Electrical Heating

Electrical heating is the process in which electrical energy is converted into heat energy. Electrical heating works on the principle of joule heating which state that an electric current through a resistance converts electrical energy into heat energy.

Let us take the case of solid material which has resistance 'R' ohm and current flowing through it is I Amp for 't' seconds, then heat produced in the material will be

$$H = I^2Rt$$

Advantages of Electrical heating :-

(i) Clean and neat atmosphere.
(ii) No pollution / no fuel gas produced.
(iii) Accurate control temprature can made easily
(iv) Response quickly
(v) Localized application.
(vi) Uniform heating
(vii) Overall efficiency is much higher
(viii) Cheap furnace
(ix) Low ambient temprature
(x) Mobility of job.
(xi) highest efficiency of utilization.
(xii) Heating of bad conductor of heat and electricity

Modes of heat transfer :-

- There are three modes of transfer of heat

(i) Conduction
(ii) Convection
(iii) Radiation

(i) Conduction :-

This phenomenan take place in solid, liquid and gas. Heat transfer is propotional to the difference of temprature between two faces. No actual motion of molecule take place in this mode of heat transfer.

(ii) Convection :-

This phenomenan take place in liquid and gas. In this mode heat is transfer is ~~propotional to the difference~~ due to actual motion of molecules.

(iii) Radiation :-

This phenomenan is confined to surface. Here radiate energy emitted or absorbed is dependent on the nature of surface.

Stephen's Law :-

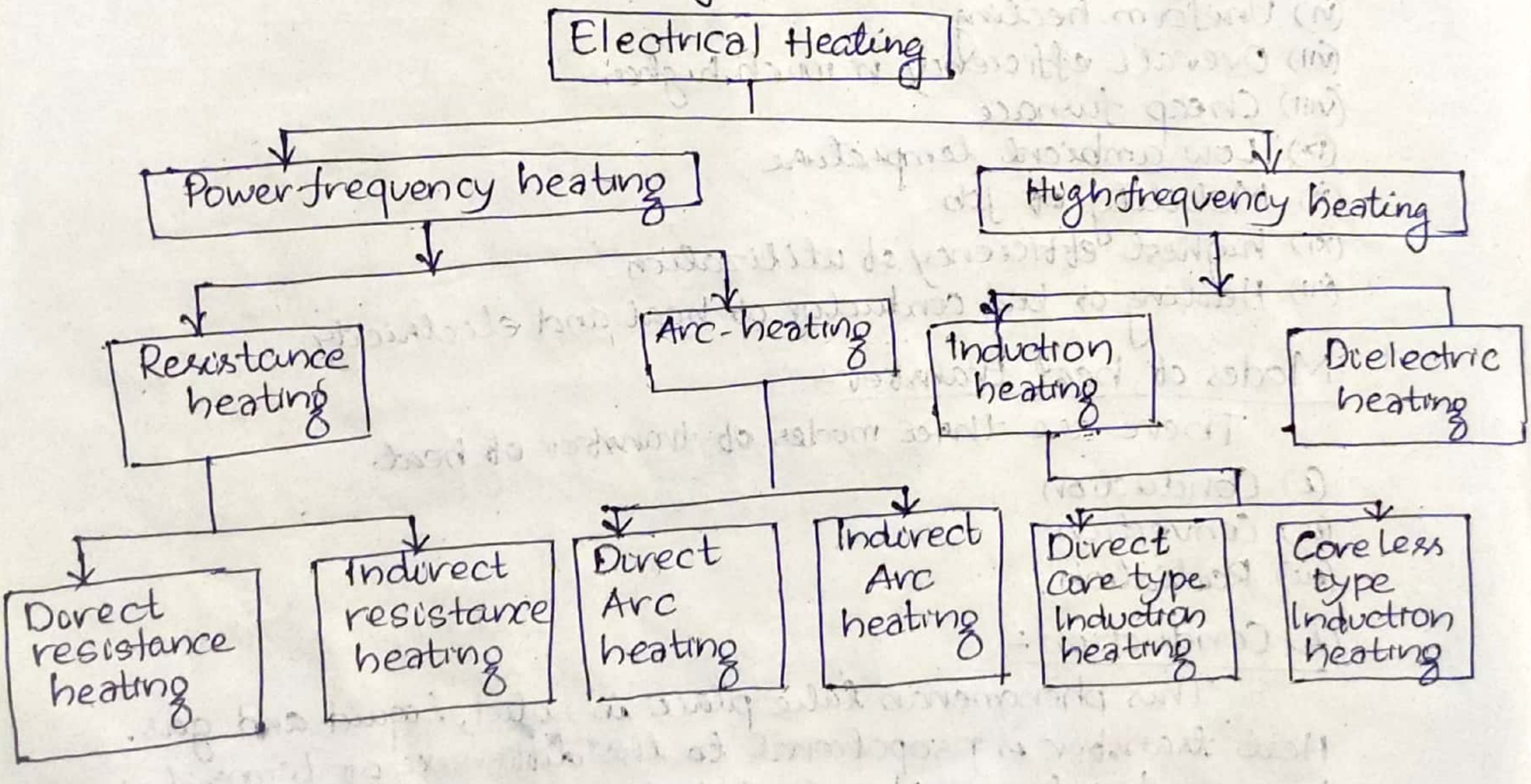
It state that the radiated power density of a black body is propotional to its absolute temprature T rise to the fourth power $E = e\sigma T^4$

Classification of Heating method :-

(i) Low temprature upto 400°C

(ii) Medium temprature heating from 400-1150°C

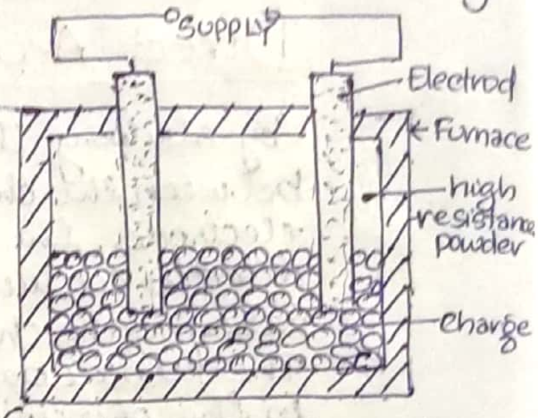
(iii) High temprature heating above 1150°C.



Principle of Resistance heating :-

This method is based upon the I^2R loss. whenever current is passed through a resistive material heat is produced because of I^2R loss. There are two methods of resistance heating. (i) Direct resistance heating (ii) Indirect resistance heating.

(i) Direct Resistance heating :-



(Direct resistance heating)

In this method of heating, the material is taken as a resistance and current is passed through it.

the charge may be in the form of powder pieces or liquid

Two electrodes are immersed in the charge and connected to the supply.

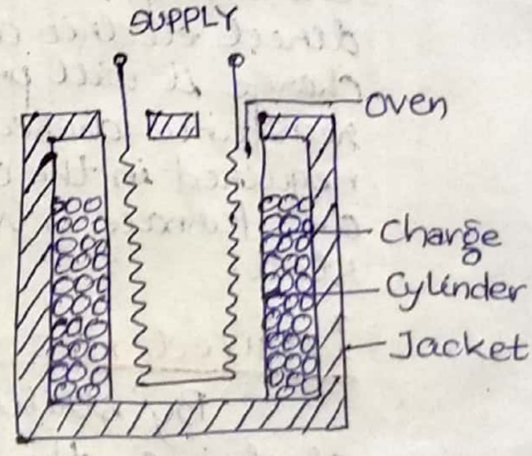
Incase of d.c or 1φ a.c, two electrodes are required. Incase of 3φ supply, three electrodes are required.

A powder of high resitive material is sprinkled over the surface of the charge to avoid direct short circuit.

Advantages :-

(i) High efficiency
(ii) Gives uniform heat and high temprature
(iii) Mainly used in salt bath furnace and water heater.

(ii) Indirect Resistance Heating :-



In this method the current is passed through a highly resistive element which either placed above or below the oven, depending upon the nature of job to be performed.

The heat is propotional to I^2R losses produced in heating element delivered to the charge either by radiation or by convection

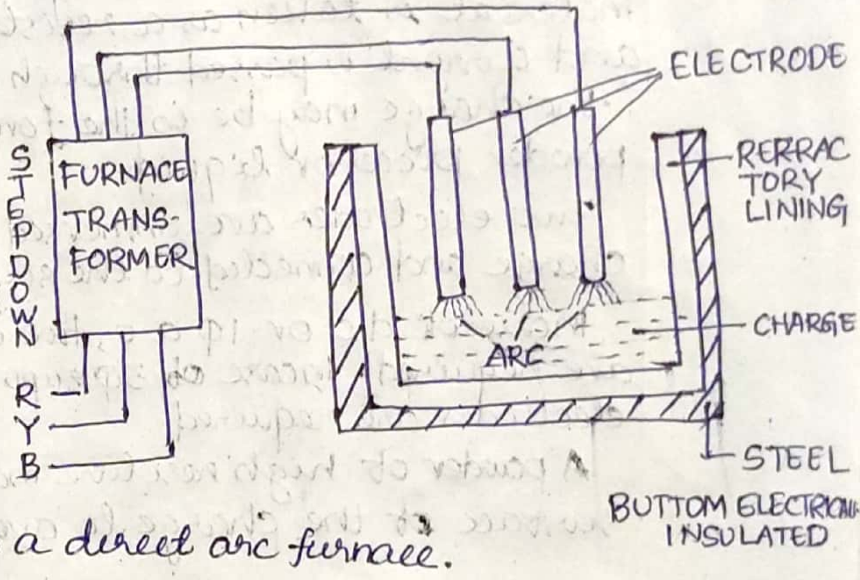
Some times in case of industrial heating. The resistance is placed in a cylinder, which is sorrounded by the charge placed in the jacket.

This arrangements provides uniform temprature. Automatic temprature control can be provided in this place.

This method is used in room heater, in bimetallic strip using starter, immersion water heater and various types of resistance oven used in domestic and commercial cooking.

Direct Arc Furnace:-

By striking the arc between the charge and electrodes, the heat is directly conducted and taken by the charge. The furnace operating in this principle is known as direct arc furnace.

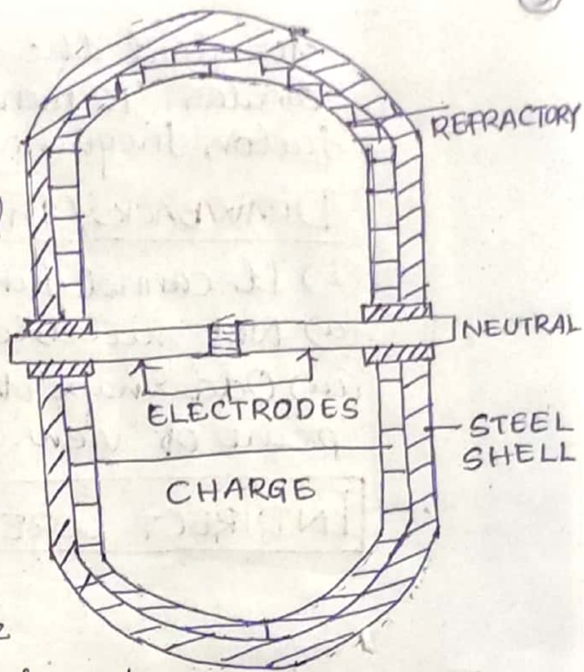


The diagram shows a direct arc furnace. The chamber of the furnace is lying with refractory material. The arc is struck between electrode and charge. Three electrodes made of carbon and graphite are projected from the top of the furnace and 3φ supply is given. The current passes through them by the charge. Since the arc is in direct contact with the charge, it is possible to produce highest temprature by direct electric arc furnace. As the arc passes through the charge it will produce automatic stering action. The arc has resistance characteristic. Some current limiting device is required in the circuit to prevent short circuit. The direct arc furnace is very commonly used for the production of steel.

Indirect Arc Furnace:-

By striking the arc between the arc between two electrode, the heat is tranfered to the charge by radiation. The furnace operating on this principle is known as indirect arc furnace.

The figure shows an indirect arc furnace. In this furnace, the arc is formed between two electrodes and heat is produced. Heat produced is transmitted to the charge by radiation. In this method the temperature is lower than direct arc furnace. So Indirect arc furnace are suitable for melting metal having lower melting point. Ex - Brass, Copper, zinc etc.

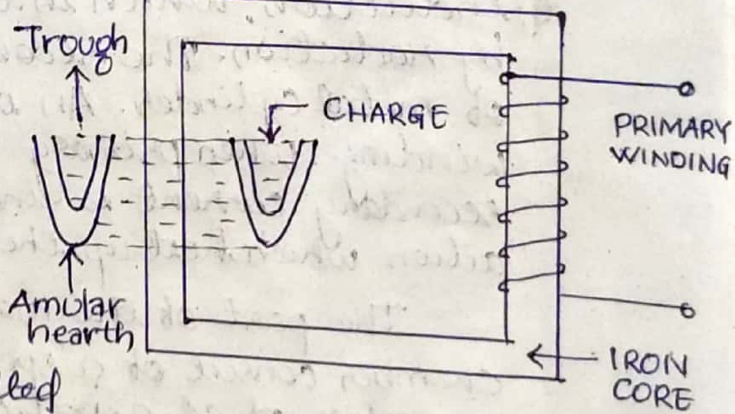


During the process of heating the electrodes are consumed, so the feeding of electrodes to the indirect arc furnace is automatic. The furnace is cylindrical. Since the arc does not come in contact with the charge, the automatic stirring action is absent. The furnace may be equipped with automatic rocking equipment. The power factor of this furnace varies from 0.7 to 0.8.

DIRECT CORE TYPE INDUCTION HEATING

In this furnace charge forms the short circuited secondary, which is magnetically coupled to the primary winding by iron core.

The furnace consist of a circular hearth, in the form of trough, which contain the charge to be melted in the form of an amular ring. The metal ring is quite large in diameter and is magnetically inter link with electrical winding. The ring is energised from a.c source.



The furnace is like a transformer in which the charge to be heated forms a single turn short circuited secondary and is magnetically coupled to the primary by an iron core

To start the furnace, molten metal has to be poured in the anular. To minimize the leakage reactance and low power factor, frequency of the order 10 Hz is used

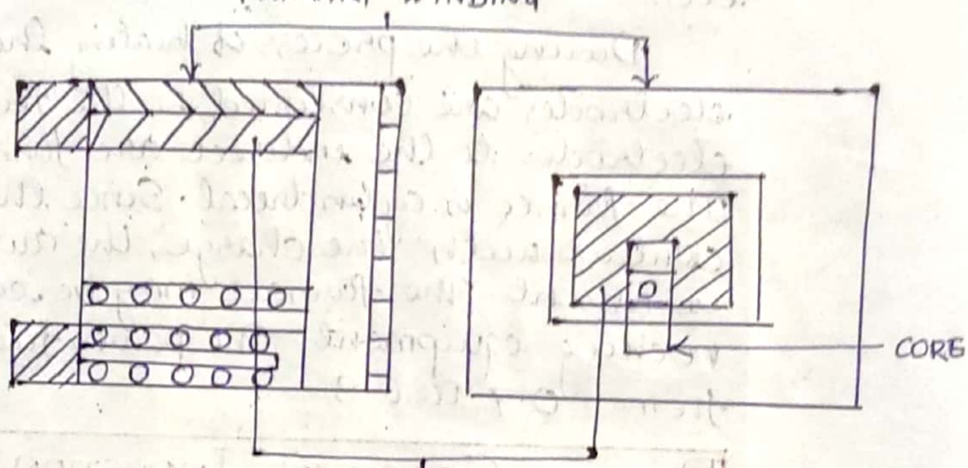
DRAWBACKS/ DISADVANTAGES :

(i) It cannot function, if the secondary circuit is not close

(ii) Not suitable for intermittent service

(iii) Odd shape of crusible are not convinvent from metalogical point of view.

INDIRECT CORE TYPE INDUCTION FURNACE

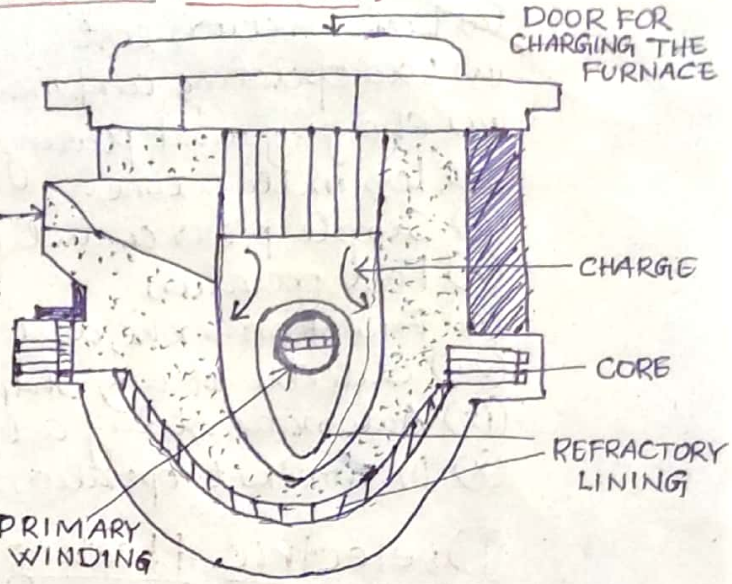


In this type of furnace, a suitable element is heated by induction, which in turn transfer the heat to the charge by radiation. The secondary winding is formed by the wall of metal cylinder. An iron core link the primary and secondary winding: when primary winding is connected to a.c supply, secondary current is induced in the metal contain by transformer action which heat up the container.

The part of the magnetic circuit, placed inside the oven chamber consist of a specially alloy which losses its magnetic properties at a perticular temprature. If chamber attain critical temprature, the reluctance of magnetic circuit increases highly. Its operating power factor is about 0.7 and temprature is 1000°C. The temprature can be controlled easily.

Vertical Core type Induction Furnace:-

This furnace has vertical channel for charge. It is also known as Ajax Wyatt vertical core type furnace.

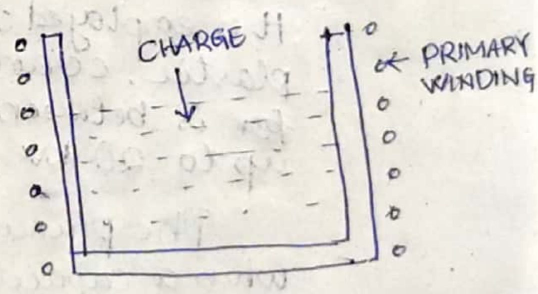


The magnetic coupling in this furnace is better than the core type. Hence leakage reactance is comparatively low and power factor is high. So it can operate from normal frequency supply.

The circulation of molten metal is kept up round the Vee portion by convection current as indicated. It is necessary to keep the Vee full of metal in order to maintain the continuity of secondary circuit. So this furnace is suitable for continous operation. The top is covered with insulated cover which can be removed for charging. Hydraulic tilting arrangement is there to take the molten metal out. It is widely used in foundries for melting refining of brass and other non ferrous metal.

Core Less Induction furnace:-

This furnace mainly consist of primary coil, a ceramic crucible with charge which forms secondary.



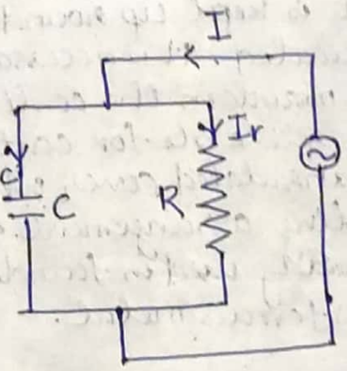
The primary winding coils are made of hollow tubes are cooled by circulation of water through them. This furnace mainly operated at high frequency. The primary winding not made of copper wire instead made of hollow copper tubes. Here convinient shape of crucible can be used.

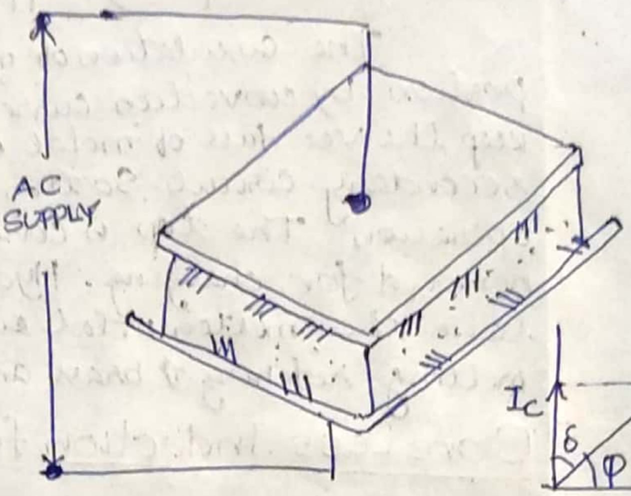
The flux produced by primary winding setup eddy current in the charge. These eddy currents are sufficient to heat the metal to melting point and also set up electromagnetic forces which produces a stirring action. A laminated yoke is built on the outside of induction coil to provide a definite path for the flux. This minimizes the stray field and also reduces the ~~exciting~~ exciting current necessary to produce the flux.

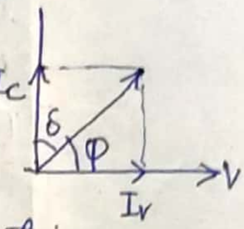
Advantages:-

(i) Low errection cost
(ii) Low operating and maintanance cost
(iii) Charging and pouring is simple
(iv) less melting time.
(v) Simple power control device can be employed
(vi) Fast operation.
(vii) Free from smoke, dust and noise.
(viii) Crucible of any shape can be used
(ix) Automatic stiring action due to eddy current
(x) Intermittent operation possible.

Dielectric Heating:-







It is also knaon as high frequency capacitive heating. It is employed for heating of insulating material like wood, plastic, ceramic. In this type of heating supply frequency applied ~~for~~ is between 10-30 megacycle per second. Applied voltage is up to 20 KV.

The principle of operation of dielectric heating is that, when a capacitor is subjected to a sinusoidal voltage, the current drawn by it neves leading the voltage by exact 90°. The angle between voltage and current is slightly less than 90°. The loss angle delta delta 'δ' is given by

$$\delta = \frac{1}{2\pi} \frac{\sqrt{\rho \times 10^7}}{\mu_r f} \text{ metre}$$

where ρ is resistivity, μ_r = relative permeability & f = frequency.

There is a small component of current, which is in phase with applied voltage and produce power loss in dielectric. The metal to be heated is placed between two sheet type electrode, which form the capacitor. The value of capacitor is given by

$$C = K K_0 \frac{A}{d} \text{ Farad}$$

where K = relative permeability
and K_0 = permittivity of vaccume = 8.854×10^{-12}
A = Surface area of electrode
d = distance between two electrode.

The necessary high frequency supply is obtain from a value oscillator as in case of high frequency current heating

The advantages of dielectric heating is that material with poor thermal conductivity can be heated as the heat produced within the material itself

The dielectric heating is used in welding, in manufacture of synthetic, wood processing industries, food processing, plastic industry, backing, book binding etc.

Microwave Heating:-

In this system, electricity is converted into electromagnetic wave, which generates energy and this energy is used to cook food. These waves are nothing but high frequency radio wave similar to those radio and TV. The wavelength of this wave is very short of very high frequency also known as microwave. These microwaves vibrate million of times per second (2400-2500 MHz). The microwaves are attracted to water and sugar molecules, they causes the molecules to vibrate at 2400 MHz/second. Leading to friction within the food which generate heat which began cooking process. In the oven, microwave are confined inside the open cavity and reflected from its wall and door. Once door is open, all microwaves are automatically switched off. The microwave heating is used in microwave oven for baking purpose, the frequency used from 900 MHz - 2400 MHz.

Application of Microwave heating:-

→ Baking Industries for manufacturing of bread and toast.
→ Drying of paper and textile.
→ Treatment of disease like cancer.
→ Manufacture of plastic
→ Processing of cement and timber etc.

Advantages of microwave heating:-

→ It has neat and clean system
→ It provides uniform heating to the substance
→ The system provides quick heating
→ The depth of penetration of heat into the material is much more.
→ Within the material, the heat is generated directly which gives much faster temprature rise.

ELECTRIC WELDING

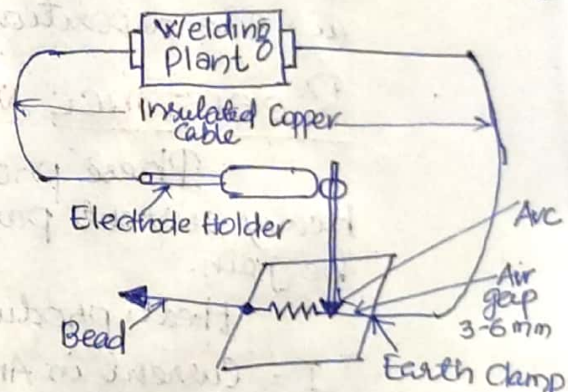
Electric weilding is defined as that branch of welding in which electric current is used to produce the large heat required for joining two or more pieces of metal.

Electric Welding

- Resistance Weilding
  - Butt Welding
  - Flash Welding
  - Spot Welding
  - Projection Welding
  - Seam Welding
- Arc welding
  - Metal Arc Welding
  - Carbon Arc Welding
  - Atomic Hydrogen Arc Welding
  - Helium Argon Arc Welding

Arc Welding :-

The welding in which the electric arc is produce to give heat for the purpose of joining two surface is called electric arc welding. The joining by fusion of two or more pieces of metal together by using the heat produce form an electric arc. The arc is flame reflection of intense heat that is generated as the electric current passes through a high resistance air gap.



Arc welding is divided into 4-type.

1. Carbon arc welding
2. Metal arc welding
3. Atomic hydrogen arc welding
4. Helium or argon arc welding

Here in arc welding pressure is not used, filler metal is obtained from electrode. Arc welding is also known as slip welding.

Principle of Arc Welding:-

A high current is passed through the circuit (Both AC&DC) one terminal is connected to the electrode other to work pieces. A suitable gap is provided between work piece and electrode as shown in figure. (3mm to 6mm) Due to interaction by the air gap or gas an arc is produce which generates heat. The electrical energy is converted into heat energy producing a temprature of 3000°C to 4000°C. This heat is meant for the edges to be melted and molten coil is form. On solidification the welding joint is obtain.

Advantages:-

(i) Simple welding equipment.
(ii) process is fast and reliable.
(iii) Welders use standard domestic current.
(iv) Use for maintanance, repair and field construction.

Disadvantages:-

(i) Not clean
(ii) The deposition made is limited.

Resistance Welding:-

These process are the pressure welding process, in which heavy current passes through the area of interface of metal to be join.

Heat produce by resistance welding is $H = I^2RT$

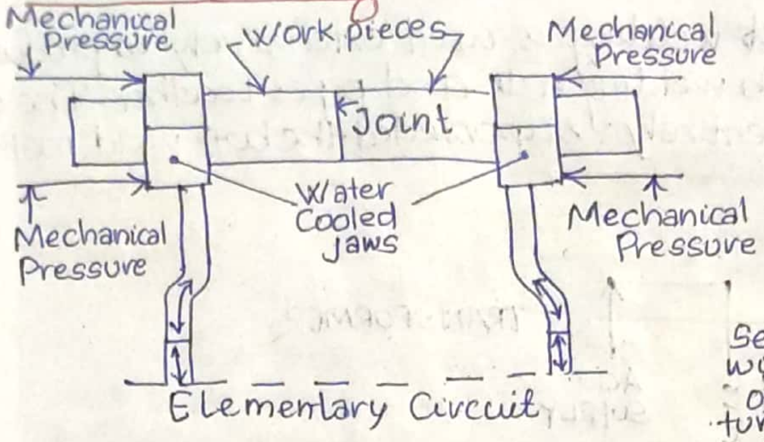
I = Current in Ampere, R = Resistance of welded area
T = Time for flow of current.

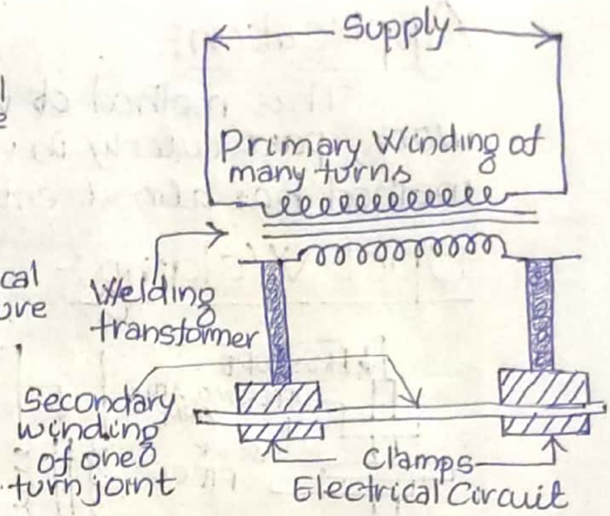
Current provided for this type of welding is few Kiloampere. and supply voltage ranges from 2-12 Volt Necessary pressure is varied from 30-60 N/m^2. Different types of resistance welding are (i) Spot welding (ii) Projection welding (iii) Seam welding and (iv) Butt Joint welding (v) Flash welding.

Advantages of Resistance Welding:-

(i) It is a quick method of joining two pieces
(ii) There is very little wastage of the metal.
(iii) The process can be accurately controlled
(iv) The welds are consistently uniform.

Butt Welding:-





In this process, heat is generated by the contact resistance between two component. The faces of components should be machined or edge prepared as shown in figure. The two parts are brought together and pressure is applied along the axial direction by a spring. A heavy current is passed from the welding transformer which creates the necessary heat at the joints due to comparatively high resistance of the contact area. The metal at the joints melts and the two parts fuse together producing a bulged joint.

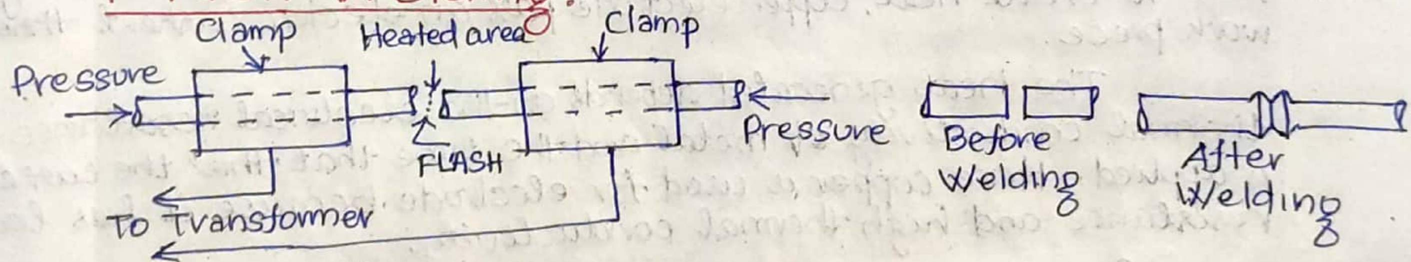
Application:

The main applications of butt welding are:

(i) where parts are joined end to end or edge to edge.

(ii) For welding pipes, wires and rods.

Flash Welding:-

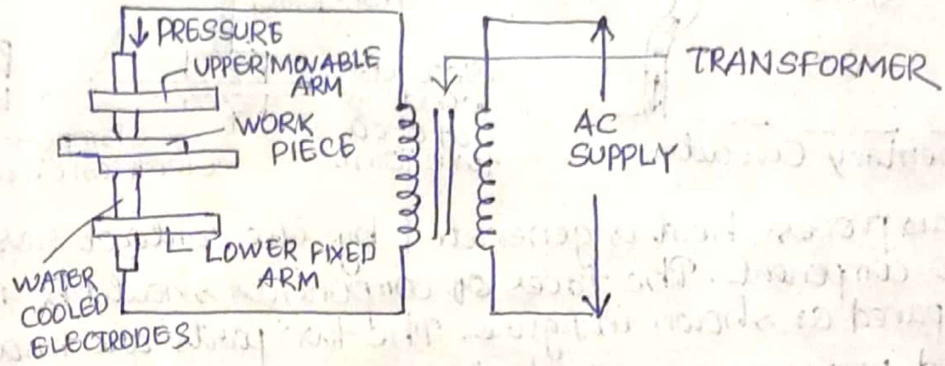


This process is similar to the butt welding except in this case current is applied to the parts before they are brought together so that when they meet arcing or flashing takes place. The two pieces are to be welded are clamped strongly in a flash welding machine. The parts are brought together and resistance to the current flow heats the contacting surface. As soon as the metal has been brought to its melting temprature, the current is shut off and the pieces are rapidly brought together under considerable pressure. As the metal heated to its plastic state, the pieces are forced together under high pressure which forces metal and slag out of the joint making a good solid weld

Application:-

This method of welding is used extensively in production work, particularly in welding rods and pipes together. The flash method has almost entirely superseded the butt weld method.

Spot Welding:-



Spot welding is one form of resistance welding which is a method of welding two or more metal sheet together without using any filler material by applying pressure and heat to the area to be welded.

The process is used for joining sheet material and uses copper alloy electrode to apply pressure and convey the electrical current through the workpiece.

The material between the electrode is squeeze together, It then melt destroying the interface between the path. The current is switched off and the nugget of molten material solidify forming join. To create heat, copper electrode pass an electric current through work piece.

The heat generated depends on the electrical resistance and thermal conductivity of metal and the time that ~~that~~ the current is applied. Here copper is used for electrode because it has low resistance and high thermal conductivity.

Current ranges from 1000-5000A, depending upon the base metal and voltage ranges from 2-12 volts. It is primarily used for joining metal are normally upto 3mm thickness.

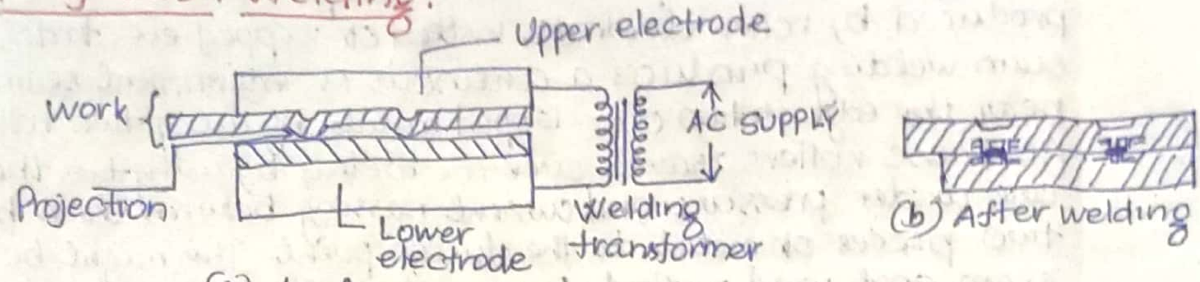
Application:-

(i) It is applied to welding of sheets.

(ii) It is used for fabricating all types of sheet metal structures where mechanical strength rather than water or air lightness is required.

(iii) It may be applied to all types of boxes, cores and enclosing cases etc.

Projection Welding:-



(a) before welding.

It is modified form of spot welding. It consist of forming slight projection on the sheet of metal. projection are accurately formed in precise location on the metal by a special set of dies. After the projection are formed, the raised portion on one piece are pressed into contact with another piece, while at the same time a heavy current is passed through the two pieces.

When these raised portion touch the second sheet of steel, as they are clamped by the electrodes in a projection welder and the current is applied, current flows at the points, heats and fuses the two pieces together.

Projection welding has following advantages over spot welding.

(i) More than one spot or weld are done at a time. Therefore more output is obtained

(ii) Due to low current density and low pressure the electrode life is increased.

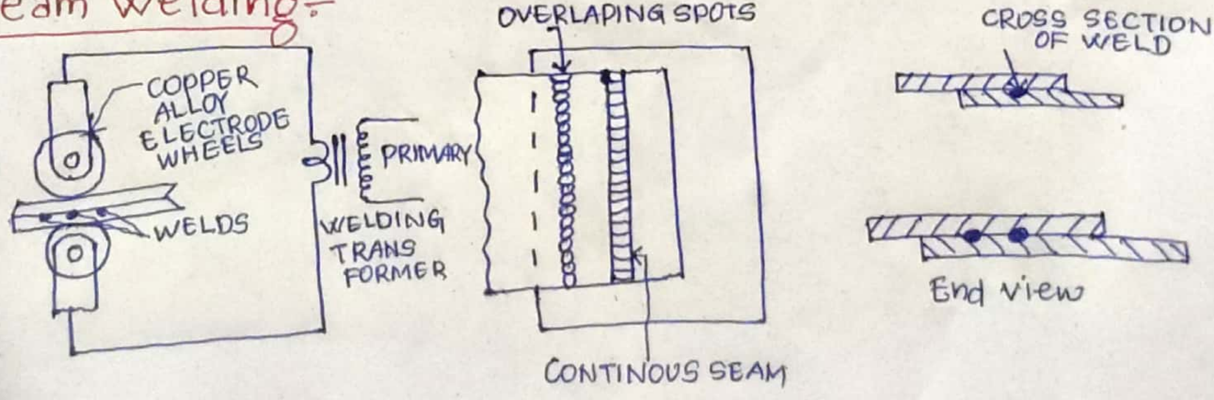
(iii) ~~Due to low~~ Good finished appearance is obtained because ~~be~~ surface remains unindented by electrodes.

(iv) It Locates the welds automatically at certain desired points by the position of projection.

Application :-

It is applied in assembling parts made by punching or stamping and for welding studs, nuts to plates.

Seam Welding:-



It is similar to spot welding except that series of spots are produced by roller electrodes instead of tipped electrodes. Most seam welding produces a continous or intermittent seam weld near the edge of two over-lapped metals, by using two roller electrodes. As these rollers travels over the metals ~~by using two~~ the pieces are under pressure and current passing between them heats the two pieces of metal to the fusion point. This might be called a seam spot weld method. Figure shows the schematic diagram of a typical seam spot weld method. Two types of seam welds are shown in figure (b). If the current to the electrodes is turned on and off, a series of over lapping spot form the seam. An uninterrupted flow of current to the electrodes will form a continous seam.

Applications:-

(i) It is used for making lap and butt welds.

(ii) It is quicker than spot welding operation.

(iii) It is used on many types of pressure tight or leak proof tanks for various purposes and number of other products particularly of the relation type such as circular or rectangular container, car body section transformer radiator units.

Utilisation of Electrical Energy & Electric traction (UET)

CH-1: Electrolytic Process

Electrolyte:- The substance which decomposes when electric current is passed through them are called electrolyte.

Electrolysis:- The process of decomposition of electrolyte by the passage of electric current through them is called electrolytic process or electrolysis.

i) Electrolyte may be solid like costic soda or silver iodide but they are generally liquid.

(ii) Two electrodes are dipped in an electrolyte and voltage is applied across them.

(iii) The electrode to which +ve terminal is connected is called anode and the electrode to which -ve terminal is connected is called cathode.

(iv) when current through the electrolyte passes, the electrolyte decomposes into two ions i.e. positive ion (anion) and negative ion (cation).

(v) positively charged ions travel toward cathode and nagatively charged ions toward ~~cathode~~. Anode.

(vi) They give up their respective charge on reaching the electrodes and become odinary molecules of respective radical.

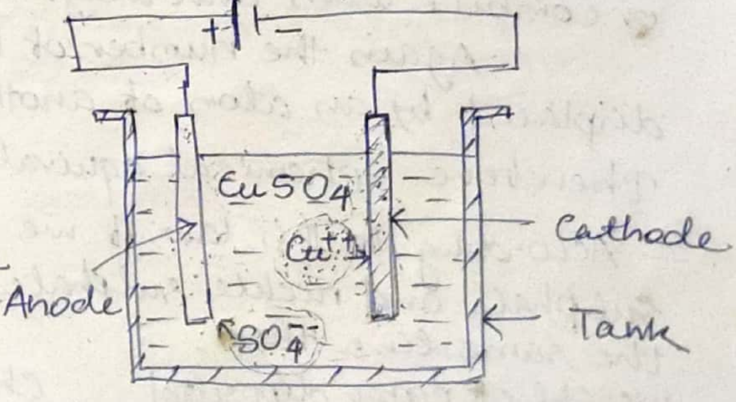
Need of electroplating

① To protect metal against corrosion.

② To give shining appearance

③ To give reflecting properties.

④ To repair damage casting.



Faraday's Law's of Electrolysis :-

There are two Laws.

First Law :- It state that the weight of a substance liberated from an electrolyte in a given time is propotional to total quantity of electricity passed in that time.

If W is the weight of substance liberated in gram

then $W \propto Q$

or $W \propto I \cdot T$

or $W = ZIT$

where Q is the quantity of electricity passed.

and Z is a constant called eletro-chemical equivalent of the substance (E.C.E) and its value depends upon the nature of the substance.

If I = 1 amp and T = 1 sec

then $\boxed{W = Z}$

Therefore, electro-chemical equivalent of a substance is the amount of that substance by weight liberated in a unit time by passage of unit current. Its unit is mg/C or gm/C.

Second law :- It state that if the same current flows for a given time through several electrolyte, the weight of the substance liberated are propotional to their chemical equivalent.

The chemical equivalent or equivalent weight of a substance is the weight of the substance which can displace or combine with unit weight of hydrogen or 8 grams of oxygen.

Again the number of hydrogen atoms that can be displaced by an atom of another substance is called it valancy.

Therefore chemical equivalent = $\frac{\text{Atomic weight of substance}}{\text{Valancy}}$

According to this law if we take two electrolytes of copper sulphate and nickle sulphate in which same current flows for the same time then,

$$\frac{\text{weight of copper deposited}}{\text{weight of nickle deposited}} = \frac{\text{Chemical equivalent of copper}}{\text{Chemical equivalent of nickle}}$$

...ed Problems

2. Find the thickness of copper deposited on a plate of $2.25\ cm^2$ during electrolysis if a current of 1 ampere is passed for 100 min. Given density of copper is 8.9 gm/cc and ECE of copper is 0.0003295 gm/Coloumb.

Data given

thickness of Cu = $2.25\ cm^2$

Current I = 1 Amp

time T = 100 min = 100×60 = 6000 sec.

According to first law

weight of Cu deposited

$W = ZIT$

$= 0.0003295 \times 1 \times 6000$

$= 1.977$ gm.

Density of Cu = 8.9 gm/cc

we know that density = $\frac{Mass}{Volume}$.

volume = $\frac{Mass}{density}$

Volume = $\frac{1.977}{8.9} = 0.222\ cm^3$

thickness = $\frac{Volume}{Area} = \frac{0.222}{2.25} = 0.0986$ cm (Ans)

Scanned with CamScanner

Application of Electrolysis:-

Q If a current of 10 ampere deposits 13.42 gm of silver from a silver nitrate solution in 20 minutes, calculate electro-chemical equivalent (ECE) of silver.

Ans Data given Current $I = 10$ Amp

Weight of silver deposited $W = 13.42$ gm

Time $T = 20$ min $= 20 \times 60 = 1200$ sec.

we know that $W = ZIT$

$$\Rightarrow Z = \frac{W}{IT} = \frac{13.42}{10 \times 1200} = 0.001118 \text{ gm/C}.$$

Q Calculate the quantity of electricity and the steady current required to deposit 5 gm of copper from copper sulphate solution, in one hour. Electro-chemical equivalent of copper is 0.3294 mg/colomb.

Ans. Data given weight of Cu deposited $W = 5$ gm.

E.C.E of Copper $Z = 0.3294$ mg/C.

$= 0.3294 \times 10^{-3}$ gm/C.

we know that $W = ZIT$

or $W = ZQ$.

$$\Rightarrow Q = \frac{W}{Z} = \frac{5}{0.3294 \times 10^{-3}} = 15180 \text{ C. (Ans)}$$

& we know $Q = IT$

$$\Rightarrow I = \frac{Q}{T} = \frac{15180}{1 \text{ hour}} = \frac{15180}{60 \times 60}$$

$$\Rightarrow I = \frac{15180}{3600} = 4.216 \text{ Amp (Ans)}$$

Electro deposition:-

The process of depositing metal over another metal or non metal by electrolysis is called electro-deposition. Electroplating is a very common example of such process.

Factor effecting the amount of Electro deposition:-

1. Time:- Time is directly propotional to the quantity of electro deposition.

2. Efficiency:- Greater is the efficiency, greater is the quantity of metal deposited for a given time.

3. Current:- The value of current is also directly propotional to the mass of metal deposited. But if we increase the current beyond a certain limit, the metal deposited will be of different color such as blackish, which is known as brunt metal.

4. Strength of solution:- If the strength of solution is more then the mass of metal deposited will be more as compared to the dilute solution of electrolyte if the other condition remain the same.

Factor governing better electro-deposition:-

(i) Current density:- At low value of current density the ions are released at slow rate, therefore deposit will be coarse and crystaline in nature. At higher value of current density the quality of deposit become more uniform and fine ground. If the current density is so high that exceed the limiting value for electrolyte then a spongy and porous deposit is obtained. The recommended current density per square meter for copper, gold, nickel and silver are 33 to 44, 110 to 330, 110 to 220 and 33 to 66 ampere respectively.

$$\text{Current density} = \frac{\text{Current}}{\text{Area}} \quad (\text{Amp}/m^2)$$

(7)

electrolytic concentration:-

By increasing the concentration of electrolyte higher current density can be achieved. Increase of concentration of the electrolyte tends to give better deposit and it is generally recommended to use concentrated electrolyte.

(iii) Temprature:-

The temprature of electrolyte is different for different metals to have better deposit. For example in chromium plating the temprature is maintained at 35°C.

(iv) Addition of Agents:- The quality of a deposit is improved by the presence of an additional agents like gums, rubber, alkalies and sugar etc.

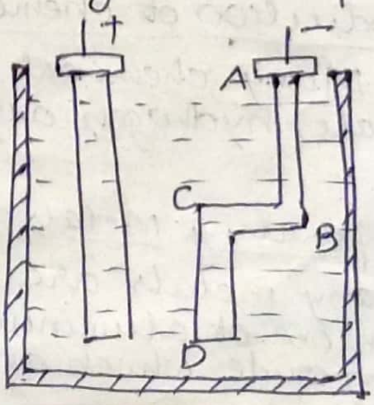
(v) Nature of electrolyte:- The smoothness of the deposit largely depends upon the nature of the electrolyte. For example silver from silver nitrate solution forms a rough deposit while that from cynaide solution forms a smooth deposit.

(VI) Nature of the metal upon which deposit to be made:-

These factor influence the growth of the crystal since it is believed that the operation of crystal is in continuation of these in the base metals.

(VII) Throwing power:- The throwing power of an electrolyte may be regardless as the quantity which produces a uniform deposit on a cathode having irregular shape.

Fig shows an article ABCD having irregular shape. The portion AB is far away from anode than CD. So resistance to the path to AB is more than CD. Therefore thickness of deposit on surface AB will be smaller than CD.



Application of Electrolysis:-

(i) Extraction of metal from their ores.
(ii) Extraction of zinc
(iii) Extraction of aluminium
(iv) Refining of metals
(v) Production of chemicals.
(vi) Separating metal from their compounds
(vii) Electrotyping
(viii) Electro forming
(ix) Electrodeposition
(x) Electro cleaning

(i) Extraction of metal from their ores:-

There are two methods of extraction of metals from ores
(a) The ore is treated with a strong acid to obtain a salt and the solution of the salt is electrolysed to liberate the metal.
(b) When the ore is in molten state it is electrolysed in the furnace.

(ii) Extraction of Zinc

The zinc ore which has mainly zinc oxide is treated with concentrated sulphuric acid. The zinc sulphate solution is obtained and then electrolysis. On electrolysis zinc is deposited on cathode.

(iii) Extraction of Aluminium:-

The ore of aluminium are treated chemically and reduced to aluminium oxide and then dissolved in fused cryolite and electrolysed.

(iv) Refining of metals:-

The metal extracted from its ore is not that much pure which would be used for electrical application. Purity of copper is obtained by electrolysis. The electrolyte solution used is copper sulphide. The anodes are made of impure copper extracted from its ore and pure copper is deposited on the cathode.

(v) Production of chemicals:-

Many chemicals such as caustic soda, chlorine gas, amonium sulphate, hydrogen, oxygen are produced by electrolysis on a large scale.

(vi) Separating Metals from their compounds:-

Many metals are separated from their compounds by electrolysis. Eg - an ore of aluminium contains about 70% aluminium oxide, silica and iron oxide which are separated using electrolysis.

Electrotyping:-

In this process wood cuts are reproduced in copper by the process of electroplating. First the mould is made of the type in wax, then it is coated with black lead to give it a metalic surface and then it is subjected to the process a film of copper is formed on the prepared surface.

(VIII) Electroforming:-

The production or reproduction of an article by electro deposition is known as electroforming. In the production of coins, models etc mould is first made by having an impression point in wax surface of the wax which has exact impression of point of the object is coated with powdered graphite in order to make it conducting. The mould is then dipped in electroforming cell as a cathode. After obtaining coating of desired thickness the object is removed and the wax is melted out of the metal shell.

(IX) Electrodeposition:-

It is the process of depositing a metal over another metal or non metal by electrolysis. Electroplating is common example of electrodeposition.

(X) Electrocleaning:-

The articles before electroplating should have a surface free from grease, oil etc. and they are cleaned by electrocleaning method. A solution of sodium phosphate is used as an electrolyte in the plating tank. The tank is connected to +ve terminal of D.C supply and work piece to be cleaned is made the cathode and is suspended in the solution of sodium phosphate. Heavy current is passed through the solution and caustic soda is produced on the cathode which has a cleaning action and also hydrogen gas is evolved at cathode which removes the grease etc. This process is called cathodic cleaning and is applicable to zinc and aluminium. For anodic cleaning the work is made anode and negative supply is given to the plating tank.