BE8255 Basic Electrical Electronic & Measurement Engineering

Unit – III

UTILIZATION OF ELECTRICAL POWER

Part-B

1.What are renewable energy source? Explain in detail about various types of solar power plant and wind power generation system.

[OR]

Write a technical note on the following [AU]

i) Wind energy generating system [8 marks]
ii) Solar panel (any two types) [5 marks]

Renewable Sources of Energy

Renewable source of energy is defined as the energy resource which produced continuously in nature, it is neither consumed nor converted into something else. Therefore, it is in exhaustible.

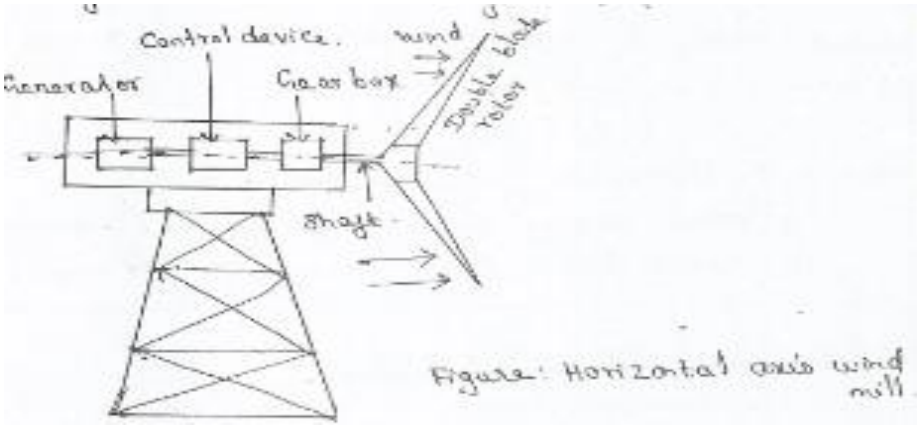
Examples:

- Hyde energy
- Solar energy
- Wind energy
- Pedal energy
- Geo - thermal energy
- Ocean thermal energy
- Energy from bio - mass

Wind Power Generation:

Design:

Several types of wind wheels have been used but the advantage of propeller rotating about a horizontal shaft, in a plane perpendicular to the direction of the wind make it the most likely type to realise economic generation on a large scale.



A propeller consisting of two or three blades (with an aerofoil section) and capable of running at the high speeds is likely to be the most efficient. Present technology has been able to build systems with 60m long blades, a lowers as high as 305m. A large tower system, to support many small rotor – generator units, can also be built.

Wind pressure rotates the wind vanes or propellers attached to a shaft. The revolving shaft rotates the rotor of a generator, through a mechanism of gears couplings etc. Thus electricity is generated.

The wind power plants can be operated in combination with steam or hydro power station which will lead to saving in fuel and increase in firm capacity, respectively of these plants.

Advantages:

1. It is non-polluting.
2. No problem of transportation.

Disadvantages:

1. Wind energy available in fluctuating in nature.
2. The problem of energy storage.
3. The overall weight of the plant in very high.

SOLAR ENERGY:

Sun in the primary source of energy. The earth receives 1.6 x 10^{18} units of energy from the sun annually, which in 20,000 times the requirement of mankind on the earth. Some of the solar energy causes evaporation of water, leading to rains and creation of rivers etc.

Applications of solar power are

- The heating and cooling of residential and commercial buildings.
- The chemical and biological conversion of organic material to liquid, solid and gaseous fuels

- Conversion of solar energy to electricity.

a) Residential cooling and heating:

A major component of our electricity bill in due to heating and cooling of buildings. This can be done using solar energy.

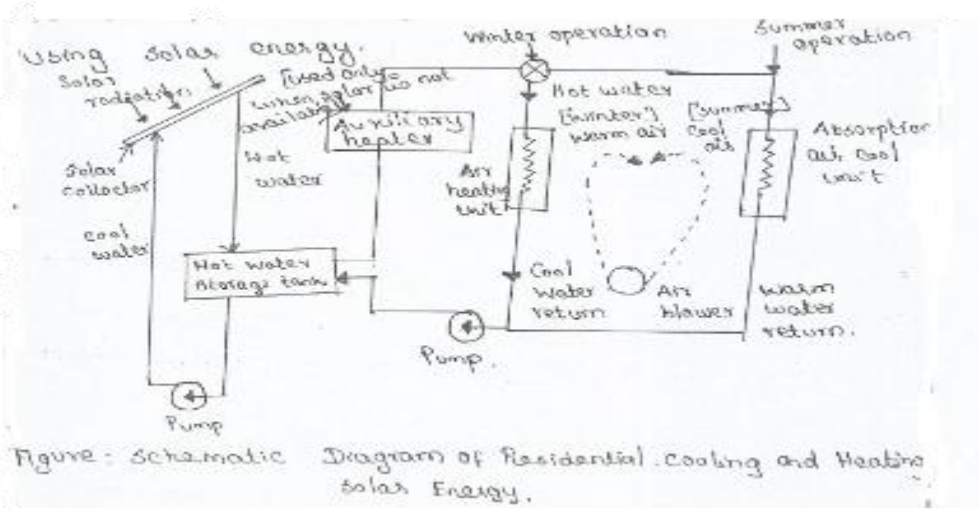


Figure: Schematic Diagram of Residential Cooling and Heating Solar Energy.

A flat plate collector is located on the roof of a house, which collects the solar energy. The cooling water is pumped through the tubes of the solar collector.

The heat is transferred from the collector to the water and the hot water in stored in a storage tank which may be located at ground level or in the basement of the house.

Hot water is then utilized to neat or cool the house by adjusting the auto-matic value. A separate circuit in there to supply hot water.

b) Photosynthesis production of Energy sources:

Solar energy can be transformed into chemical energy in the form of plants and trees, through the process of photosynthesis, which in the basis of the world's fossil fuels. It is now possible, to produce organic matter with high heat content, by using suitable chemical processes.

i. Solar power plant:

The below diagram shows the arrangement & general view of a solar power plant, carried by a man-made satellite.

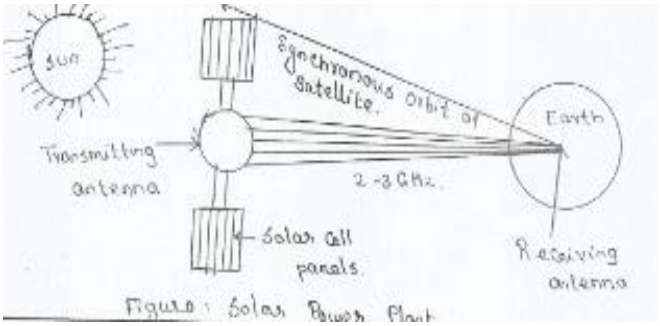


Figure : Solar Power Plant

The solar cell panels to be installed on the satellite may vary in area 16 to 100 sq. km according to the plant capacity.

The solar cells arranged in space would generate d.c electric power and transmit it by means of microwaves. Using a transmitting antenna.

On the earth, this energy will be converted into high voltage d.c, or commercial frequency electric power.

The solar cells operate on the principle of photo electricity i.e., electrons are liberated from the surface of a body when light in incident on it.

Backed by semi-conductor technology, it is now possible to utilize the phenomenon of photo-electricity.

If an n-type semiconductor is brought in contact with a p-type material, a contact potential difference is set-up at the junction, due to diffusion of electrons.

When the p-type material is exposed to light, its electrons get excited, by the photons of light, and pass into the n-type semiconductor. Thus, an electric current is generated in a closed circuit.

The PN Junction silicon solar cells have emerged as the most important source of long duration power supply necessary for space vehicles.

These cells are actuated by both, direct sun rays and diffuse light.

The efficiency of solar heating/cooling installation depends on the efficiency of collection of solar energy it transfers to the working fluid (e.g. water, air etc.). There are two main classes of collectors.

a) The flat plate collector is best suited for low and

Intermediate temperature applications which include water heating for buildings, air heating and small industrial applications like agricultural drying etc.

b)The concentrating collector are usually employed for power generation & industrial process heating.

a) Solar concentrators:

Solar concentrators are the collection devices which increases the flux on the absorber surface as compared to the flux impinging on the concentrator surface.

Due to the apparent motion of the sun, the concentrating surface, whether reflecting or refracting, will not be in a position to redirect the sun rays onto the absorber, throughout the day if both the concentrator surface, and absorber are stationary.

Ideally the total system consisting of mirrors or lenses and the absorber should follow the sun's apparent motion so that the sun rays are always captured by the absorber.

Solar concentration consists of the following.

i) a focusing device
ii) A reflecting or refracting surface
iii) An absorbing surface i.e., an absorber
iv) A fluid flow system to carry away the heat.
v) A cover around the absorber.
vi) Insulation for the un irradiated portion of the absorber
vii) A self-supporting structural capability & well-adjusted tracking mechanism.

b) Flat plate collector:

It consists of the following component.

i) an absorber plate (metallic or plastic)
ii) tubes or pipes for conducting or directing the heat transfer fluid.
iii) One or more covers.
iv) Insulation to minimise the downward heat loss from the absorbing plate.
v) Casing which encloses the foregoing components and keeps them free of dust, and moisture and also reduces the thermal losses.

In most of these collectors, the absorber element us made of a metal such as galvanised cron, aluminium copper etc. and the cover is usually of glass of 4mm thickness.

The back of the absorber is insulated with glass wool, asbestos wool or some other insulating material.

The casing, enclosing all the components of the collector is either made of wood or some light metal like aluminium.

2.Explain in detail about sodium vapour lamp with neat diagram?

[OR]

Describe in detail about the working of sodium vapour lamb with neat diagram.

Sodium Vapour lamp:

A sodium vapour lamp consists of an inner bulb of special glass containing the sodium and the inert gas either neon or argon and is fitted with two filaments.

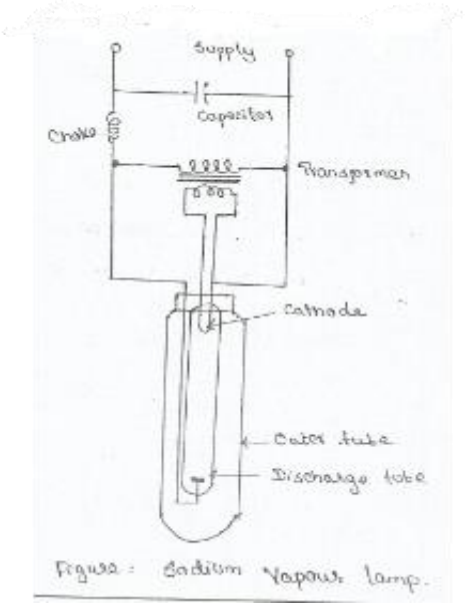


Figure : Sodium Vapour lamp.

Construction:

- It consists of a u type of special resistant glass which is known as discharge tube.
- A small quantity of neon gas and sodium vapour are introduced in the tube. The presence of neon gas is to start the discharge.
- In order to reduce the heat losses, the u tube is enclosed in double walled evacuated glass known as outer tube.
- A transformer is connected in the circuit. This provides high voltage (about 480V) to start the discharge, also due to its high reactance, this transformer act as a stabiliser.
- Capacitor C is connected in order to improve the power factor.

Working:

- As lamp is switched ON, electrons are emitted from cathode and attack the gas molecules. This starts the process of ionisation and produce the discharge. The sodium is vapourised due to heat and lamp assumes normal operation. The lamp will produce bright light as output in about 15 minutes.
- The lamp emits yellow light at wavelength about 5980 Am strong unit. Due to this reason, it is sometimes called monochromatic lamp. The working temperature is about 300^0c.
- The starting time of lamp is from 5 to 6 minutes due to supply failure it will again take much time to start. Such lamps are manufactured as 45, 60, 85 and 140 watt ratings. The average life is about 3000 hours.

Application:

- This type of lamp is used for highway and general outdoor lighting where colour discrimination is not required.
- Used for street lighting.

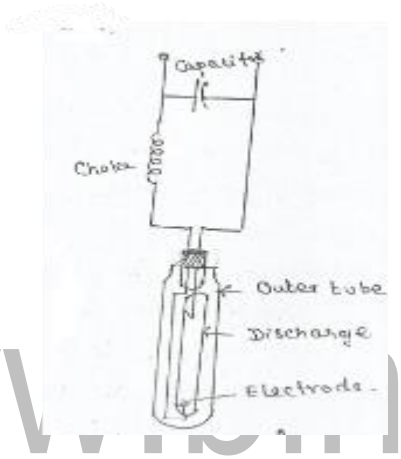
3.Explain Mercury vapour lamp in detail

[OR]

Describe in detail about Mercury vapour lamp

The mercury vapour lamp contains mercury and argon gas inside the tube. It is used for general lighting application.

Construction



- Heart of lamp is an arc tube which is fabricated from quarty with a tungsten electrode disposed at either end.
- The tube contains few milligrams of mercury and pure argon us a buffer gas to produce light while the lamp warms up. The produced heat vapourise the mercury and produce the light.
- The starting electrode is placed next to one of the main electrodes to produce heat in the tube. The voltage is applied between one electrode and the starting electrode via a small resistor.
- The gap between the main electrode (one electrode) and the starting electrode in much smaller and the voltage produce is sufficiently high that ionisation will occur.

Working:

- There is a special quality glass containing argon gas and little mercury at low pressure. It is enclosed in an evacuated outer tube in order to prevent the heat loss.
- Two oxide coated electrodes arc enclosed in the inner tube.
- The working temperature in about 600^0c and the lamp should be operated at vertical position. So that the mercury does not touch the inner wall of the glass tube.
- There is a starting electrode used in order to start the discharge.
- It contains a high resistance of order of 50kw in series with supply.

- The end of starting electrode touches the main electrode. When lamp is switched ON. Later this voltage extended between the two main electrodes. Thus the ionisation occurs.
- When the ionisation is completed, discharge starts in the tube and the mercury starts evaporating due to heat of discharge. Thus, lamp glows.

4.Explain in detail about working principle of fluorescent lamp.

[OR]

With neat diagram explain the fluorescent lamp.

- It is a low-pressure mercury vapour lamp. Due to low pressure, the lamp is in the form of long tube. In this type of lamp, fluorescent powder are used to coat the inside of the lamp. The tube is filled with small quantity of mercury with small amount of argon gas. The electrodes used here are oxide coated filaments in the form of spiral.

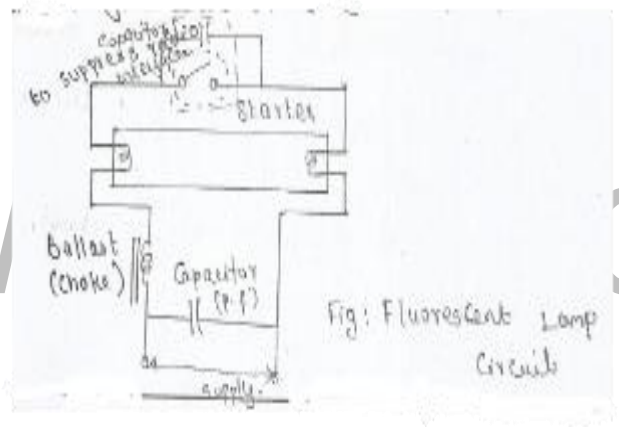


Fig: Fluorescent Lamp Circuit

- A starter‘s’ connected between two oxide coated filaments (electrodes). The choke (ballast) is connected in series with the tube filament as well as supply.
- Choke acts as a ballast and gives 1000v while the starter is open. This choke gives low tube, choke, supply are connected in series.
- The starter opens and interrupt the current in the circuit while the tube is running. Capacitor is connected across the supply to improve the power factor.
- Different sizes of lamps are available from 2ft -20w, 4ft-40w. Lamps are also available in different colours like red, green, blue and tricolour.

Working:

- When the starter is not connected in the circuit the electrodes are open.
- As the lamp is switched ON, the current passes through the filament so that the filament are heated and emit large amount of electrons.
- Thus the current also passes through normally close contact of starts and heated it. Thereby the contacts are separated after few seconds.

- This sudden opening of starter, due to the action of choke, high voltage of about 1000v is induced across the electrode and discharge starts and the light lights up immediately.
- Its efficiency is between 30-40 lumens/watt.

5.Explain in detail about construction and operation of domestic refrigerator with its electrical circuit diagram.

[OR]

Discuss the various components of the Refrigerator in detail.

- The domestic refrigerator is one found in almost all the homes storing food, vegetables, fruits, beverages and much more.

Internal parts of domestic refrigerator:

Some internal parts are located at back of the refrigerator, and some inside the main compartment of the refrigerator.

a) Refrigerator

The refrigerant flows through all the internal parts of the refrigerator.

b) Compressor

The compressor is located at the back of the refrigerator in the bottom area.

c) Condensor

The condenser is the thin coil of copper tubing located at the back of the refrigerator. The refrigerator from the compressor enters the condenser and release the heat outside.

d) Expansion value or capillary:

The refrigerant leaving the condenser enters the expansion value. The expansion value is the thin copper tubing made up of number of turns of copper coil. When the refrigerant is passed through the capillary its pressure and temperature reduces. (Liquid becomes cool).

e) Evaporator:

The refrigerant at very low pressure and temperature enters the evaporator. This absorbs the heat from the inner things present in refrigerator.

f) Temperature control device (or) thermostat:

To control the temperature inside the refrigerator, there is a thermostat, whose sensor in connected to the evaporator.

g) Defrost system:

It helps to remove excess ice from the surface of evaporator.

External visible parts

a) Freezer compartment:

The food items that are to be kept at freezing temperature are stored in freezer compartment. The temperature here is below zero degree Celsius.

b) Refrigerator Compartment:

It is the biggest part of the refrigerator. Here all food items are maintained at the temperature above zero degree Celsius.

c) Refrigerator door compartment:

There are number of smallest subsections. Some of these are egg compartment, butter, diary etc.

d) Switch:

This is small button that operates small light inside the refrigerator.

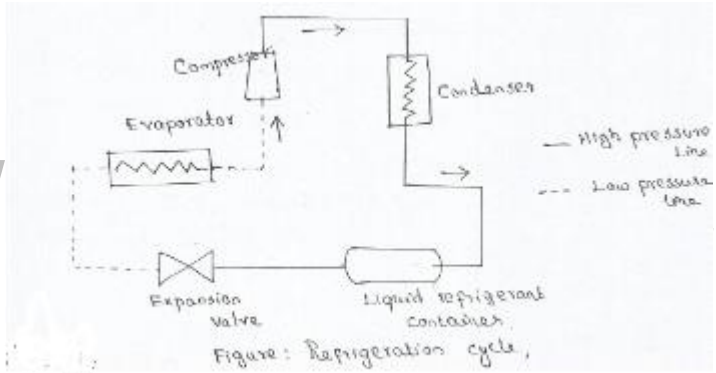


Figure: Refrigeration cycle.

Working:

- The refrigerant passes through the evaporator is cooled liquid, this evaporator has the capacity to absorb heat from the things present inside the refrigerator. When it absorbs, the heat, the refrigerant passing through the evaporator coil evaporate and changes into high temperature, low pressure gas.
- This low pressure gas is made to pass to compressor. The motor which is present inside the compressor converts low pressure gas into high pressure gas.
- This high pressure gas is passed to the condenser coil which is located at backside of the refrigerator.
- The condenser coil removes all the heat outside and converts the gas back to liquid.
- This liquid is made to pass to the capillary tube or expansion value for further cooling. This cooled liquid in passed to evaporator and the process continuous.

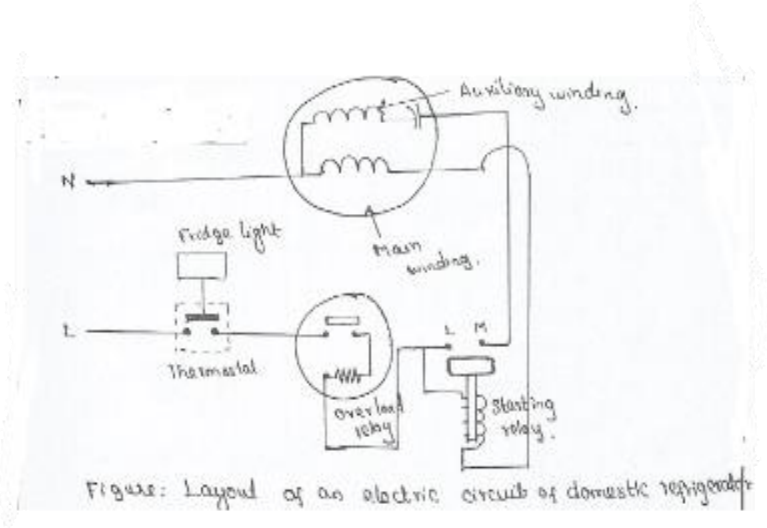


Figure: Layout of an electric circuit of domestic refrigerator

Electrical Circuit

Compressor motor:

Alternating current (Ac) motor is used. The size of the motor depends upon the capacity of the refrigerator.

Starting relay:

The relay is of electromagnetic type and used for making or breaking the contact with the supply.

Thermostat:

It is a thermal switch. As soon the temperature reaches -7^0c in freezer and 10^0c in other parts of fridge, the thermostat automatically cut off the supply.

Thermal overload protector:

It is a protective device for protecting the motor unit of the refrigerant.

6.Explain in detail about construction and operation of Air conditioner with its electrical circuit diagram.

[OR]

With neat diagram, explain the two types of Air conditioner.

The air conditioner can cool a room, a whole house or an entire building. The machine has five main parts. They are

- Compressor
- Condensor
- Evaporator
- Refrigerant
- Expansion value in the form of capillary tube.

Evaporator:

- It is basically a heat exchanger coil that are responsible for collecting heat from inside the room then the liquid refrigerant absorbs the heat and evaporates to become gas. Hence the component is known as evaporator.
- It is located as indoor unit (i.e.) inside the room.

Compressor:

- Here the compression of gaseous refrigerant occur.
- It is located in the outdoor unit (i.e.,) the part outside the house.

Condensor:

- The condenser receives the vaporized refrigerant from the compressor, converts it back to liquid and remove the heat outside.
- It is located at back of Ac.

Expansion value:

- Expansion value is located between the two set of coils (i.e.,) between chilled coil of evaporator and hot coil of condenser.

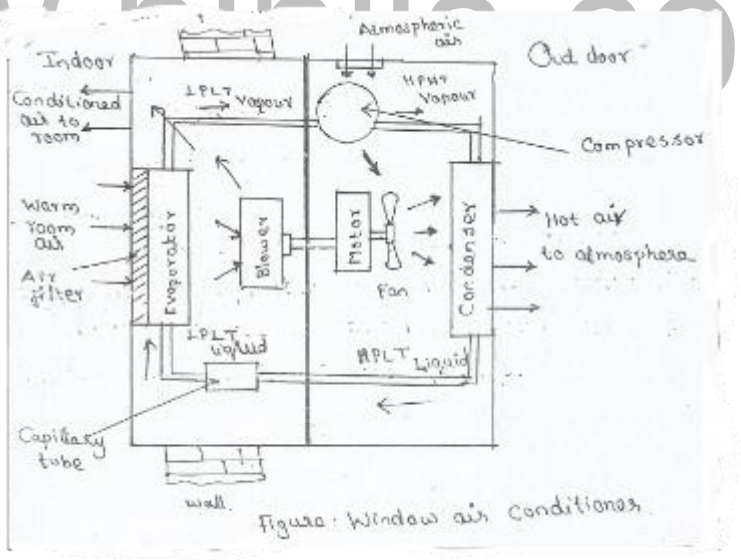


Figure: Window air Conditioner

Electric circuit diagram of window Air conditioner:

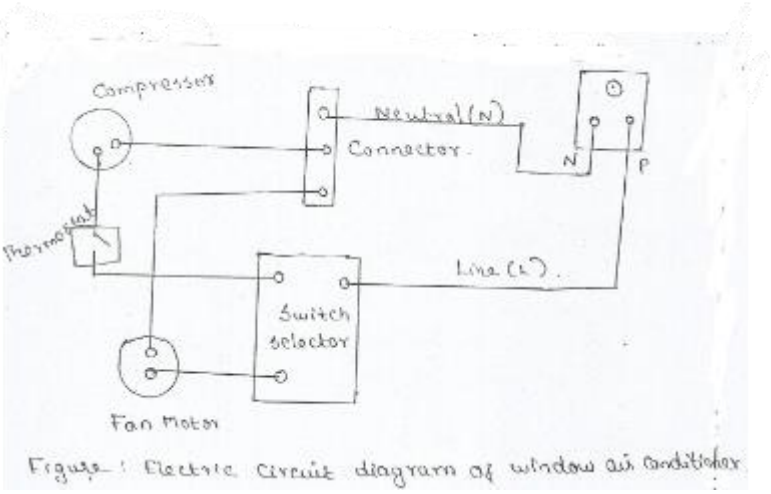


Figure : Electric circuit diagram of window air conditioner

Advantages of window A.C:

- Self-contained unit.
- For more than one room in a residential building several window units can be used. A separate temperature control is provided in each room, in which the unit is installed.
- No Ducts.
- Installation is simple and plumbing is not required.

Disadvantages of window A.C:

- Not suitable for large halls
- The installation must be made only on an external wall of the room.

Split Type Room Air conditioner:

It is built in two parts cooling unit and condensing unit and hence the name split system. Split type room air conditioner is also known as split package unit.

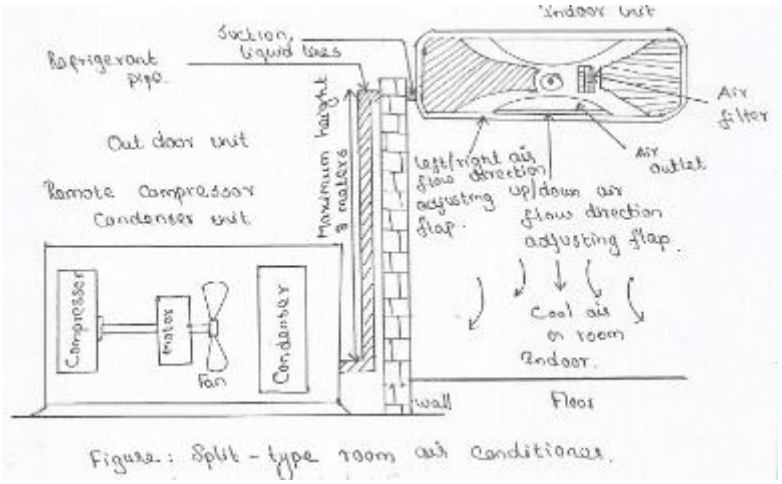


Figure : Split - type room air conditioner

Construction and working of split type room A.C.

Cooling unit (Indoor Unit)

i) Evaporator coil and capillary tube:

The high pressure low temperature (HPLT) liquid refrigerant from the condenser is passed to the capillary tube. In the capillary tube the refrigerant expands. The low pressure low temperature (LPLT) liquid refrigerant then passes to the evaporator.

ii) Evaporator Fan:

Evaporator fan draws air continuously from the inside of the room through an air filter. The air is forced to, pass over the evaporator coil by the fan and is cooled by the refrigerant consequently the refrigerant evaporates by absorbing the heat from the air.

iii) Mounting of cooling Unit:

Cooling unit may be floor mounted, wall mounted or ceiling mounted, depending on the requirement.

iv) Controls:

When a controlled atmosphere is required in air conditioning, the humidity of the air is varied, when dry air is required, it is dehumidity by cooling or by dehydration. In the latter process, the air is passed through absorptive chemicals such as silica gel. Air is humidified by circulation through water sprays.

Condensing Unit (Outdoor Unit):

i) Compressor:

High temperature evaporated refrigerant from the evaporator is drawn by the section of the compressor. The compressor compresses it and delivers it to the condenser.

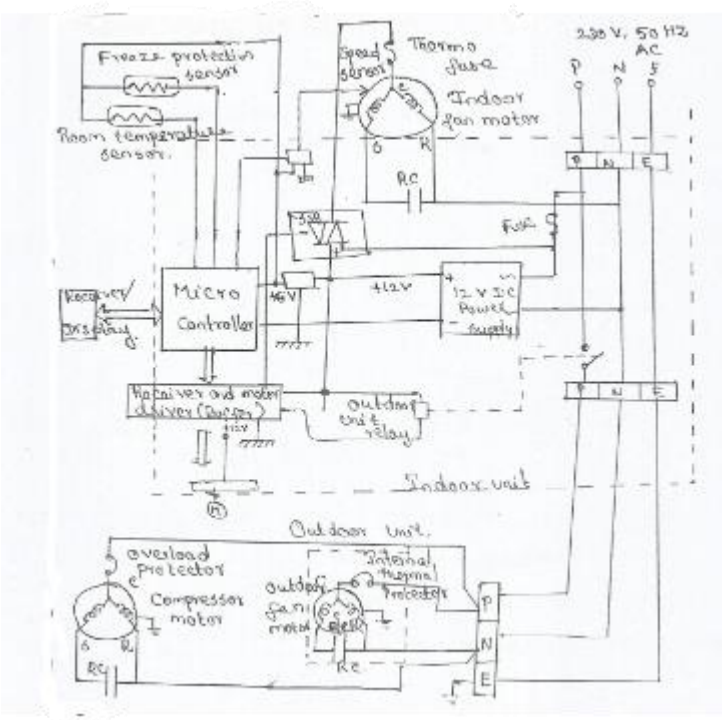
ii) Condenser coil:

The condenser can be air cooled in the case of room air conditioner or water cooled in the case of centralized air conditioner. If a water cooled condenser is to be used, the condenser is provided with connections for either city water or well water.

iii) Condensor Fan:

The condenser fan draws atmospheric from the exposed side. The HPHT refrigerant passing, inside the condenser condenses by giving – off the heat to the atmospheric air.

Electric Circuit diagram of split Type Air conditioner



7.What is Battery? What are the types of batteries?

[OR]

Define Batteries. Write short notes on i) primary batteries ii) Secondary batteries iii) Fuel battery.

[OR]

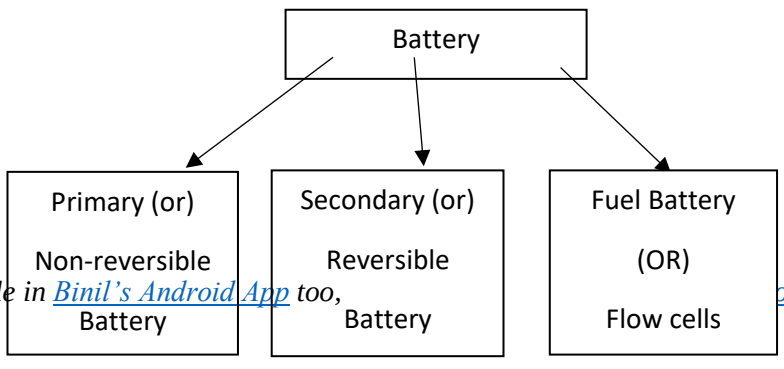
What are batteries. Write short notes on i) Non reversible battery ii) Reversible battery iii) Flow cells.

Answer:

Battery:

A battery is an arrangement of several electrochemical cells connected in series that can be used as a direct electric current. Battery contains several anodes and cathodes. Cell is a device which consists of one anode and cathode.

Types of Battery:



a) Primary batteries (or) Primary cells (or) Non-reversible battery:

- It this type of batteries, the electrode and electrode reaction cannot be reversed by passing an external energy. The reaction occurs only once and after a use they become dead. (Ex) Dry cell, alkaline battery, mercury cell.

b) Secondary batteries (or) Secondary cells (or) Reversible battery

- In this type of battery, the electrode and electrode reaction can be reversed by passing an external energy, i.e., they can be recharged by passing electric current. (Ex) Lithium ion battery, Lead acid battery, Nickel-Cadmium battery.

c) Fuel Battery (or) Fuel cells (or) Flow cells

- In this type of battery, the reactants, products, and electro types are continuously passing through the cell. Here chemical energy gets converted into electrical energy. (Ex) H_2 – O_2 Fuel cell, Methyl alcohol – oxygen fuel cell.

8.Explain the construction and working principle of Lead Acid Battery.

[OR]

Describe in details about construction and working principle of Lead storage battery.

[OR]

Briefly explain any one of the secondary batteries.

Answer:

Lead Acid battery

- A lead acid storage cell or battery is a secondary battery. Which can operate both as voltaic cell and as an electrolytic cell. When it acts as a voltaic cell, it supplies electrical energy. When it is recharged, the cell operates as an electrolytic cell.

Construction:

It consists of number of voltaic cell (3to6) connected in series to get 6 to 12v battery.

Anode	- Lead (Pb)
Cathode	- Lead dioxide ($Pb O_2$)
Electrolyte	- dil. $H_2 So_4$

- A number of lead plates (anode) are connected in parallel and number of lead dioxide plate (cathode) are also connected in parallel.
- These plates are separated by a insulator like rubber or glass.
- The entire combination is immersed in dil. H_2So_4 having the density of 1.30 gm./ml.

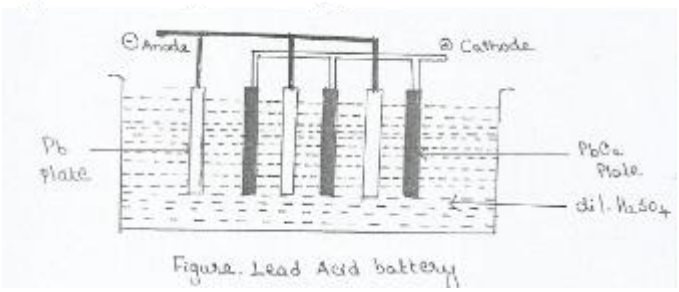


Figure. Lead Acid battery

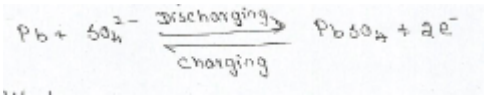
Working

During discharging

When the lead acid battery operates, at the anode oxidation reaction takes place and **at the cathode the reduction reaction takes place.**

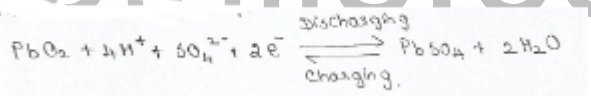
At Anode:

Lead (Pb) oxidized to Pb^{2+} ions and then combines with So_4^{2-} to form $PbSo_4$.

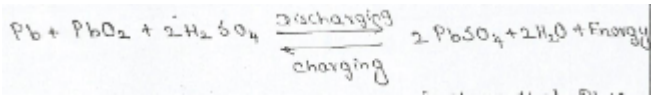


At cathode:

PbO_2 reduced to Pb^{2+} ions and then combines with So_4^{2-} to form $PbSo_4$.



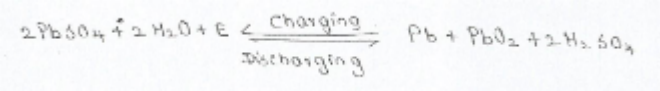
Overall Cell reaction during use (discharging):



From the above reaction it is clear that $PbSo_4$ is precipitated at both the electrodes and H_2So_4 is used up. So, concentration of H_2So_4 decreases and hence the density of H_2So_4 falls below 1.2 gm/ml. So, the battery needs charging.

Recharging:

On passing the current in opposite direction, the reaction get reversed. As the result Pb deposited on anode and PbO_2 deposited on cathode.



Uses:

- Used to supply current in automobiles such as cars, buses, trucks etc.
- Used in hospital, power station etc.

Advantages:

- It is made easily.
- It produces very high current.

Disadvantages:

- Recycling of this battery causes environmental hazards.
- Mechanical strain and normal bumping reduce battery capacity.

9.Explain in details about construction and working principle of Lithium-Ion Battery.

[OR]

Briefly explain any one of the secondary batteries.

Answer:

Lithium ion battery:

It is a rechargeable secondary battery.

Construction:

Anode – Layers of pores graphite (Lithium intercollated graphite)

Cathode - Lithium intercollated cobalt oxide.

Electrolyte - A non-aqueous electrolyte diethyl carbonate $[(C_2H_5)_2Co_3]$ is used.

EMF of the cell = 3.2 v

Both anode and cathode electrodes are dipped in the electrolyte and separated by a separate which is perforated plastic and allows the Li^+ to pass through.

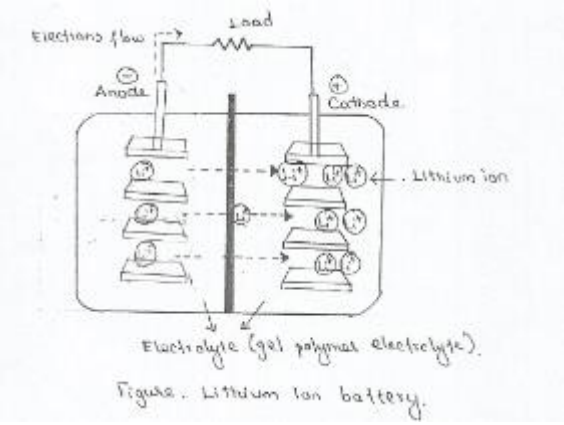


Figure. Lithium ion battery.

Working:

During discharging:

At anode:

Oxidation reaction takes place, with the loss of electron.

Li C_6 $L_iC_6 \rightarrow Li^+ + 6C + e^-$

At cathode:

Reduction reaction takes place, with the gain of electrons.

$$C_o O_2 + Li^+ + e^- \rightarrow LiC_oO_2$$

Over all cell reaction:

$$Li\ C_6 + C_o O_2 \rightarrow Li\ C_o O_2 + 6C + E$$

Recharging:

When the current is passed in the opposite direction the reaction gets reversed.

$$Li\ C_o O_2 + 6C + E \rightarrow Li\ C_6 + C_o O_2$$

These cells are also called SWING cells.

Advantages:

- Lithium ion battery (LIB) is much lighter than other secondary batteries.
- LIB is smaller in size.
- It is durable, safe, low cost & long life.
- It has high energy density.
- Variety of shapes & size are available.
- It can handle hundreds of charging & discharging cycles.

Application:

- Used in mobile phones.

- Used in note book computer, LOD PV.

10. Explain in detail about Nickel cadmium battery

[OR]

Describe in detail about construction and working principle of NICAD battery.

[OR]

Explain briefly any one of the secondary batteries.

Answer

Nickel cadmium battery (OR) NICAD battery

It is rechargeable battery which is used in calculators and electronic watches.

Construction:

Anode - Cadmium

Cathode - a metal grid containing Nickel oxide [$Ni\ O_2$]

Electrolyte - Potassium Hydroxide (KOH) solution

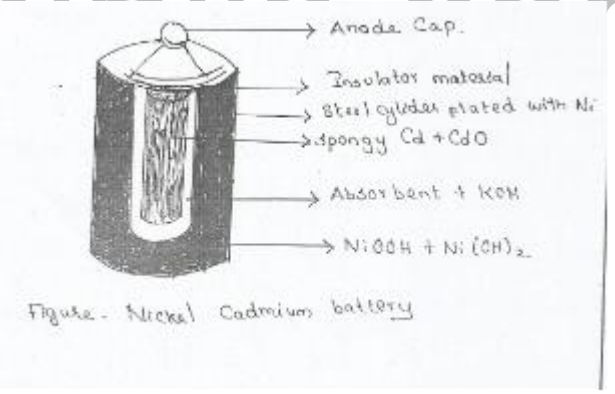


Figure - Nickel Cadmium battery

Working Principle:

Discharging:

At anode:

Cadmium is oxidised to Cd^{2+} and further it combines with OH^- ions to form Cd $(OH)_2$

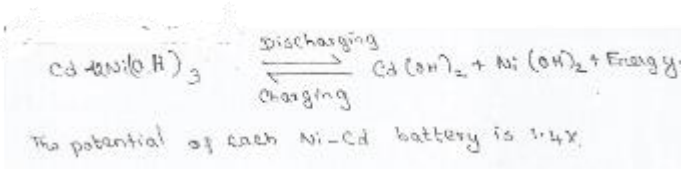
$$C_d + 2OH^- \rightarrow C_d\ (OH)_2 + 2e^-$$

At cathode:

NiO_2 is reduced to Ni^{2+} ion and further it combine with OH^- ions to form Ni $(OH)_2$

$$2N_i\ (OH)_3 + 2e^- \rightarrow 2Ni(OH)_2 + 2OH^-$$

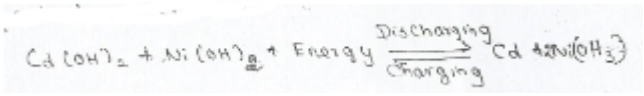
Over all cell reaction:



The potential of each Ni – Cd battery is 1.4x.

Recharging:

When external current is passed in opposite direction, the electrode reaction get reversed. During recharging, cd gets deposited on anode and NiO_2 deposited on cathode,



No gases are produced during discharging and charging of the battery. So it can be sealed and are compact.

Advantages:

- It is smaller & lighter
- High efficiency

Disadvantages:

- More expensive
- Toxity due to cadmium.

11. What is the need for earthing? And also explain the different types of earthing. [AU]

[OR]

Discuss the methods of Earthing.

Answer:

Earthing

Earthing is an electrical network as a safety measure to protect human life as well as equipment, the main objective of earthing is to provide an alternative path for dangerous current to flow so that accident due to elective shock and damage to equipment can be avoided

Basic needs of earthing:

- To protect human lives as well as provide safety to electrical devices and appliances from leakage current.
- To keep voltage as constant.
- To protect electrical system and building from lightning.
- To avoid risk of fire in electrical insulation system.

Advantages of earthling:

- Reduce operation and maintenance cost.
- Greater safety.
- Better system and equipment over current protection.
- Improved lightning protection.

Methods of earthing:

- Pipe earthing
- Plate earthing

Pipe earthing:

This is most common and best system of earthing. In this method the galvanized steel and perforated pipe of approved length and diameter is placed in a permanently wet soil. The pipe is placed at 3.75 meters below the surface. The bottom of the pipe is surrounded by salt and charcoal at the distance of about 15 cm

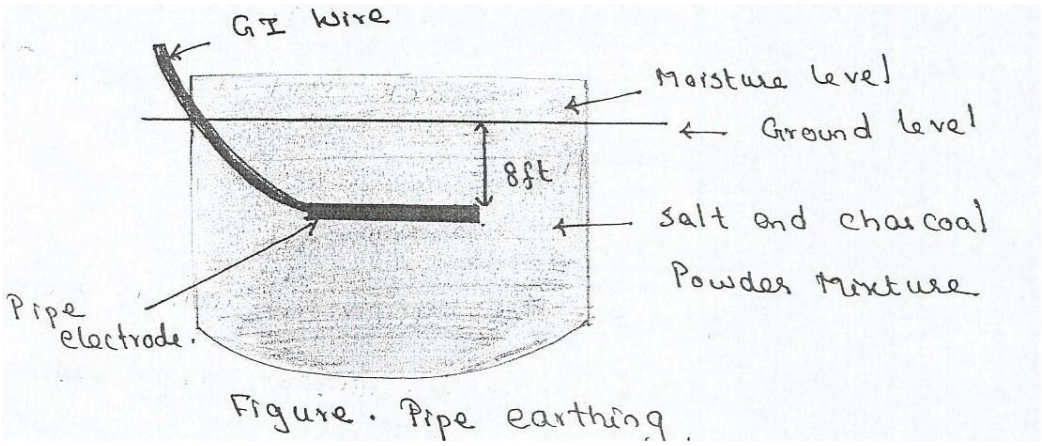
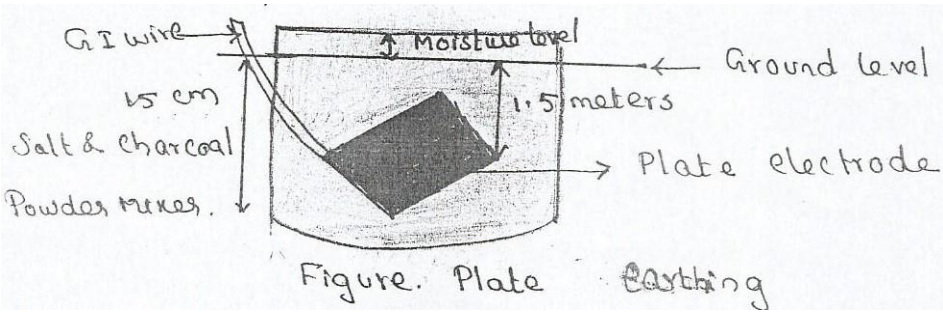


Figure. Pipe earthing

Plate earthing:

In plate earthing an electrical plate either of copper of galvanized iron is buried into the ground with its face vertical at a depth of not less than 3 meters from ground level.



12. What is the use of Fuse? And also explain the types of fuse.

[OR]

Describe in detail about Fuse.

Fuses:

A fuse is an essential device used in various electrical circuits which gives protection from the over current. It comprises a strip or metal wire that dissolves, when the heavy flow of current supplies through it.

Use of fuse:

They are used to prevent home applicance from the high current or overload damage.

Working principle of fuse:

- The working principle of fuse is “heating consequence of the current”. It is fabricated with a lean strip or thread of metallic wire.
- The connection of fuse in an electrical circuit is always in series. When too much of current is produced in electrical circuit, the fuse get soften and it opens the circuit. Therefore, it prevents the supply to pass.

Advantages:

- It is simple form of protection.
- It requires no maintenance.
- Its operation will be automatic.
- Smaller size of fuse element is enough.

Disadvantages:

- They have to be replaced after each operation.
- The heat produced by the arc may affect the associated switch.

Fuse elements:

- Lead

- Tin
- Copper
- Zinc
- Silver

Characteristics of fuse element:

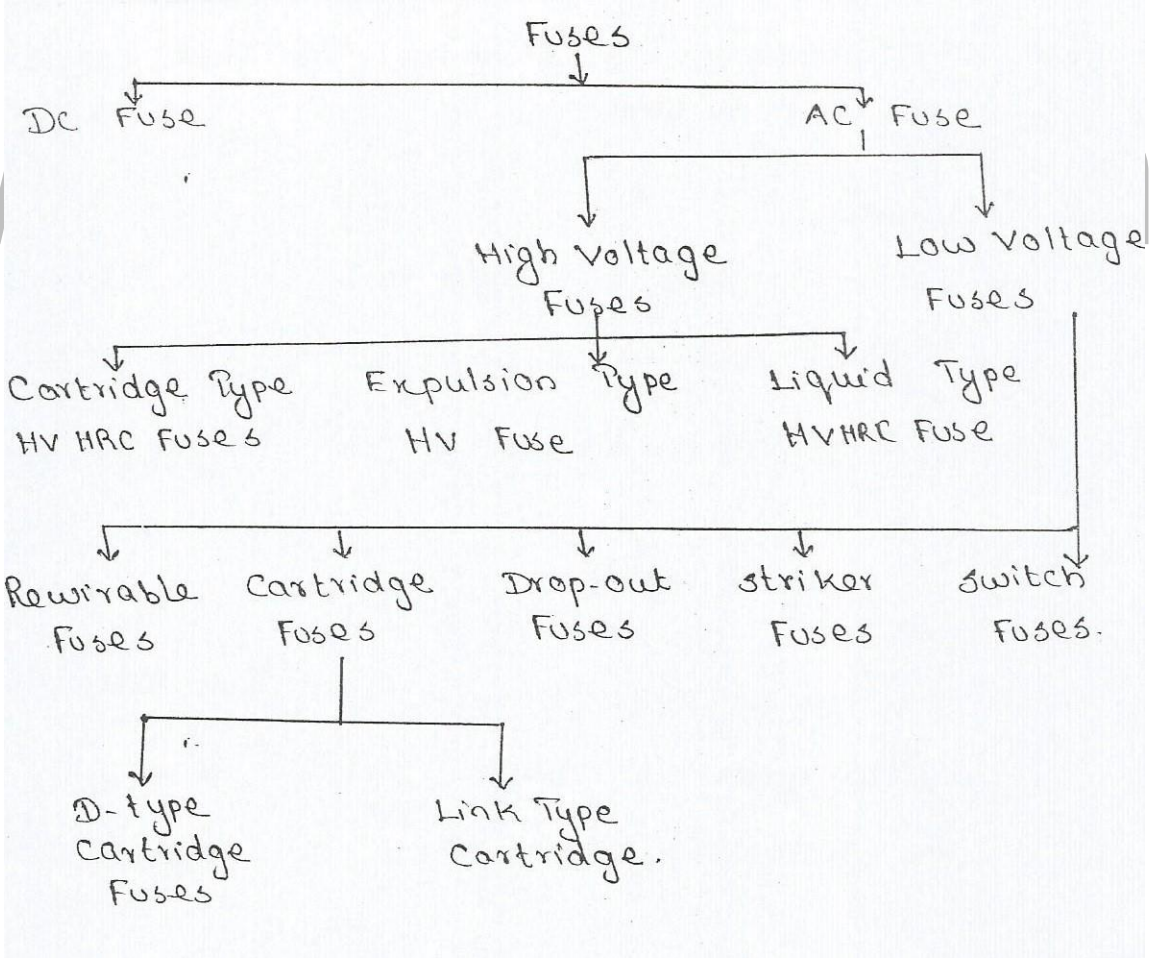
- It has low melting point.
- It has high conductivity.
- Its cost is low.

Types of Fuses:

The Fuses are mainly classified into two type, i.e., DC Fuse and the AC Fuse.

DC Fuse:

The DC Fuse opens or breaks the circuit when the excessive current flow through it.



AC Fuses:

They are categorized into two types.

1. Low voltage fuse
2. High voltage fuse

1. Low voltage fuse:

Low voltage fuse can be classified as rewirable fuse, cartridge fuse, Drop-out fuse, Striker fuse, Switch fuse.

i) Rewirable fuse:

This type of circuit is mostly used in the small current circuit or for domestic wiring. The fuse base and fuse carriers are the two main parts of rewirable fuse. The fuse base is made up of porcelain and it hold wire made of lead, copper. The fuse caxxiers can be easily inserted or taken out.

ii) Cartridge fuse:

The fuse element is totally enclosed in the enclosed container and it has metal contacts on both sides.

a) D type cartridge
b) Link type cartridge

iii) Drop-out Fuse:

The melting of fuse causes the fuse elements to dropout under gravity about its lower support. It is used for protection of outdoor transformer.

iv) Striker fuse:

It is a mechanical device having enough force and displacement which can be used for closing tripping/indicator circuits.

v) Switch Fuse:

It is used in low voltage & medium voltage circuit.

2. High voltage fuse:

They are mainly classified into

i) Cartridge type High voltage HRC Fuses.
ii) Liquid type High voltage HRC Fuses.
iii) Expulsion type high voltage Fuses.

i) Cartridge type high voltage fuse:

The fuse element is wound in the shape of the helix which avoid the corona effect at high voltage.

ii) Liquid type high voltage fuse:

In this type of fuses is filled with carbon tetrachloride and sealed at both ends of the cap. When fault current occurs, fuse element blown out.

iii) Expulsion type high voltage fuse:

It is used for protecting feeders and transformers because of their low cost. The fuse elements are placed in tubes and ends of tubes are connected to suitable fittings at **each end.**

13. Explain the working principle and types of circuit breakers.

[OR]

Describe in detail about circuit breakers.

Circuit breaker:

It is a switching device that interrupts fault current. The circuit breaker is mainly designed for closing or opening of an electrical circuit, this protects the electrical system from damage.

Working Principle:

Circuit breakes consist of fixed and moving contacts. These contacts are touching each other and carrying the current under normal operating condition when the circuit is closed.

When the fault current occur, the moving coil get separated from the fixed coil so that the circuits get open and no current flows in the circuit.

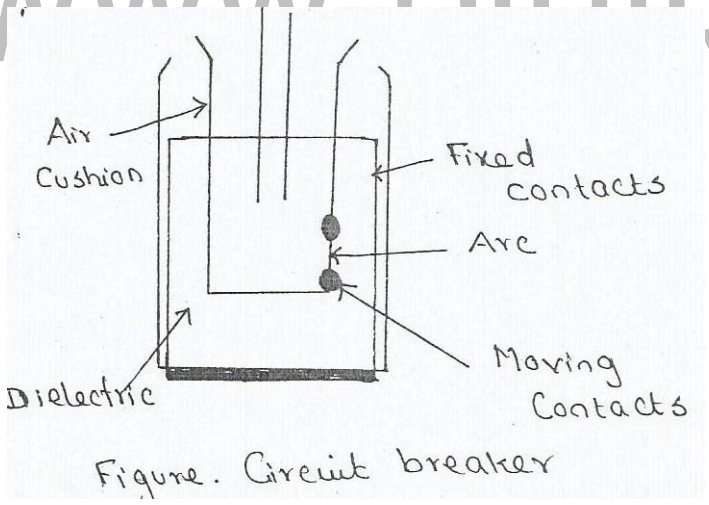


Figure. Circuit breaker

Types of circuits:

Circuit breakers are mainly classified on the basis of rated voltage circuit breakers below rated voltage of 1000v are called the high voltage circuit breaker.

Types:

1. Oil circuit breaker
2. Minimum circuit breaker
3. Air blast circuit breaker

4. Sulphur Hexafluoride circuit breaker
5. Vaccum circuit breaker.
6. Air break circuit breaker.

1. Oil circuit breaker:

Here oil is used as dielectric or insulating medium, when fault occurs in the system the contacts of the circuit breakers are open under the insulating oil and an arc is developed between them and heat of arc is evaporated in the surrounding oil.

2. Minimum oil circuit breakers:

Circuit breaker uses oil as the interrupting media. It requires less amount of oil so it is called as minimum oil circuit breaker.

3. Air blast circuit breaker:

Air blast circuit breakers are used for system voltage of 245kv, 420kv and also even more. Air blast circuit breaker are of two types.

1. Axial blast breaker
2. Cross blast breaker

i) Axial blast breaker:

In the axial blaster breaker the moving contact will get separated from the fixed coil by passing air force from the air reservoir while the excess current occur.

Advantages:

1. Smaller in size.
2. It requires less maintenance.
3. Arc quenching is much faster.
4. **Speed of circuit breaker is much higher.**

Disadvantages:

1. It contains high-capacity air compression.
2. The air has relatively low arc extinguishing properties.
3. From the air pipe junction there may be a chance of air pressure leakage.
4. There is the chance of a high rate rise of re-striking current and voltage chopping.

ii) Cross Blast Air circuit breaker:

The working principle of cross blast air circuit breakers is quite simple.

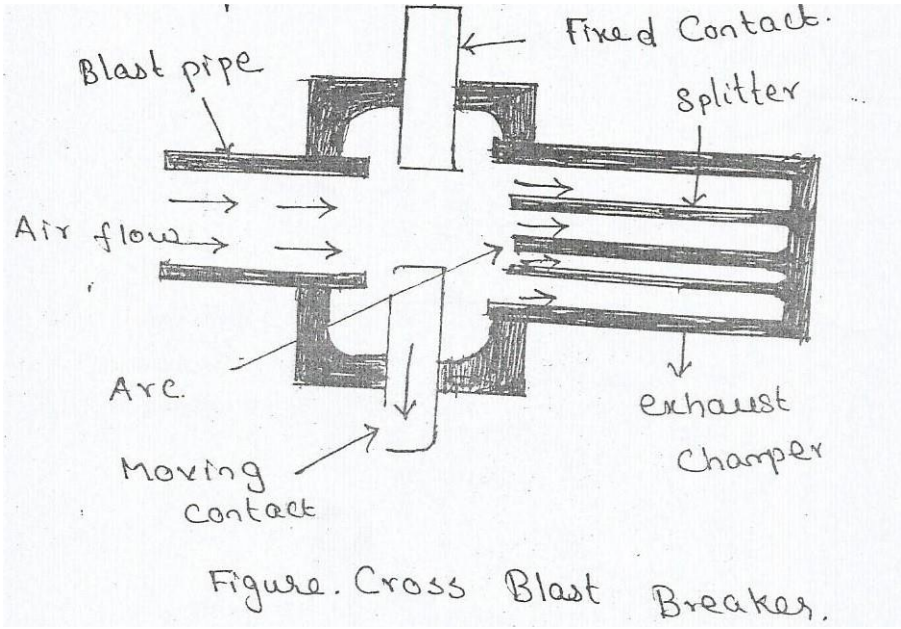


Figure. Cross Blast Breaker.

In this system the blast pipe is fixed in perpendicular to the movement of moving contact in the arcing chamber and on the opposite side of arcing chamber one exhaust chamber is also fitted at the same alignment of blast pipe, so that the air comes from blast pipe can straightly enter into exhaust chamber through the contact gap of the breaker.

The exhaust chamber is split with are splitter when moving contact separated from fixed contact due to fault current arc produced is splitted through the arc splitter.

4. Sulphur Hex fluoride (SF6) Circuit breaker:

A circuit breaker in which SF6 under pressure gas is used to extinguish the arc is called SF6 circuit breaker.

5. Air break circuit breaker:

In air break circuit breaker the arc is unitiated and extinguish air in which arc moves. Such breakers are used for low voltage upto 15Kv.

6.Vaccum circuit breaker:

A vacuum which use vacuum as an arc extinction medium is called VCB. In this circuit breaker the fixed and moving contact is enclosed in a permanently sealed vacuum interrupts. It is used for medium voltage from 11 to 33Kv.

14. What is tariff? Explain in detail about types of tariff.

[OR]

How does the tariff support energy efficiency and demand side management? Explain in detail [AU].

Tariff:

Tariff means the schedule of rates or charges. The rate at which energy is supplied to a consumer is known as tariff.

Objective:

The main objective of tariff is to distribute equitably the cost of supplying energy among the various classification of use.

i) Recovery of cost of operation, supplies and maintenance of equipment.
ii) Recovery of cost of metering equipment, billing.
iii) A satisfactory return on the cost of capital investment.

Tariff to consumers and energy efficiency:

To reduce consumption tariffs will operate with a first black of consumption (per month or quarter) that is charged at a low rate followed by further blocks charged at progressively higher rates.

- Energy efficiency measures are installed to help reduce the need for high consumption.

Demand side management:

- Actions taken on the consumer side of the electricity meter. Such as energy efficiency measures and power factor correction.
- Arrangement for reducing loads on request, such as interruptibility contracts, direct load control and demand response.
- Fuel switching, such as changing from electricity to gas for water heating.
- Distributed generation, such as stand-by generators in office buildings or photovoltaic modules on rooftops.

Types of Tariffs:

1. Flat Demand tariff
2. Simple tariff
3. Flat rate tariff
4. Step rate tariff
5. Block rate tariff
6. Hopkinson Demand rate (or) Two part tariff
7. Maximum Demand Tariff
8. Power Factor Tariff
9. Three-part Tariff or Doherty Rate
10. Off-peak tariff

Types of Tariff:

1. Simple tariff:

A fixed rate per unit of energy consumed is called.

a) Simple tariff:

In this type tariff, the price charged per unit is constant. i.e., it does not vary with increase or decrease in number of units consumed. The consumption of electrical energy at the consumer's terminals is recorded by means of an energy meter.

Disadvantages:

i) The cost per unit delivered is high.
ii) It does not encourage the use of electricity.
iii) The used for irrigation purposes.

2. Flat rate tariff:

When the different types of consumers are grouped into different classes and each class of consumers is charged at a different uniform rate.

Advantages:

- It is more fair to different types of consumers and is quite simple in calculations.
- Generally applied to domestic purposes.

Disadvantages:

- Since the flat rate tariff varies according to the way the supply is used, separate meters are required lighting load, power load etc. This makes the application of such a tariff expensive and complicated.

3. Block rate tariff:

When a given block of energy is charged at a specified rate and the ascending blocks of energy are charged at progressively relucted rates, it is called block rate tariff.

In block rate tariff, the energy consumption is divided into blocks and price per unit is fixed in each block.

Application:

Used for majority of residential and small commercial consumers.

Advantages:

The consumer gets an incentive to consume more electrical energy.

This increases the load factor of the system and hence the cost of generation is reduced:

4. Two-part tariff:

When the rate of electrical energy is charged on the basis of maximum demand of the consumer and the units consumed, it is called a two-part tariff.

In two-part tariff, the total charge to be made from the consumer is split into components viz.., fixed charges and running charges.

The fixed charges depend upon the maximum demand of the consumer while the running charges depend upon the number of units consumed by the consumer.

Total charges = Rs (b x kW + c x kWh)

Where,

b = charge per kW of maximum demand

c = charge per kWh of energy consumed.

This type of tariff is mostly applicable to industrial consumers who have appreciable maximum demand.

Advantages:

i) It is easily understand by the consumers.
ii) It recovers the fixed charges depend upon the maximum demand of the consumer but are independent of the units consumed.

Disadvantages:

i) The consumer has to pay the fixed charges irrespective of the fact whether he has consumed or not consumed electrical energy.
ii) There is always error in assessing the maximum demand of the consumer.

5. Maximum demand tariff:

It is similar to two-part tariff with the only difference that the maximum demand is actually measured by installing maximum demand meter in the premises of the consumer.

This removes the objection of two-part tariff where the maximum demand is assessed merely on the basis of rateable value.

This type of tariff is mostly applied to big consumers. However, it is not suitable for a small consumer (e.g., residential consumer) as a separate maximum demand meter is required.

6. Flat demand tariff:

This is one of the earliest form of tariffs used for charging the consumers for electrical energy consumption.

7. Step rate tariff:

Step rate tariff is the group of flat rate tariff of decreasing unit charges for higher range of consumption.

8. Power factor tariff:

This tariff in which power, factor of the consumer's load is taken into consideration is known as power factor tariff.

In an a.c system, power factor plays an important role. A low power factor increases the rating of station equipment and line losses. Therefore, a consumer having low power factor must be penalised.

9. Three-part tariff:

When the total charge to be made from the consumer is split into three parts viz., fixed charges, semi-fixed charge and running charge, it is known as a three-part tariff.

Total charges = Rs (a + b x kW + c x kWh)

Where,

a = fixed charge made during each billing period. It includes interest and depreciation on the cost of secondary distribution and labour cost of Collecting revenues.

b = charge per kW of maximum demand.

c = charge per kWh of energy consumed.

10. Off-peak tariff:

The load on power station usually has pronounced peak load in the morning and early evening and a very low load during night. (From 10 p.m. to 6 A.m.)

15. What is the importance for Earthling, Fuses and circuit breaker in an electrical Circuit. [AU]

[OR]

What is the need for Earthing, Fuses and circuit breakers in an electrical circuit?

Earthing:

- To protect human life as well as equipment, the main objective of earthing is to provide an alternative path for dangerous current to flow so that accident due to electric shock and damage to equipment can be avoided.
- To keep voltage as contant.
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- It comprises a strip or metal wire that dissolves when the heavy flow of current supplies through it,

Circuit breaker:

- A circuit breaker is a switching device that interrupt fault current.
- The circuit breaker is mainly designed for closing or opening of an electrical circuit.
- This protects the electrical circuit, this protect the electrical system from damage.