Battery

Objectives: At the end of the lesson you shall be able to
- **state the classification of cells**
- **describe the primary cells**
- **describe the secondary cells**
- **describe the construction of a lead acid battery**
- **describe the chemical action during discharging**
- **describe the chemical action during charging**
- **describe the maintenance of a battery**
- **describe the testing of a battery.**

A cell is an electrochemical device consisting of two electrodes and an electrolyte. The chemical reaction between the electrodes and the electrolyte produces a voltage.

Cells are classified as:

– dry cells

– wet cells.

Dry cells : A dry cell has paste or gel electrolyte. It is semi-sealed and could be used in any position.

Wet cells : It consists of two plates and a liquid electrolyte. These cells have vent holes to allow the gases to escape during charging and discharging. The most common wet cell is the lead acid cell; wet cells can be recharged for reuse.

Primary cells : Primary cells are those cells which are not rechargeable. Chemical reaction that occurs during discharge is not reversible. The following types of primary cells are used.

– Voltanic cell

– Carbon zinc cell

– Alkaline cell

– Mercury cell

– Silver oxide cell

– Lithium cell.

Secondary cell (Lead acid battery) : These cells can be recharged by supplying electric current in the reverse direction to that of a discharged battery.

Lead acid battery (Figs 1 & 2)**:** This battery is an electrochemical device for converting electrical energy into chemical energy and vice versa. The main purpose of the battery is to store electrical energy in the form of chemical energy. It provides supply of current for operating various electrical accessories, when the engine is not running. When the engine is running it gets electric supply from the dynamo/alternator. It is also known as accumulator and storage battery.

Fig 1

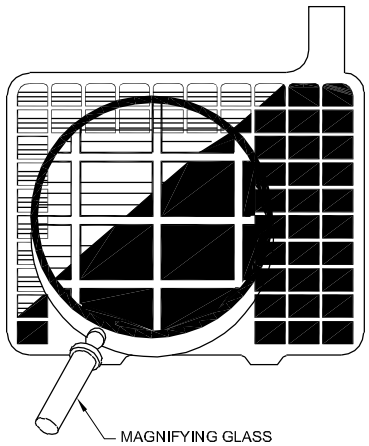
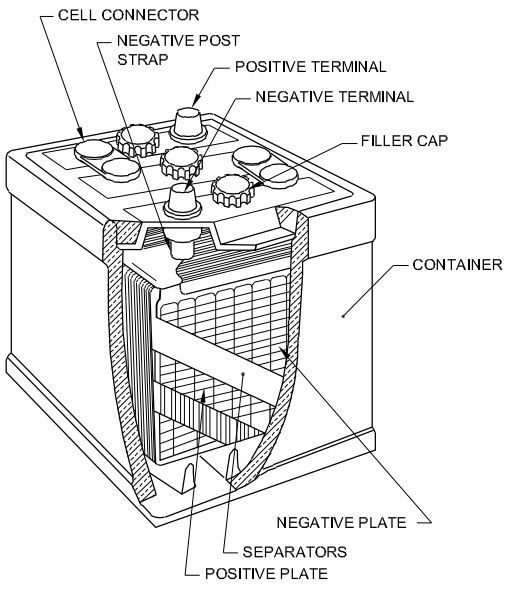


Fig 2



Construction: The automobile battery's plates are rectangular. They are made of lead. Antimony alloy is used to provide them strength.

The group of plates, which are connected to the positive terminal of the cell, consists of grids filled with a paste of lead peroxide. This lead is brown in colour. The group of plates, which are connected to the negative terminal of the cell, consists of grids filled with metalic lead which is spongy in nature. This lead is dull grey in colour.

Each a group of plates is held together by a post strap, to which individual plates are welded. The post strap is extended up to the cell cover to provide battery terminals. The positive and negative plates are arranged alterna-tively, and in between the plates, seperators are used to prevent contact of the positive and negative plates. Separators are made of specially treated wood, hard rubber, resin, integrated fibre or in combination with rubber or mats of glass fibres. The container in which the plates are placed is made of hard rubber which is not affected by the electrolyte. A solution of sulphuric acid and distilled water is added until the level of the liquid in the container is about 1/4" to 3/8" above the top of the plates. A filler cap with air vents is provided to allow gases to escape From battery cells..

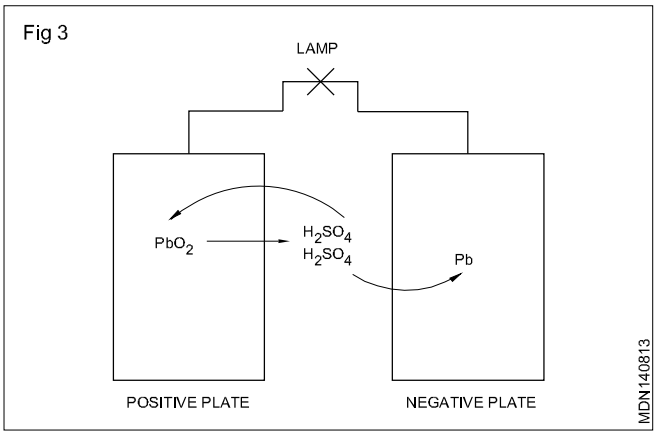
Chemical Reactions

Discharging (Fig 3)**:** During discharging, the sulphuric acid is broken into two parts, hydrogen (H_2) and sulphate (SO_4). The hydrogen is liberated at the lead peroxide plates (PbO_2) reducing them to lead oxide (PbO) which combines with parts of the sulphuric acid to form lead sulphate ($PbSO_4$) and water (H_2O). The SO_4 is liberated at the spongy lead plate (Pb) and combines with them to form lead sulphate ($PbSO_4$). During this process the electrolyte becomes less concentrated due to absorption of the sulphate by the lead plates.

$$PbO_2 + 2H_2SO_4 + Pb \rightleftharpoons PbSO_4 + 2H_2O + PbsO_4$$

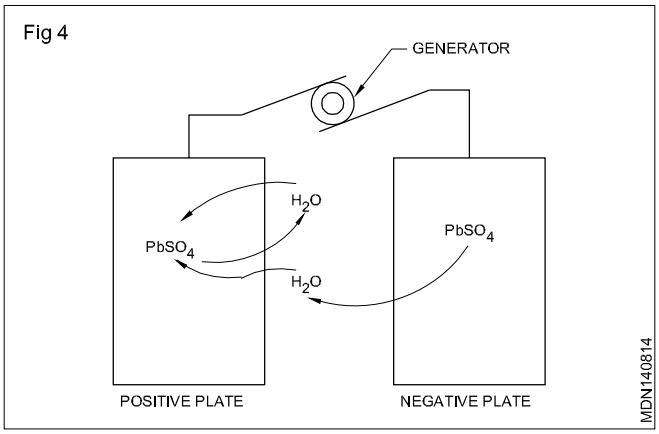
(+ve) (electrolyte) (-ve) (+ve) (water) (-ve)

Fig 3



Charging (Fig 4)

Fig 4



When the battery is charged (Fig 4) by passing current through a dynamo or charger in the opposite direction, the reverse chemical reaction takes place. The lead sulphate on one plate becomes lead peroxide (+ve plate). The lead sulphate on the other plate (-ve plate) becomes spongy lead and the electrolyte becomes more concentrated because of the increased amount of sulphuric acid.

$$PbSO_4 + 2H_2O + PbSO_4 \rightleftharpoons PbO_2 + 2H_2SO4 + Pb$$

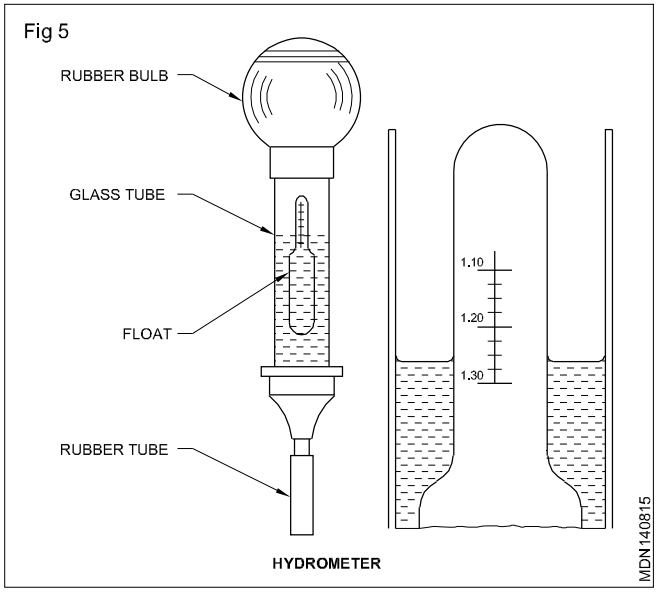
(+ve) (water) (-ve) (+ve) (Electrolyte) (-ve)

Maintenance of battery : Batteries are expensive items to replace. They should be serviced regularly as recommended by the manufacturer. If maintained properly, they can be used for longer periods. The following aspects are to be checked to maintain the battery in good condition.

Check and top up electrolyte level every week. Electrolyte should be 10 mm to 15 mm above the plates.

Check the specific gravity of the battery with a hydrometer.(Fig 5) If the specific gravity falls below 1.180 then add a few drops of sulphuric acid.

Fig 5



Sp. gravity readings and the state of charge of the battery are as follows.

Sl.No.	Specific	State of charge of the battery
1	1.260 - 1.280	Fully charged
2	1.230 - 1.260	3/4 charged
3	1.200 - 1.230	1/2 charged
4	1.170 - 1.200	1/4 charged
5	1.140 - 1.170	About run down
6	1.110 - 1.140	Discharged

Check the voltage across the cell terminals of each cell by using a cell tester. Cell voltage is 2 to 2.3 volts per cell for fully charged condition.

If the voltage of each cell is less than specified, then the battery should be recharged.

While charging do not overcharge the battery.

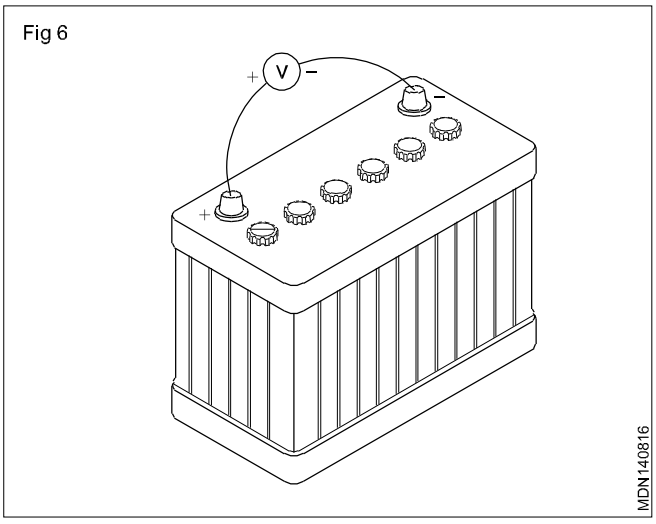
Keep the battery terminals always tight and clean.

To prevent formation of corrosion on the terminals smear petroleum jelly on it.

Voltage check of battery : With the help of a voltmeter the voltage of battery is tested. This will commonly vary from 12-13V

Battery selection (Fig 6)**:** Most cars in current production are equipped with a 12V battery. When a manufacturer installs a battery in a new car that battery is chosen to meet the requirements of that particular car. Prime importance is the battery's ability to crank and start the engine. The current required to crank on engine can range from 150A to over 1000A depending on the size of the engine, the temperature and the viscosity of the oil in the engine. Those factors are all considered in battery selection. The number and type of electrical options installed in the car are also considered.

Fig 6



The lead acid batteries are made for different vehicle application to suit the electrical demands, While the voltage of the battery remains same for all application, the ampere-hour rate changes as per demand.

The following examples reveal the importants of ampere-hour of a battery.

Vehicle type	Battery applicable
2.5 Amps 12V	Two wheeler without starter
7 Amps 12V	Two wheeler with starter motor
35 Amps 12V	800CC - 1000 car petrol
40 - 45 Amps 12V	1300CC Diesel vehicles
60 Amps 12V	2.5 Ltrs LCV
80 Amps 12V	4 Ltrs medium
120 Amps 12V	6 Ltrs Diesel HCV
180 Amps 12V	6 Ltrs Diesel passenger

Battery rating

Ampere-hour rating: The ampere-hour rating provides a measure of how much current a battery at 80^0F (27^0C) will deliver for a fixed period of time without the cell voltage dropping below 1.75V (10.5 total terminal volts). Due to a specified 20 hour time period, this test is sometimes referred to as the "20 hour test". The rating number is determined by multiplying the current delivered by 20. If a battery can deliver 3A for the 20 hour period, it receives a 60 ampere-hour rating. If a battery can deliver 5A for the 20 hour period, it receives a rating of 100 ampere-hour.

CONVENTIONAL BATTERIES

BATTERY CAPACITY (AMPERE HOURS)	DISCHARGE RATE (AMPERES)
36	155
41	145
45	190
53	175
54	225
68	220
77	228

MAINTENANCE-FREE BATTERIES

BATTERY CAPACITY (AMPERE HOURS)	DISCHARGE RATE (AMPERES)
53	200
63	215
68	235

Battery charging: A discharged battery in good condition can be charged and retuned to service.

Many types of battery in use, but all chargers operate on the same principle. They apply an electrical pressure that forces current through the battery to reverse the electro chemical action in the cells.

Charging rates: The amount of charge a battery receives is equal to the rate of charge, in amperes, multiplied by the amount of time, in hours, that the charge is applied. As an example, a battery charged at the rate of 5A for a period of 5 hours would receive a 25 ampere-hour charge. To bring a battery to a fully charged condition.

Initial rate for constant voltage taper rate charger.

To avoid damage, charging rate must be reduced or temporarily halted if:

1 Electrolyte temperature exceeds 125^oF.

2 Violent gassing or spewing of electrolyte occurs.

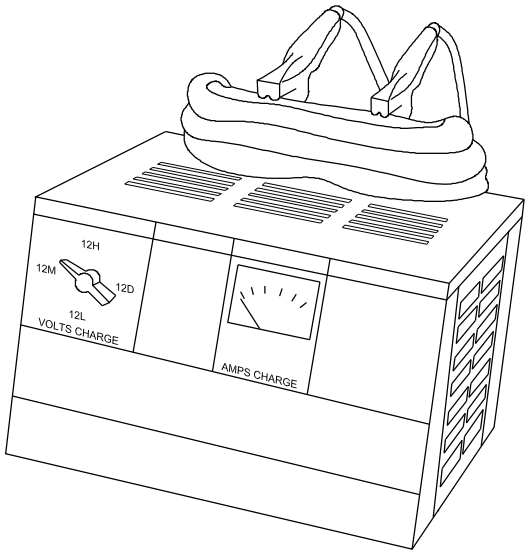
Battery is fully charged when over a two hour period at a low charging rate in amperes all cells are gassing freely and no change in specific gravity occurs. For the most satisfactory charging, the lower charging rates in amperes are recommended.

Full charge specific gravity is 1.260 - 1.280 corrected for temperature with electrolyte level at split ring.

Slow charging (Fig 7)**:** Slow charging consists of charging a battery at a rate of about 5A for a time sufficient to bring the specific gravity of the electrolyte to its highest reading. Slow charging many require from 12 to 24 hours of time. A battery that is sulphated may require even more time. During the charging period, the electrolyte temperature should not exceed 110^0F (43^0C). If the electrolyte temperature rises above 110^0F (43^0C), the charging rate should be decreased.

A conventional battery with vent plugs is considered fully charged when the electrolyte is gassing freely and when no further rise in the specific gravity is noted at intervals of 1 hours. a sealed battery should be slow charged until the green dot appears in the built-in hydrometer. in some instances, a sealed battery must be slightly shaken to allow the green dot to appear.

Fig 7

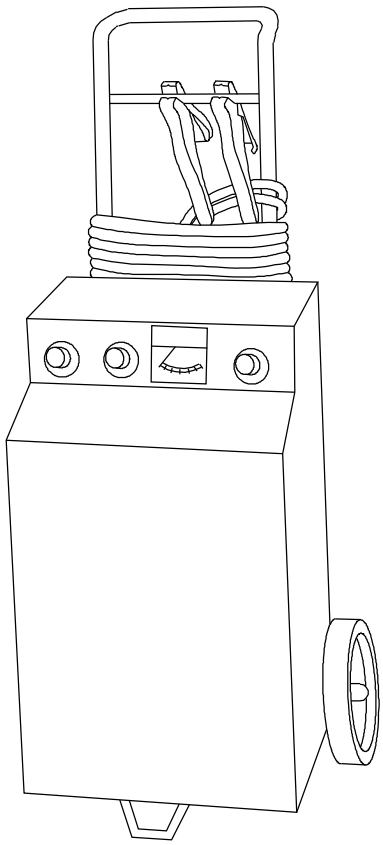


A TYPICAL SLOW CHARGER

Fast charging (Fig 8)**:** Fast charging will not fully recharge a battery, it will restore the charge sufficiently to allow the battery to be used.

Fast charging consists of charging a battery at a rate from 10 to 50A. The exact charging rate depends on the construction of the battery, the condition of the battery and the time available. The temperature of the electrolyte provides an indication of the current charging rate. If the electrolyte temperature rises above 125^0F (65^0C), the charging rate is too high and should be reduced. Since a high charging rate and the resultant high temperature can damage a battery, a battery should be charged at the lowest possible rate.

Fig 8



A TYPICAL FAST CHARGER

Features of sealed maintenance free battery

- No need for checking electrolyte level and tapping throughtout the life.
- Seal construction ensures no leakage of electrolyte from terminal or casing.

Benefits

- Saving of 100 litres of distilled water through out its life time as compared to convention batteries.
- Saving of man power for regular topping up & cleaning corroded terminals as in conventional batteries.
- No damage of flooring by spoilage of batteries acid or water during maintenance.
- No need of separate battery room.
- It indicates the battery current charging rate through inbuilt indictor.

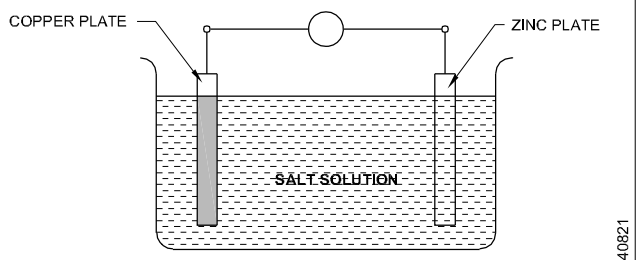
Electricity effects

Objectives: At the end of this lesson you shall be able to
- **state the electro chemical process**
- **state the effect of an electric currents.**
- **state the thermo couple**
- **state the thermo electric energy**
- **state the piezo electric energy.**
- **state the photo voltaia energy.**

Chemical sources (Electro chemical process) (Fig 1)

If two electrically conducting materials (metals) are immersed in salt solutions, an electric charge is produced between the two metals (electrodes, poles). Two examples are given below.

Fig 1



ELECTRICITY GENERATION BY DISSOLVING IN ELECTROLYTES

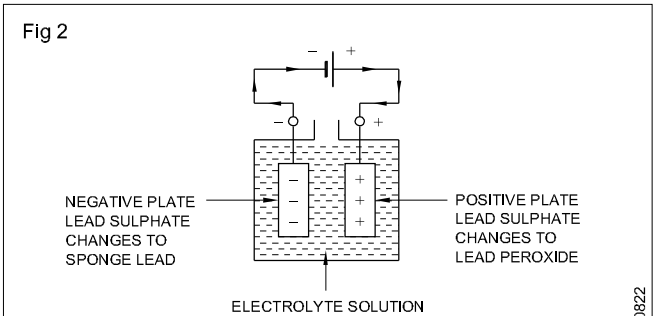
Copper and Zinc in salt solution is one combination

Lead and sulphuric acid is another combination.

This arrangement is known as wet cell and gives direct current. The second combination is used in a Lead Acid Battery for Motor vehicles.

Dynamic electricity (Fig 2)

Fig 2



DURING CHARGING PROCESS

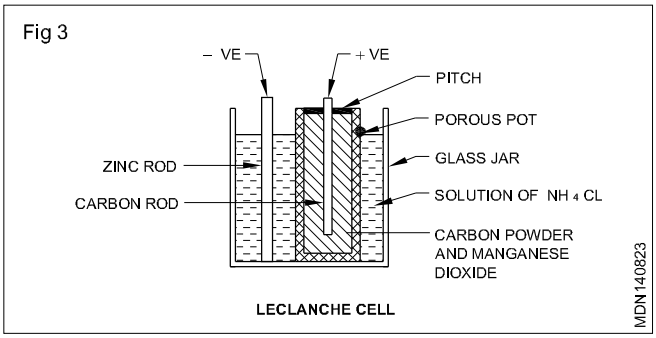
The current is produced by A/C or D/C generators, by conversion of mechanical energy into electrical energy. The generation of electric current is based on the fact when a conductor is moved in a magnetic field an E.M.F is set up in the conductor. When a large number of conductors are moved in a powerful magnetic field, high voltages and current are produced. This is the Principle of Dynamo.

The effect of an electric current

Let us now study effects of an electric current. When an electric current flows through a circuit, its presence could be analysed by its effects. They are stated below.

Chemical effect (Fig 3)

Fig 3



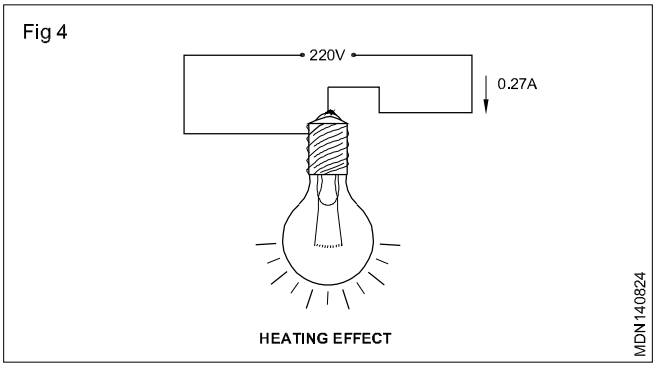
LECLANCHE CELL

When a current is applied to a battery from a battery charger various chemical reactions are produced which enable the electrical energy to be stored in a chemical form.

The process is called charging a battery by electrolysis method (using electric current).

Heating effect (Fig 4)

Fig 4



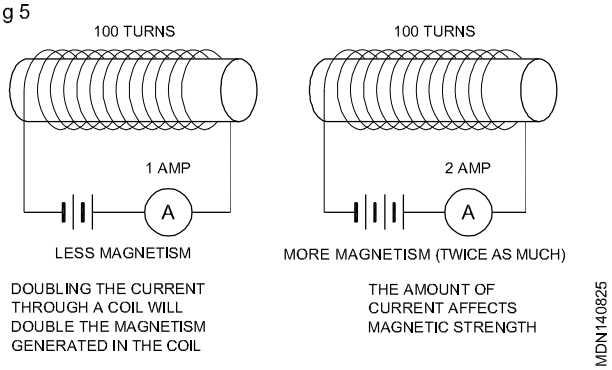
HEATING EFFECT

When a current is applied to a bulb filament (fine wire) it becomes white hot and thus produces light.

Magnetic effect (Fig 5)

- If a soft iron bar is placed in a coil of wire and a current is passed through the wire, the iron bar becomes magnetised. If the current is withdrawn the bar with retain some magnetism depending on the materials.
- If a bar magnetic is moved in a coil of wire, to and fro then Current flow is occurred in the coil of wire. This can be find by connecting a "Galvanometer".The current, will flow only when the bar magnet is moving actually. Because, the turns of coil of wire should cut the lines of force.

Fig 5



Shock effect

If the current flow through Human body, it may give a severe stock or cause even death of the individuals so one must be careful in dealing with electrical current during work.

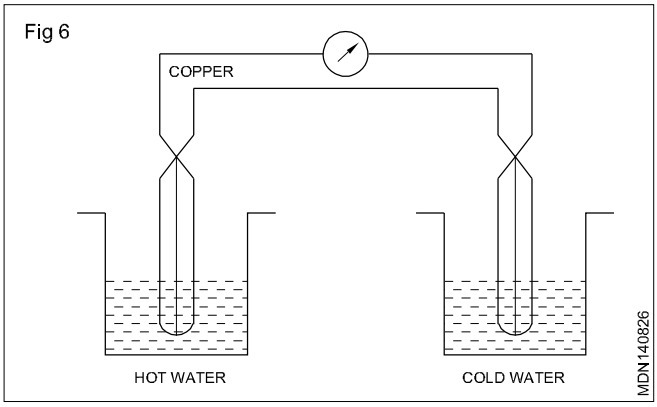
Note :

In motor vehicle trade application, the following effect electric current are widely used

- Chemical effect-for battery.
- Heating effect-Head lamp bulbs for lighting.
- Magnetic effect-Electro magnets in relays and cuts.

Thermocouple (Fig 6)

Fig 6



This is such an arrangment where circuit is closed by wires of different metals. One metal wire is kept at low temperature and the other at high temperature. In this way thermo-electro motive force is created which can be seen by galvanometer. This works on the effect of seebake.

Thermo electric energy

Thermo electric energy is the electrical energy produced by waste heat of an IC engine using seeback effect.

Thermo electric generation can convert waste heat from an engine coolant or exhaust into electricity.

Piezo - electric energy

Piezo electric sensor is a device that uses the piezo electri effect to measure the changes in pressure, acceleration or force, by convertring them to an electrical charge.

Application

It is used to initiate combustion in the IC engine mounted into a holes into the cylnider head.Glow plug is a in-built miniature piezo-electric sensor.

Photo voltaic energy:

Photo volatile (PV) is a term which covers the conversion of light into electricity by using semiconducting materials that exhibit the photovoltaic effect. This effect is seen in combination of two layers of semi conductor materials, one layer of this combination will have it depleted number of electrons.

When sunlight strikes on this layer, it absorbs the photons of sunlight ray and consequently the electrons are excited and jump to the other layer. This phenomenon creates a charge difference between the layer and resulting to a tiny potential difference between them.

The unit of such combination of two layers of semi conductor materials, for producing electric potential deference in sunlight is called solar cell. Silicon is normally used as solar cell. For building cell, silicon material is cut and very thin wafers. Some of these wafers are doped with impurities. Then both doped and undated wafers are and switched together to build solar cell. A metallic strip is reached to two extreme layers to collect current.

A desired number of solar cell are connected together in both parallel and series to form a solar module for producing desired electricity.

The solar cell can also work in cloudy weather as well is moon light but the rate of production of electricity low as and it depends up on intensity of incident light ray.

Fig 1 describes the typical system of solar panels, controller, energy storage, inverter for converting DC into AC and how the system is connected to power grid.

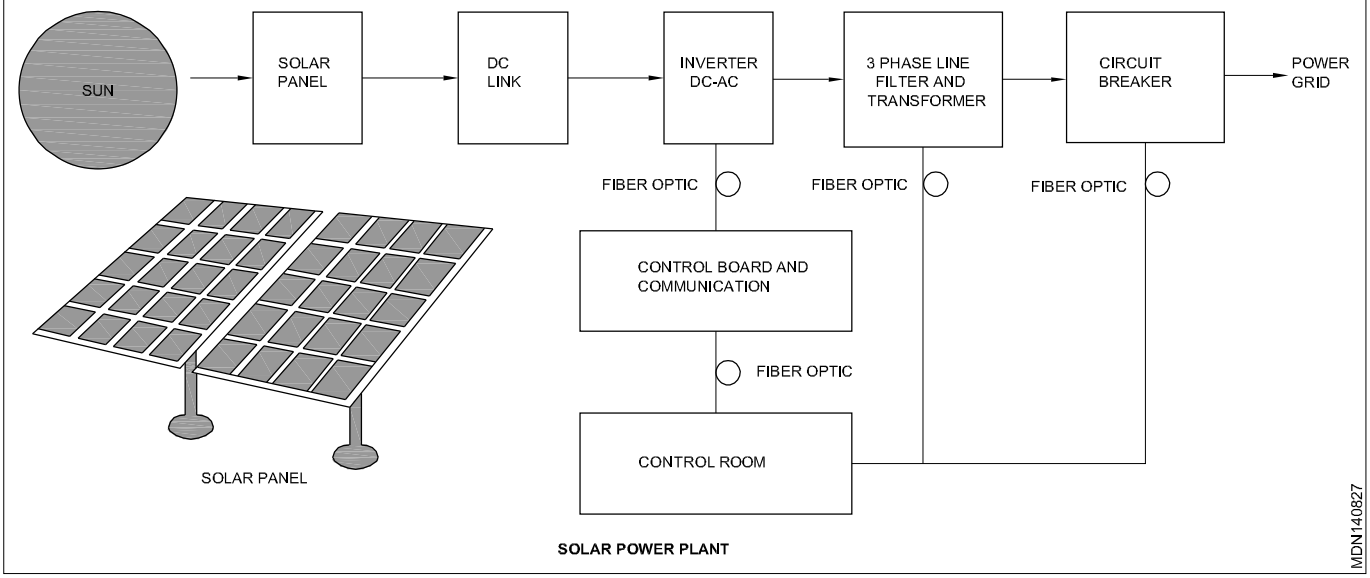
Solar panels installation may be ground, rooftop or wall mounted. The solar panels mount may be fixed a solar tracker to follow the sun across the sky.

Photo voltaic systems have long been used in specialized applications and stand alone and grid-connected PV systems have been in use since the 1990. After hydro and wind powers, PV is the third renewable energy source in term of global capacity. The PV energy covering approximately two percent of global electricity demand. It is an environmentally clean source of energy and it is free and available in adequate quanties in all the parts of world.

Advantages of solar photo voltaic: Solar panels once installed. Its operation generates no pollution and no green house gas emissions it is simple salability in respect of power needs and silicon has large availability in earth

Disadvantages of solar photovoltaic (Fig 7) : The power output is dependent on direct sunlight. That 10-25% is lost, if a tracking system is not used. Dust, clouds and other obstruction in the atmosphere also diminish the power output. Solar photovoltaic power needs to be stored for later use.

Fig 7



SOLAR POWER PLANT

Electromagetic induction, self-induced emf - inductors

Objective: At the end of this lesson you shall be able to

- **state the principle and law of electromagnetic induction.**

Faraday's Law of Electromagnetic induction are also applicable for conductors carrying alternating current.

What are Faraday's Law of Electromagnetic Induction?

Faraday's First Law states that whenever the magnetic flux is linked with a circuit changes, an emf is always induced in

The second Law states that the magnitude of the induced emf is equal to the rate of change of flux linkage.

According induced emf can be produced either by moving the conductor in a stationery magnetic field by changing magnetic flux over a stationery conductor. When conductor moves and produces emf, the emf is called as dynamically induced emf Ex. generators.

When changing flux produces emf the emf is called as statically induced emf as explained below. Ex: Transformer.