date has been from cells using semiconductor materials, especially all of the solar cells used for both space and terrestrial applications. These have been made of the semiconductor silicon. Future cells may use such materials as the semiconductors like Gallium arsenate, copper sulfate cadsulphide, etc.

The device used to utilize the PHOTO VOLTAIC EFFECT is SOLAR CELL.

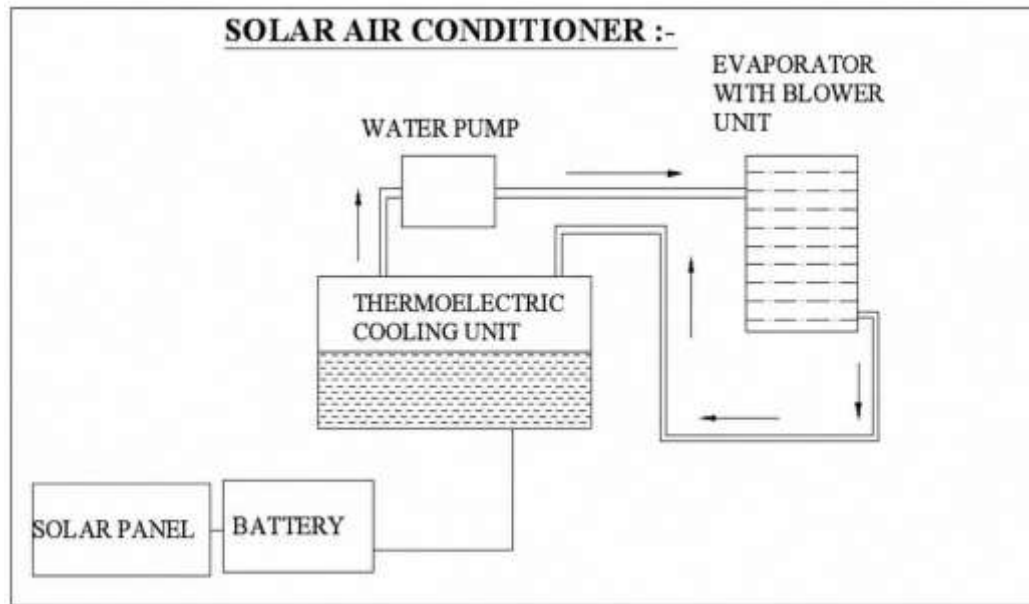
WORKING PRINCIPLE



Solar panel is used for charging the lead acid battery. Here we are using a 12 volt 10 watts panel for demo purpose. The battery supply is given to the thermo-electric zip cooler. Before that, the water is kept inside of the zip cooler. This water is cooled by the principle of Seebeck effect. In our zip cooler, there are two options:

1. Cold Water
2. Hot Water

There is a one changeover switch is used to convert the water into those two mode. This water is circulated by the D.C reciprocating water pump to the evaporator unit. The D.C high speed blower is fitted in front of the condenser so that the cooled air is rushed out force.



ADVANTAGES & DISADVANTAGES

ADVANTAGES

1. Simple in construction
2. This system is noiseless in operation
3. It is portable, so it can be transferred easily from one place to other place
4. Its operate in battery
5. Maintenance cost is low
6. Solar panel is used. so this non-conventional one
7. Solar panel, battery is also used as a lighting system

DISADVANTAGES

- It does not purify air

APPLICATIONS

- Domestic Application
- Office and Bank Application
- It is very much useful in College and Schools

CONCLUSION

In this changing modern world every day there is a new discovery in all fields of science and technology, benefiting the mankind. In this work the design of solar air conditioner is slightly modified with an addition air cooler. If one utilizes energy which goes as waste even more useful things can be made.

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