Electrolytic process — Unit-8

→ The process of depositing a metal on surface of some other metal by electrolysis is called Electroplating.

→ The process of decomposition electrolyte by the passes of electric current through it is called Electrolytic process.

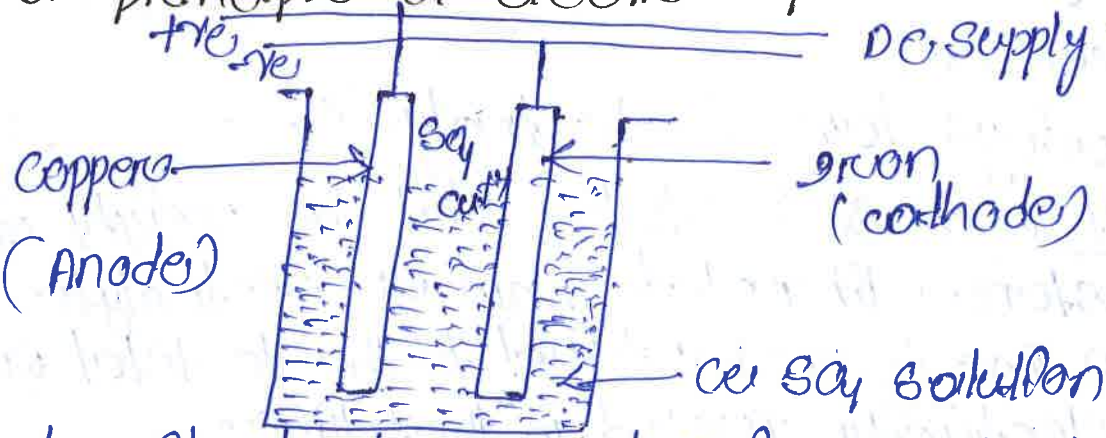
→ The substance which decompose after passing electricity is called electrolyte.

Need of Electroplating :

The electroplating is used for.

i. To protect metal agent corrosion.
ii. To give reflecting products to reflector.
iii. To give shining a prices to the articles.
iv. To replace material from.
v. To repair damage casing.

* Basic principle of Electro deposition :→



→ If two electrode are deep in an ~~elect~~ electrolyte and potential is apply across there.

→ The electrode are name as +ve (Anode) & -ve (cathode)

→ Let us consider an iron plate is to be given a copper coating for his purpose the copper of solute solution is use as an electrolyte.

→ The solute solution readly breakes into the Cu^{++} ion & SO_4^{--} ion.

→ The (−)ve ion move towards the Anode made of copper.

→ The (+)ve copper ion rise (+)ve electrode and reache to electrode from supply circuit to. copper atom and get de posited on the cathode surface.

$$CuSO_4 \rightleftharpoons Cu^{++} + SO_4^{--}$$

At Anode SO_4^{--} loss two electrons = SO_4 molecule

$$SO_4 + Cu \longrightarrow CuSO_4.$$

At cathode Cu^{++} Electrons = metallic Cu atom.

metallic coating of surface of some other metal through is called electroplating processes.

faradays law of electrolysis:

(i) First law: It is states that the weight of substance liberated from an electrolyte in a given time is proportional to the to total quantity of electricity passed in that time.

Let W be the weight of substance liberated in gm. and is the quantity of electricity passed. then

$$W \propto Q$$

$$W \propto It$$

$$\rightarrow \boxed{W = ZIt}$$

→ where 'z' is a constant and is called electro-chemical equivalent of the substance. (ECE)

→ The electrochemical equivalent is the amount of substance by weight liberated in a unit time by passes of unit current.

$z \rightarrow$ unit = Mg / coulomb.

→ **2nd law:**

If same current flows for a given time through several electrolytes the weight of substance liberated are proportional to the chemical equivalent = $\dfrac{\text{atomic weight}}{\text{valency}}$.

→ According to this law if 2 electrolytes of $CuSO_4$ & $NiSO_4$ in which same current flow for the same time then weight of Cu deposited by given quantity of electricity / weight of nickel deposited by same quantity of electricity.

$$= \frac{\text{chemical equivalent of copper}}{\text{chemical equivalent of Nickel}}$$

Current efficiency:

→ Due to impurities which cause secondary reaction the quantity of substance liberated is less than that calculated from faraday's law.

$$\text{current efficiency} = \frac{\text{Actual quantity of substance deposited}}{\text{Theoretical quantity}}$$

Energy efficiency:-

energy efficiency is defined as the ratio between theoritical energy and actual energy required.

$$\text{Energy efficiency} = \frac{\text{Theoritical energy}}{\text{Actual energy required}}$$

Q1 If a current of 10amp deposites 13.42gm of silver from silver nitrate solution in 20minutes calculate electro chemical equivalent of silver.

$$W = ZIt$$

Given data:

$I = 10\,Amp$

$W = 13.42\,gm$

$t = 20\,min = 60 \times 20$

$= 1200\,sec.$

$$Z = \frac{W}{It}$$

$$= \frac{13.42}{10 \times 1200} = 1.18\,mg/coulomb$$

Q.2 calculate the quantity of electricity and steady current required to deposite 5gm cu from $CuSO_4$ solution in 1hour given electro chemical is 0.3294 mg/coulomb.

Given data:

$W = 5\,gm$

$t = 1\,hour = 60\,minutes = 60 \times 60 = 3600\,sec$

$Z = 0.3294\,mg/coulomb.$

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ved.

of
ites
silver

$$w = ZIt$$

$$\rightarrow I = \frac{w}{Zt}$$

$$= \frac{5}{0.3294 \times 3600} = 4.216\ amp.$$

$$Q = It$$

$$= 4.216 \times 3600$$

$$= 14400\ coulomb.$$

steady current $I = 4.216$ Amp
electricity $Q = 15177$ coulomb.

Q.3 An ameter connected in series with a silver electrolytic cell reads 0.6 Amp and it is found that 0.322 gm of metal deposite in a run lasting 10m... what is the error of ameter to this point of its range.
(given ece of silver is 1.118 mg/coulumb)

given data:

$$w = 0.322\ gm$$

$$t = 10\ minutes = 60 \times 10 = 600\ sec.$$

$$Z = 1.118\ mg/coulomb \times 10^{-3}$$

$$w = ZIt$$

$$I = \frac{w}{Zt} = \frac{0.322}{1.118 \times 10^{-3} \times 600} = 0.48\ amp.$$

V. Imp ans

Application of electrolysis :-

following are the applications of electrolysis.

(i) Extraction of metal from their ores:-

→ There are 2 methods of extraction of metals from ores depending upon the physical state of the ore.

(a) The ore is treated with a strong acid to obtained a salt & the solution of the salt is electrolised to liberate the metal.

(b) when the ore is in molten state it is electrolised in furnace.

(ii) Extraction of Zn:-

→ The zinc ore which has mainly zinc oxide is treated with conc. sulphuric acid & passed through various chemical process to remove impurities like cadmium, Cu, etc, by precipitation.

→ The $ZnSO_4$ soln thus obtaind is the electrolysis in a wooden box with inner lining of lead.

(*) Extraction of Aluminium:-

→ The ores of aluminium like bauxite, cryolite, bauxite ore, treated chemically & reduced to the aluminium oxide & then disolved in fused cryolyte & electrolysed the furnance is lined with the carbon - aluminium metal gets deposited at cathode.

* Refining of metals:-

→ The metal extracted from its core is not that much pure which would be used for electrical application to obtained electrolysis process is used.

→ The anodes are made of impure Cu extracted from its core & pure metals is deposited on cathode.

* production of chemicals:-

→ many chemicals such as caustic soda, chlorine gas, amonium sulphate, & oxygen are produced by electrolysis.

→ Separating metals from their compound.

→ many metals are separated by electrolysis i.e an ore of aluminium contains about 70% aluminium oxide, silica & iron oxide.

→ 1st pure aluminium oxide is obtained by suitable chemical treatment & pure aluminium is obtained by electrolysis process.

* Electrotyping:-

→ on this process wood cuts are re produced in copper by the process of electroplating first the mode is made of wax & then it is coated with blacklead to give metalic surface then it is the subjected to the process a film, cu is formed on the surface.

* Electroforming:-

→ The production of an article by electrodeposition is known as electroforming.

→ In the production of coins, models made is made of wax which has exact impression of objects coated with powdered graphite in order to make it conductive the would is then deep in an electroforming cell as cathod after obtaining desired thickness the object is then remove wax is melted out to get a properly shaped object.

* Electro weaning:-

→ The artical before electroplating should have a surface free from gross, oil etc.

And they are cleaned by electrocleaning method.

→ A solⁿ of sodium phosphate is used as an electrolyte in the plating tank the tank is connected to positive terminal of dc supply & work piece to be cleaned is connected to cathod & suspended in the solution of sodium phosphate

→ Heavy current is passed through the soln & custic soda is produced on the cathod which has the cleaning action also Hydrogen gas is evolve at cathode which remove the grease this process is called cathodic cleaning.

Q. calculate the time taken to deposite a coating of nickel 0.05cm thick on a metal surface by means a current of 20Amp per square inch of surface Nickel is a divalent metal of atomic weight of 5.. & density of 9 gm/coulomb silver has an atomic weight of 108 & electro chemical equivalent of 1.18 mg/coulombe

length of plate = 2.54

$$Area = 2.54 \times 2.54\ cm^2$$

$$= 6.451\ cm^2$$

weight of nickel =

$$(2.54)^2 \times 0.05 \times 9$$

$$= 2.903 \text{ cubic cm.}$$

$$Z = \frac{E.C.E\ of\ Ni}{E.C.E\ of\ Ag} = \frac{wt\ deposite\ Ni}{wt\ deposite\ Ag}$$

$$= \frac{chemical\ equivalent\ of\ Ni}{chemical\ equivalent\ of\ Ag}$$

$= \frac{59.12}{108} = 0.273$

$\Rightarrow \frac{E.C.E \text{ of } Ni}{0.001118} = 3.053 \times 10^{-4}$ mg / coulomb.

weight of metal deposited:-

$\Rightarrow m = ZIt$

$\Rightarrow 2.903 = 3.053 \times 20 \times t$

$\Rightarrow t = \frac{2.903}{3.053 \times 10^{-4} \times 20} = 475.5$

factors affecting electro deposition:-

$M = ZIt$

(i) Time is directly proportional to the quantity of electro deposition more mass will be deposited in more time.

(ii) efficiency:- greater is the efficiency greater is the quantity of metal deposited in a given time.

current:-

→ The value of current is also directly proportional to the mass of metal deposited so greater is the current, greater is the quantity of metal deposited by the other condition remain same.

Strength of Soln:-

→ If the strength of soln is more the mass of metal deposited will be more.

factor governing better electrodeposition:-

→ In order that deposits have fine grain smooth appearances suitable conditions have to be the provided. factors which effect the appearance of deposited material at discussed.

① current density:-

→ At low value of current density the ions are released at slow rate therefore the deposite will be coarse & cristalike in nature.

→ At a higher value of current density the quality of deposite become more unifor & fine grained. If current density exceeds limiting value then a spongy or porous is obtained.

② Electrolytic concentration:-

→ By increasing the concentration of electrolyte higher current density can be archieved & gives metal deposite.

→ Hence is recomainded to use concentrated electrolyte.

③ Temperature:-

→ The temperature of electrolyte is different for different metals to have better deposite.

for ex:- in chromium platting the temperature is maintain at 35° centigrade, in cu platting at 50° centigrade, in nickel platting it is between 50-60° centrigrade.

④ Addition of agents:-

→ The quality of deposite is improved by the presence of additional agents which may be organic compound such as gum, rubber, alkali & sugar.

⑤ Nature of electrolyte:-

→ The smooth-ness of deposite largly depends upon the nature of electrolyte.

Ex:- silver from silver nitrate solⁿ forms rough deposite while from cyanide solution forms smooth deposite.

⑥ Nature of metal:-

→ These factors implace the growth of the crystal hence shape of metal playes a significant role in nature of metal deposition.

⑦ Throwing power:-

→ Throwing power of electrolyte may be regard less as the quantity which produces a uniform deposite on a cathode have irregular surface.

→ By increasing the distance between object & anode the relative variation in resistance betⁿ anode & different parts is reduced & the throwing power is improved.

→ By using coloidal matter which results in the increase of current density for this region solⁿ of cyanides give better throwing power than solution of sulphates.

$I\ R$

I^2R - power loss in form of heat

Heat energy $= I^2Rt$ - Joule.

$$H = \frac{I^2Rt}{4.2} \text{ calories.}$$

4.2 is a constant called mechanical equivalent of heat

Unit-2 Electrical Heating:

Electrical Heating:

→ Electric heating is based on the principle that when electric current is passed through a medium heat is produce.

→ There are three modes of heat-transfer.

(i) conduction.
(ii) convection.
(iii) Radiation.

→ liquids are heated by convention method.

→ Solids are heated by conduction method.

→ Gases are heated by Radiation method.

→ Distance objects are heated by radion method.

→ Advantages of electric heating:-

(1) clean and neat atmosphere:

→ There is no coal dust/smoke while operating on electric heating appliance.

(2) No pollution:

→ Absence of flue gases doesnot result in pollution of atmosphere, & there are no heat loss of involved through flue gases.

(3) controlled temperature:

→ The temperature can be controlled within +/-5° centigrade which is not possible in non-electrical heating process.

(4) Ease of control:

→ The heating can be started instantaneously & stop at a required time.

→ Automatic control is also possible.

⑤ Localised application:-

→ A work piece can be heated upto a perticular depth for heat treatment where as the piece as a whole receives heat in non-electrical heating process.

⑥ uniform heating:-

→ Heating can be generated from with in the workpiece resulting in uniform heating through induction heating.

→ Heating of bad conductor of heat & electricity wood, plastic & Bakry items can be uniformly & suitably heated in di-electric heating process.

⑦ Highest efficiency of utilisation:-

→ Heat produced electrically doesn't grow waste through chimney or other byproducts hence most of heat is utilized by the material being heated electrically. This results in highest of efficiency.

Heating methods:-

→ Basically heat will be produced due to the circulation of current through a resistance. The current may be circulating due to application of potential difference or may be due to induced eddy currents.

→ Similarly in magnetic materials hysteresis loss can be used as heating method.

→ production of arc between two electrodes can also be used as a method of heating.

* Resistance heating:-

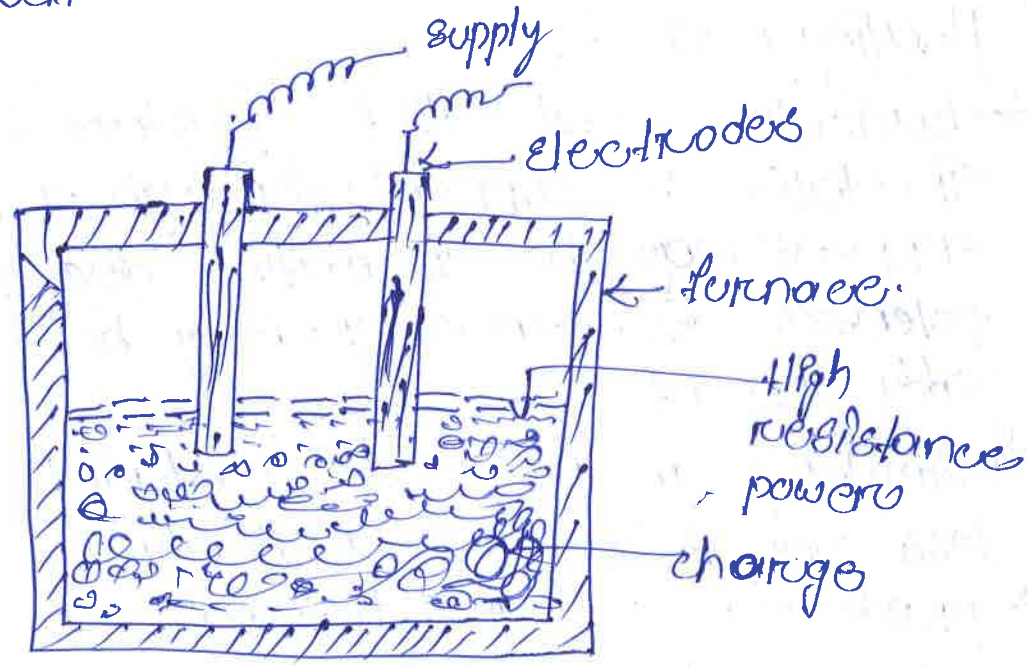
→ This method is based upon I^2R loss when current is passed through a resistive material heat is produced because of I^2R loss.

① Direct resistance heating:-

→ In this method of heating the material to be heated is taken as a resistance & current is passed through it. The charge may be in the form of powder the 2 electrodes are immersed in the charge & connected to supply.

→ when metal piece are to be heated a powder of high resistivity material is sprinkly over the surface of charge to avoide direct short circuit.

→ The current flows through the charge & heat is produced. This methode has high efficiency since heat is produced in the charge it self.

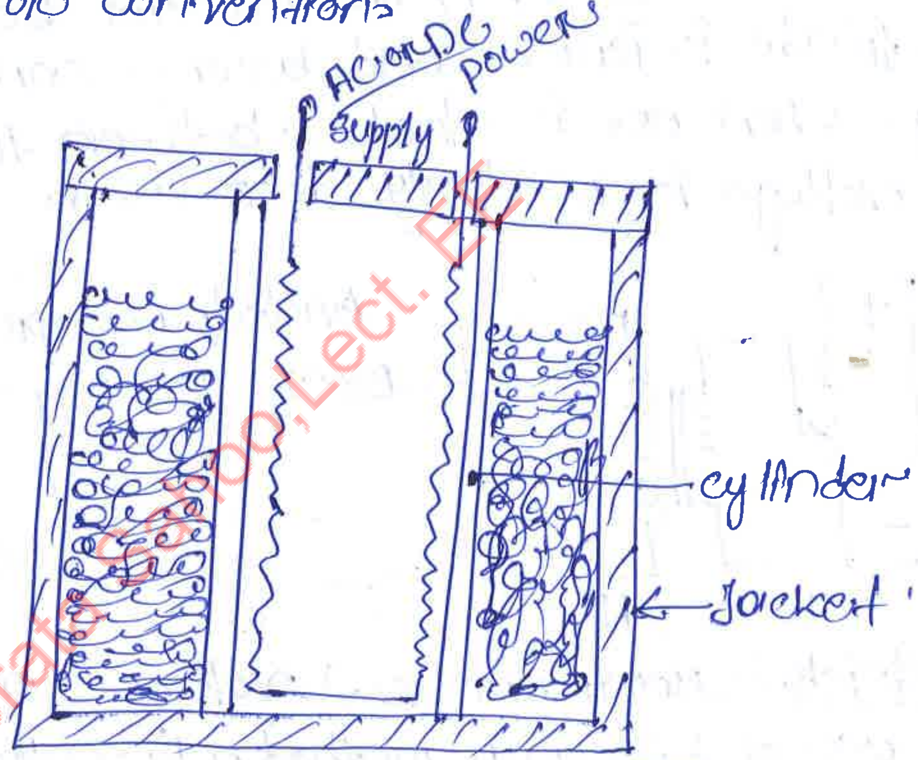


(Direct Resistance Heating)

② In-direct Resistance heating:-

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

→ The heat proportional to I^2R losses produced in heating element delivered to material by radiation or convection.



(Indirect Resistance Heating)

* Arc furnaces:-

→ The furnances used for melting or extraction of ferrous & non-ferrous metal need a high temperature operation. one of the method of produce heat in an furnace is through production of electric arc, which gives an arc temperature between 3000° to 3500° centigrade.

* Method of striking Arc:-

→ There are two method of striking an arc between two electrode. one of the method is H.T strike and other is L.T strike.

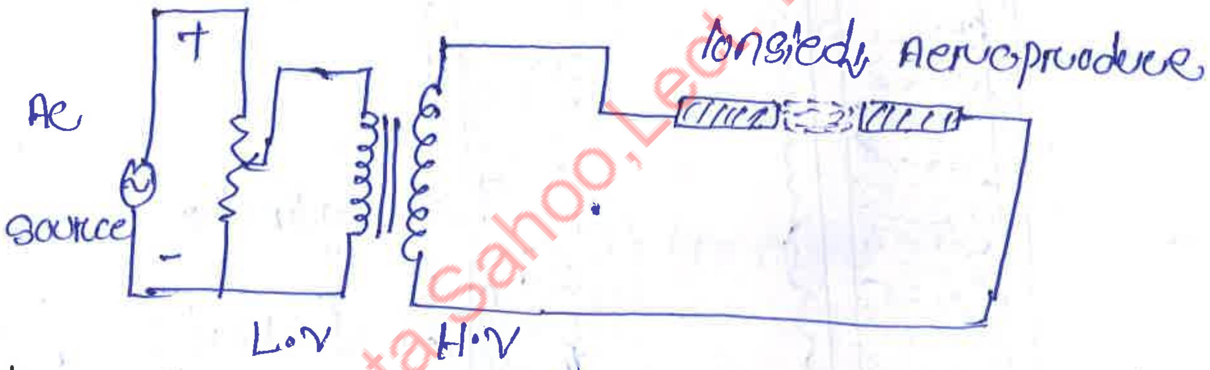
* H.T Strike :-

→ In this method a constand gap is maintain across Made of carbon. ~~the electroses~~

→ The electrodes are connected accross the HT Secondary of stepup transformer.

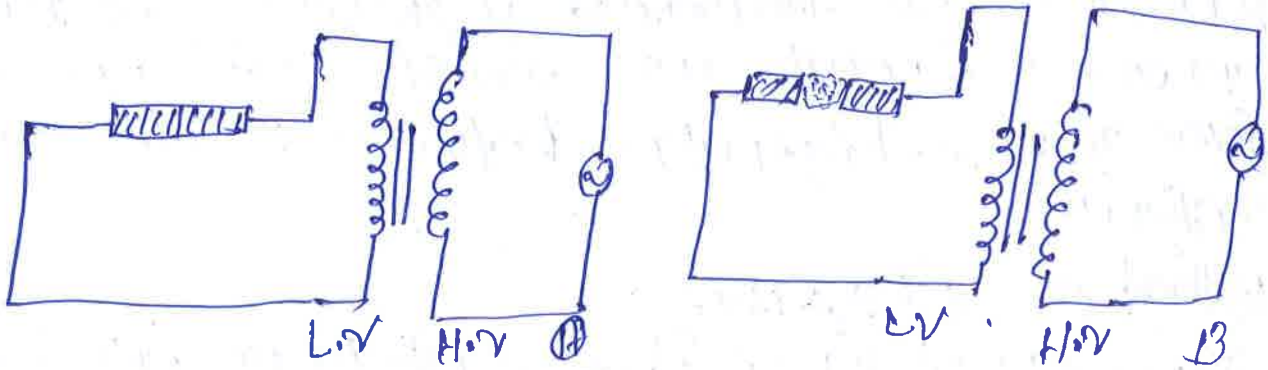
→ The primary side is connected to a variabl voltage is gradually increase which increase the voltage in secondary side.

→ A stage comes when the midium between two electrode is ionised and become conducting. At this stage when arc is stroke between two electrodes the voltage is graduvally decreased.



* L.T strick :- (Maximum use) voltage constant.

→ In case of L.T strick method a low voltage is used. a strick an arc between two electrode in this case electrode are connected to the low voltage side of the T/F. These are momentarly short circuited & separated imediately resulting in production of an arc.



(L.T strick)

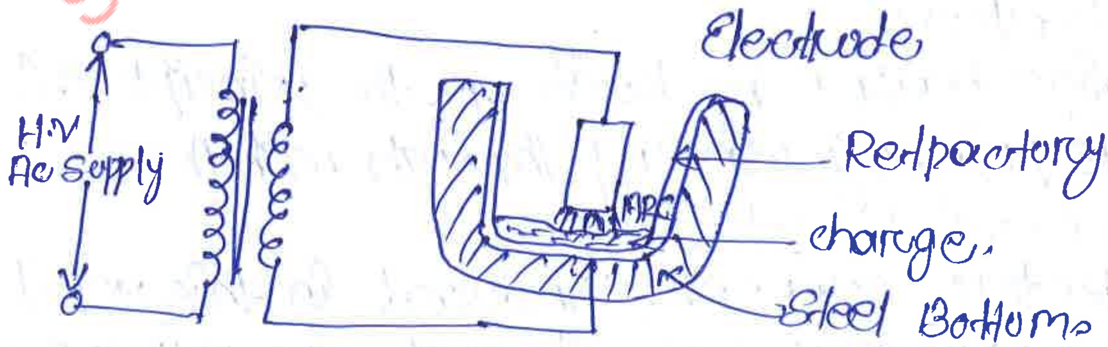
→ L.T Strick Arc furnace divided into two catagories
(i) Direct Arc furnace.
(ii) Indirect Arc furnace.

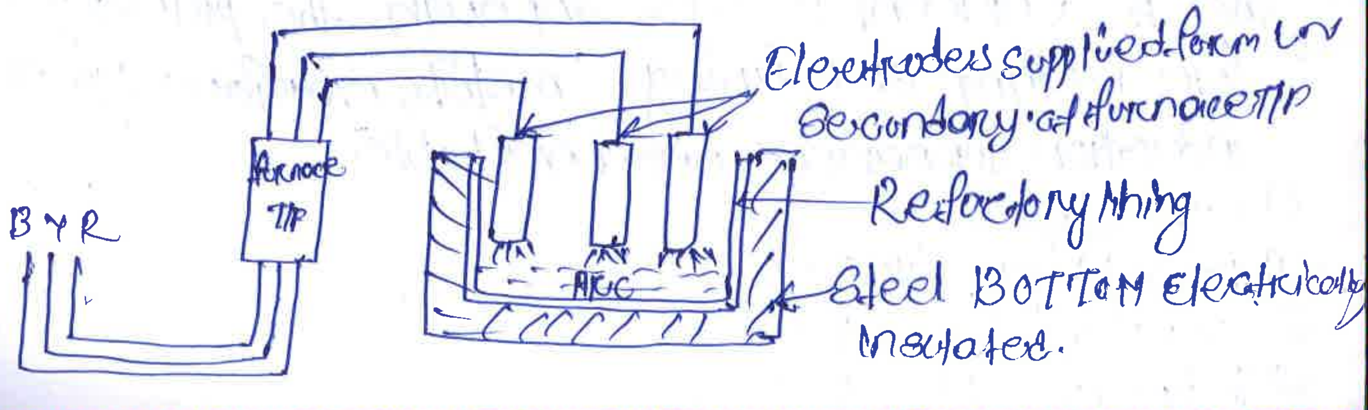
(i) Direct Arc furnace:-

→ when the arc is strick between electrode and charge to be heated so that the current flow through the charge and there is direct constant ~~between the charge is called direct is direct constant~~ between arc & charge is called direct arc furnace. In this heating process is faster and Efficency is too high. Electrically direct arc furnace are divided into two catagories.
(i) conducting bottom.
(ii) non-conducting bottom.

(i) conducting Bottom →

→ In this furnance the bottom of this furnace an the furnace bottom of an Electrical circuit where has no current flow through the body of furnace in non conducting bottom type.





Indirect arc furnaces:-

→ The figure shows a rocking arc furnace working on the principle of indirect arc.

→ When the given case low voltage AC, high singlephase applied across the electrodes.

→ The Arc is stroke by that circuiting by electrodes manually.

→ The heat from the arc is ~~transfer~~ transferred to the charge at the top layer and refractory lining through radition and from top layer of charge to other person of the charge through conduction. To the distribute the heat properly the furnace has to be rocked continuously exposing not only to heat transfer from arc but from further lining. This results in prolonged of the lining as well as during a rocking a portion of lining is not continuosly as well heat has in the case of non rocking furnace.

Induction heating:-

→ Induction heating process make use of currents induced by electromagnetic action in the material to be heated.

→ Induction heating is base on the principle of T/F.

→ That is primary winding through with AC.

– which metal to be heated?

→ An electric current is induced in this metal when the AC current is pass through the primary coil.

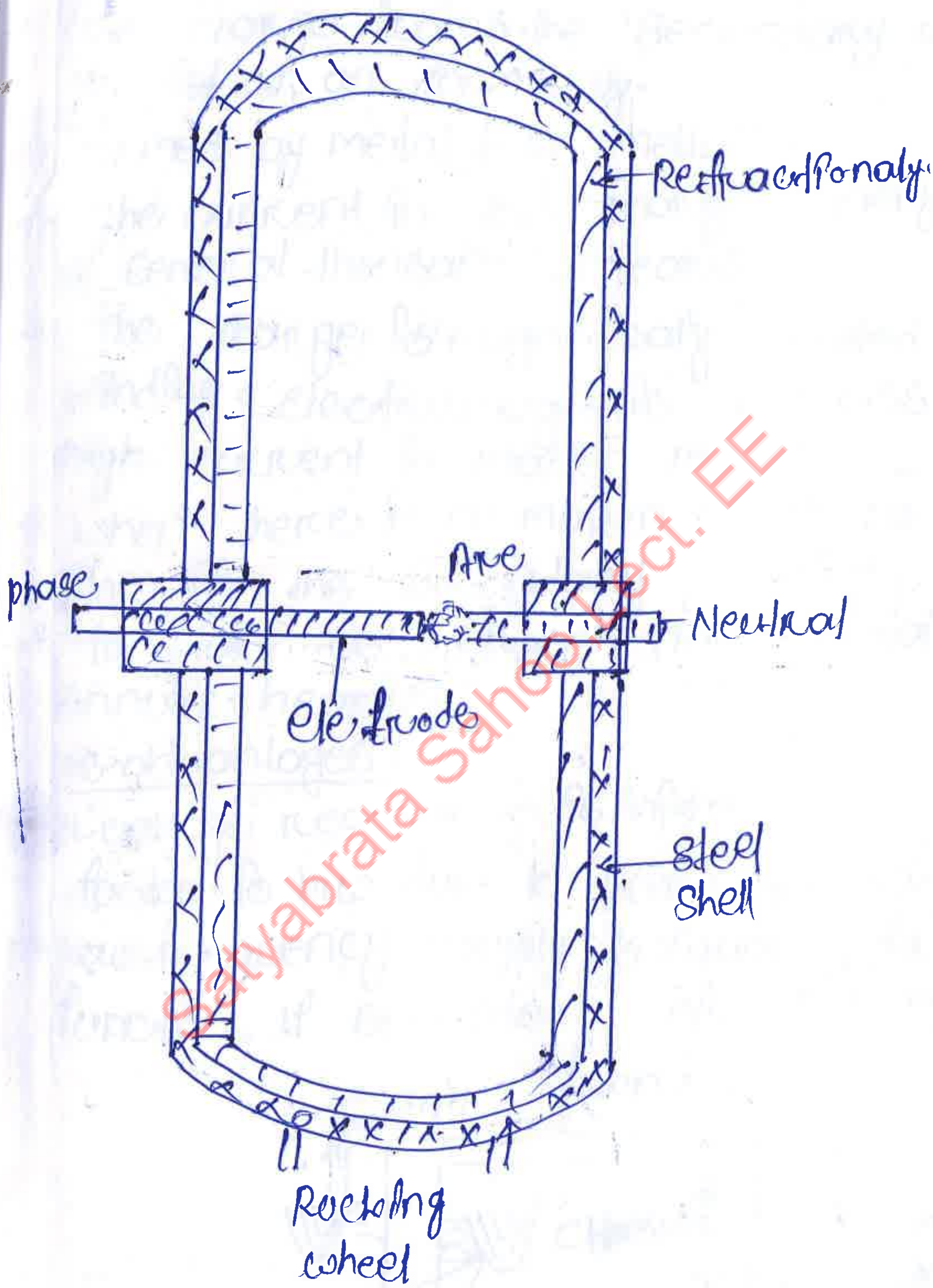
→ For melting or refining metals various types of induction furnances are available

① core type:-

(a) Direct core type.

(b) vertical core type.

(c) Indirect core type.



(Indirect arc furnace)

virtical channel for the charge. Thus c

(ii) core less type:-

(a) Direct core type:-

→ It is like T/f

→ The charge froms the secondary winding and consist of on form only.

→ formed by metal to be meltaled.

→ The current in the charge is very high of the order of several thousand amperes.

→ The charge is magnetically coupled to primary winding. electromagnetic process are set-up the high current in molten metal.

→ when there is no molten metal no current will flow in the secondary winding.

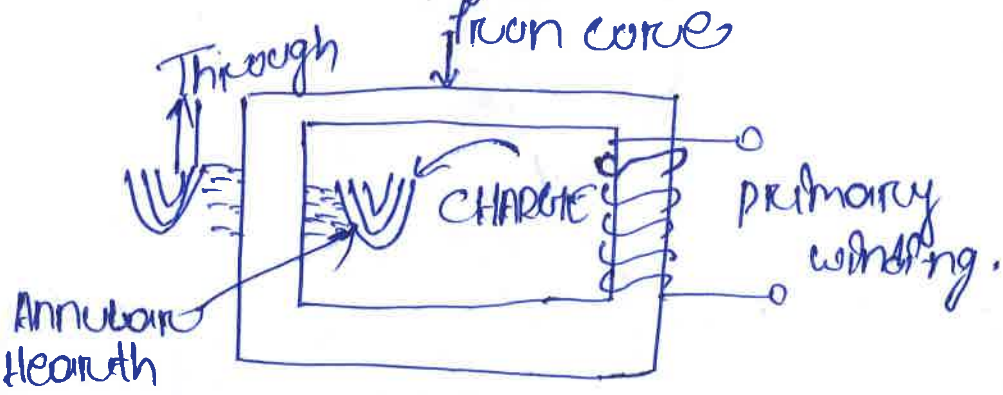
→ To start the furnace molten metal is poored in annular hearth.

Dis-advantages:-

→ Leakage reactance is high.

→ factor is low due to poor magnetic coupling

→ Low frequency supply is equal to furnace can't function if secondary circuit is opened.

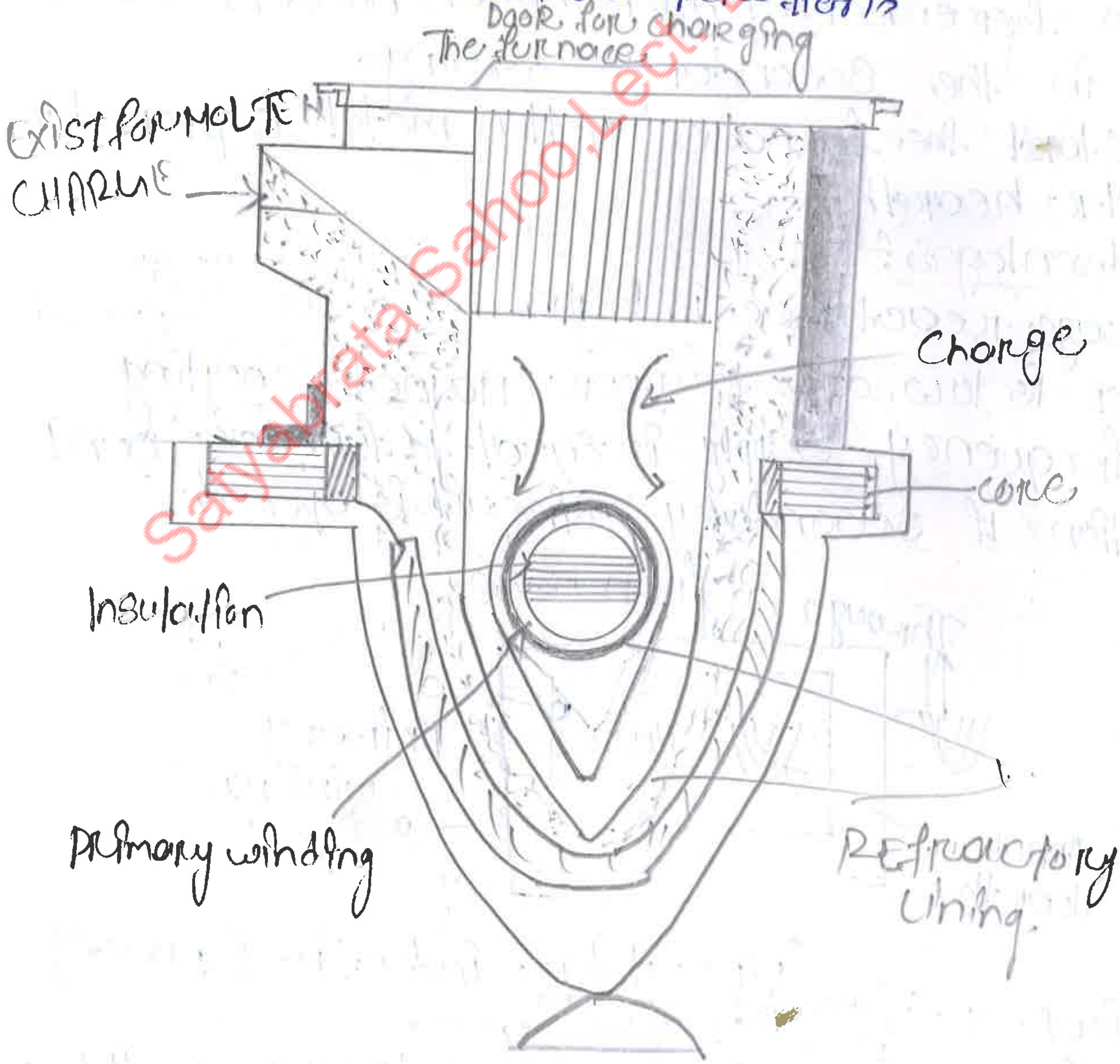


(Direct type Induction furnace)

(b) Vertical core type Indication furnace:-

→ This furnace is an improve core type furnace it has vertical channel for the charge. thus c used in also vertical which is suitable for metal point of view.

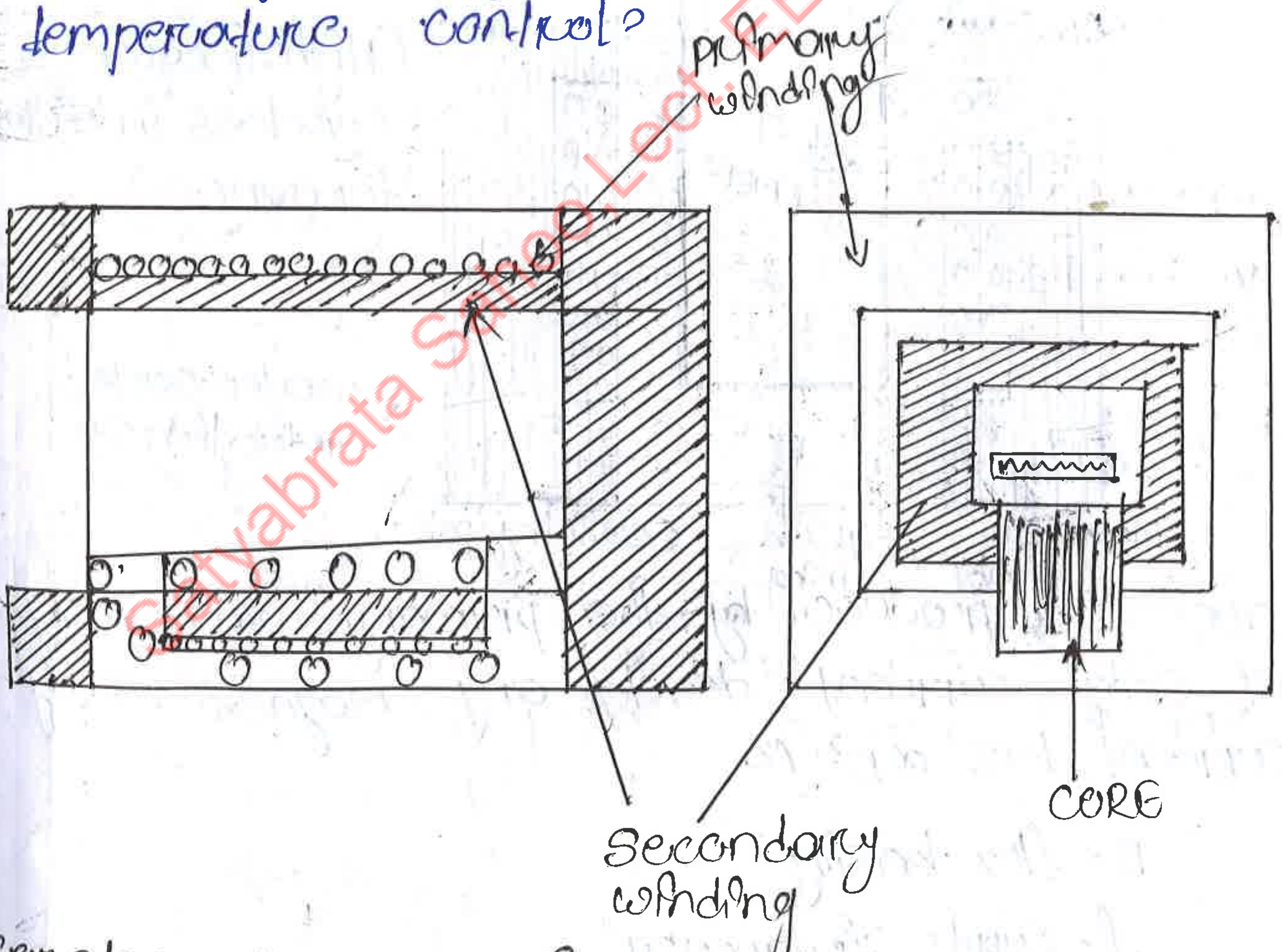
- The magnetic coupling in this furnace is better then core type. Hence leakage reactance is comparatively Low and also power factor high.
- So it can operate from normal supply frequency.
- The circulation of Molten metal is kept at round the V position by convection current and by the electro Magnetic process between in the lower half Vee.
- It is nessary to keep it full of metal to maintaince continuity for secondary circuit. So the furnace is suitable for continous operations.



(Ajax wyatt vertical core furnace)

Indirect core type Induction furnace:-

→ The induction principle can be used for general heat treatment for metals and other charges of inductively heated element is employed to transmit the heat to charge by radiation so far as the charge is consider the condition are similar to those as in the resistance oven the secondary winding forms of a walls of a metal container & the iron core lies in the primary as well as secondary winding. It has simple method of the temperature control.

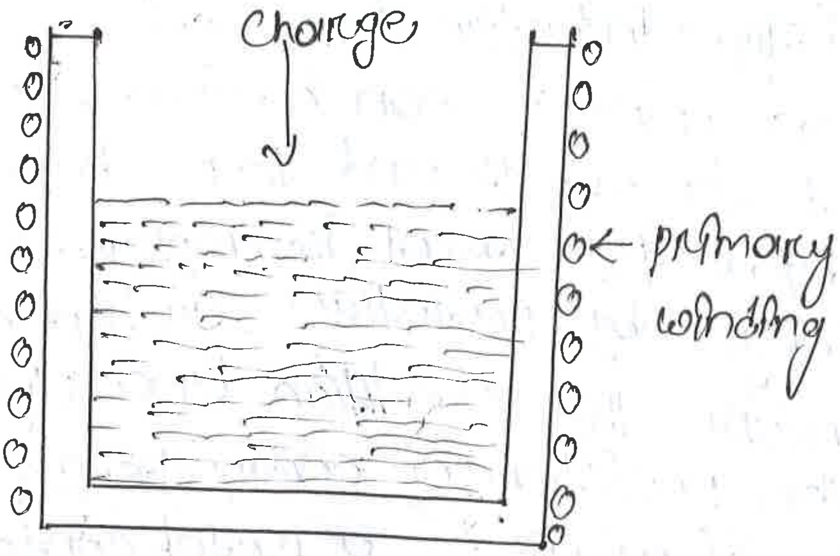


Coreless Induction furnace:-

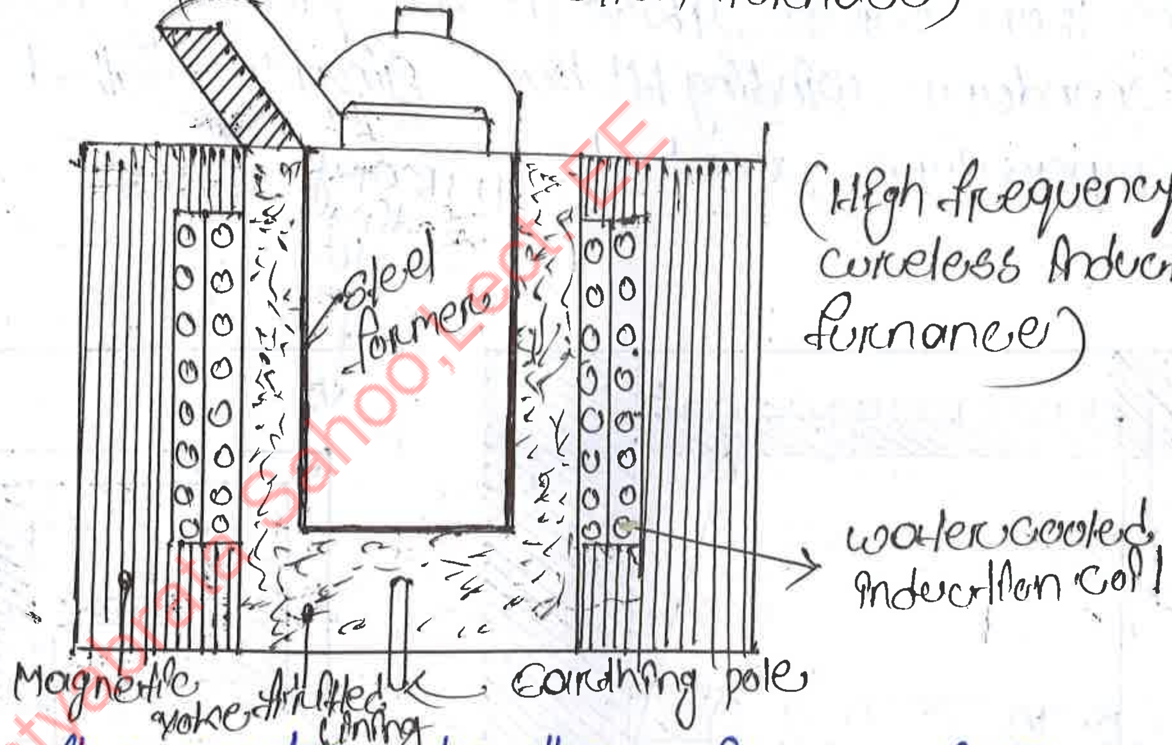
→ General construction of this type is shown as figure.

eddy current - $P_e = k B^2 f^2 t$

hysteresis - $P_h = k B^{1.6} f^{0.6}$



(Coreless Induction furnace)



(High frequency coreless Induction furnace)

→ The flux produce by the primary winding setup of eddy current develop any magnetic eddy-current loss $\alpha B^2 f^2$

B = flux density

f = supply frequency.

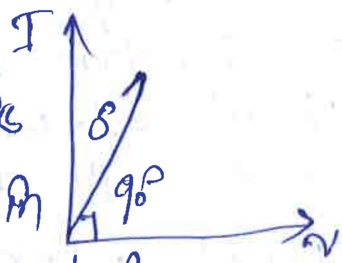
- These eddy current are sufficient to heat the metal to melting point and also setup electro-magnetic forces, which produce a striking action. The primary coils are wound around the refractory lining flux produce by primary winding induces

eddy current to the charge.
→ The coil is constructed in the form of hole tube through which cold water is circulated.

Advantages of coreless Induction furnace:-
→ Time taken to reach melting temperature is less.
→ free size control power can be employed.
→ crushible any shape can be used.
→ Automatic sparcing in the charged to eddy current.

Dielectric heating:-
→ This is also sometimes called high frequency capacitive heating and is emplyed for heating of insulating materials like wood, plastic & ceramic etc. the supply frequency applied for this type of heating is between 10 to 30 Megaharz. The applied voltage up to 20kv.
→ The principle of operation of Dielectric heating is that when a capacitor is substract to a sinosodial voltage the current drawn by heat is never leading the voltage by exactly 90°. the angle between voltage & current is slightly less than 90° which is called loss angle.

→ This clearly shows that there is a small component of current which is in phase with applied voltage & in term produces power loss in dielectric.



→ At normal frequency this loss may be small but at high frequency this loss become so large that it sufficient to heat the dielectric, so the material to be heated in between, the speeds of electrodes.
→ The necessery of high frequency supply obtain from a valve ocillator.
→ The dielectric heating is used in seaming and welding of in.
(i) Manufacturing of sendhetic.
(ii) wood prossing.
(iii) breaking foundring.
(iv) food processing.

Micro wave heating:-

→ In this system electricity is converted in to electromagnetic wave which generate energy, and this energy is used to cook the food. This waves are nothing but high frequency radio wave. similar to used in Television. The wave length of these wave is ~~very short but frequency~~ is very short but frequency is very high known as a microwave.
→ In the oven microwaves are confind in site the oven cavity & reflected of to the wall & those. once the door is open all microwaves automatically switched off. when microwave energy comes into contact with some substance it is reflected. transmitted. or absorve. These waves are reflected by metal transmitted through paper, glass, plastic, & observed by water & moister. when this energy

but observed heat is produce and cooling produce.

that

Applications

ial → This type of heating is having the following

node ① Breaking manufacture of bread or toast.

ion ② Drying of paper & textiles.

③ food processing

④ treatment of cancer.

⑤ Manufacture of plastic.

⑥ processing of cement & timber.

Electric welding

Date:- 21.10.2022

Electric welding:

→ welding is a process in which 2 metal parts are joint by heating. the metal parts are heated to melting point which adhare on solid fication in some cases the pices of metal to be joint are to heated to plastic stage and fuse together.

→ The process in which 2 metal parts are brought to molten state and then allow to solidly is known as fuse in welding It may be devided into following 3 groups It may be devided into following 3 groups.

(i) Arc welding.

(ii) gas welding.

(iii) Thermite welding.

Electric welding:

→ electric welding is defined as that branch of welding in which electric current is used to produce the heat required for joining together

classification of electric welding:

- resistance welding
  - butt welding.
  - flash welding.
  - Spot welding.
  - projection welding.
  - Seam welding.
- Arc welding
  - Metal Arc welding
  - carbon Arc welding
  - Atomic hydrogen Arc welding.
  - Hilium or Argon Arc welding

→ Arc welding:-

→ An electric Arc is produce by drinking 2 conductors connected to a suitable source of electric current momentarily in contact and then separally small distance.

→ The current continues to flow across a small gap & gives intense heat.

→ the heat develop is utilised to melt the part of work is and filled of metal & thus form the Joint.

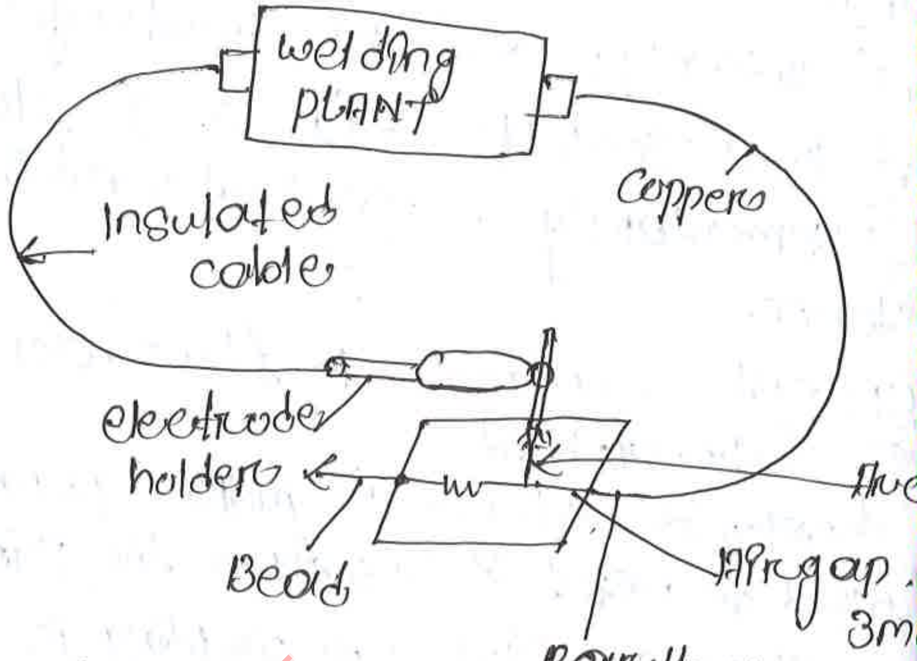
→ Maximum voltage specified for welding is about 100v for safety of the operator.

→ current ranges from 30-500 Amp from manually operated welding & 75-600 Amp for automatic operated welding.

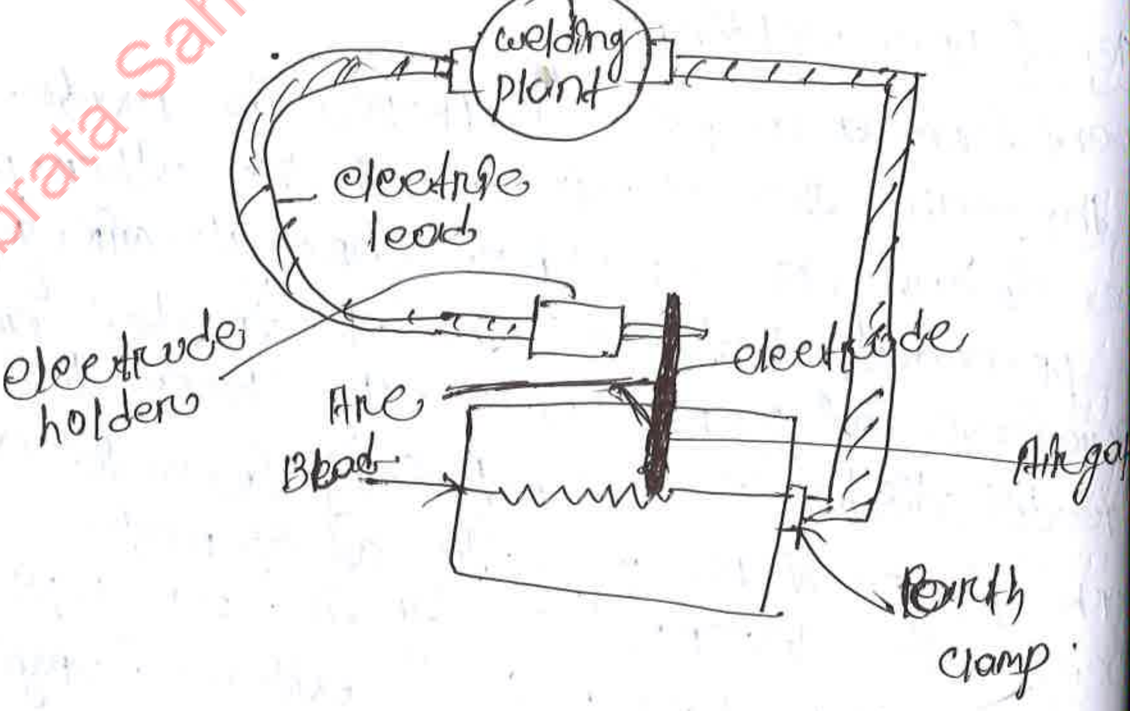
Principle of Arc welding:-

→ current form a source (AC or DC) is made of flow through the electrode & the other parts and the circuit is completed through air gap. The gap is provided between the electrode and the surface of work piece by keep the electrode distance [3mm to 6mm] from the surface of work piece. It is for safety of operator.

→ due to the interruption by the air gaps heat is produce and temperature attend varyis from 3700° centigrade - 4000°C electrical energy is converted into heat energy through Arc.



principle of Arc welding:



comparision between AC & DC welding:-

AC Arc welding	DC Arc welding
(1) AC welding plant has no rotating part so wear and tear is less.	(1) DC welding plant has both Motor & generator i.e. rotating parts so wear & tear is more.
(2) AC welding transformer has very high efficiency	(2) Motor generator set has low efficiency
(3) The problem of ARC blow is not much because it control automatically.	(3) Problem of ARC blow can control easily.
(4) Arc is not stable	(4) Arc most stable.
(5) cost of equipment require is low.	(5) cost of equipment require is high
(6) only flux coated electrode can be used.	(6) Any type of electrode can be used.
(7) energy consumption is low as welding is intermediated in nature	(7) energy consumption is more as motor generator set is require to run continuously.
(8) In case AC welding heat is equal in both poles.	(8) heat distributed in different part to poles. 70% +ve pole 30% -ve pole.
(9) They heat produce is not uniform because current passes through 0 value.	(9) heat is uniformed.
(10) There is always danger of shock to operator due to high open circuit voltage.	(10) There is no danger of electric cock due to low operating voltage
(11) In case of AC 1φ transformer causes unbalance in 3φ supply	(11) Motor generator uses 3φ induction motor which is a balanced load that is no voltage unbalance in 3φ supply.

* Application of ARC welding:-

→ The necessity of arc welding is done by hand process.

→ The operator holding and electrode holder into which the electrode is fitted in his hand guiding the arc as required

→ when the electrode has been consumed it is replaced & process in continues.

* Different types of arc welding process are describe are follows:-

Metallic Arc welding:-

→ In this welding the metal rod is used as electrode and arc is strucked betn electrode & work piece. which respectively formed 2 ter of AC supply. form Secondary of welding transfor or DC supply from DC welding generator

→ The work is then suddenly touched by the electrod & then Separated from it. this resu in arc betn the Job and electrode due to th heat generated by the arc a little portion of wor melts also the tip of the electrode. the two pie to welding are fused together and when electr is removed the metal cools & solidifies giving strong welded Joint.

Carbon Arc welding:-

→ This methode is normally used for welding cop & Alloys. The carbon electrode which is kept -ve with respect to the work if DC is used. If the carbon electrode made +ve the carbon partic have a tendency to go into the welded joint & caused brittle less therefore the work should be connected to +ve terminal & electrode to the -ve. this type of welding only DC can be used.

→ Two methods of carbon Arc welding method-

→ In one method no flux in used & a other method flux in the form of powder or paste is use to prevent the weight from oxidation.

* Atomic hydrogen Arc welding:-

→ The essentials of the atomic hydrogen ARC welding process.

(i) electrodes with supplyed energy to an ARC is transform to heat.

(ii) Molecular hydrogen is below through the ARC and transform catalitically into the atomic form which act as a vehicle per transfer of energy from ARC to work. rapid decrease in contentraction.

(iii) The direction away from the Arc a sudden decrease of temperature causes rapid concentration of atomic hydrogen and release of heat of decombination To strike and Mentain the ARC open circuit voltage of 300V in necessary and a current of 50A is required.

→ Helium, Argon arc welding:-

→ This method is used for welding aluminium alloy, Magnesium & magnesium alloys and arc is struck between electrode of tungsten & the work. & helium for argon is used to give and inner atmosphere so that oxidation of welded point doesn't take place.

Resistance welding:-

→ The underline principle of resistance welding is generation of heat in the joint by passing the heavy current through the pressure followed by application of Mechanical pressure which welds metal & refines grain structure.

* Generation heat:-

Heat generated by passes of electric current (I) through resistance (R)

$$H = I^2Rt \quad \text{Joule}$$

$$= \frac{I^2Rt}{4.2} \quad \text{calorie (heat equivalent).}$$

Advantages of resistance welding:-

resistance welding has a no of Advantages.

(i) It is a quick method of joining 2 pieces.

(ii) There is very little wasteye of metal.

(iii) The process can be control accurately.

(iv) The which are consistantly uniform.

→ The following electrical resistance welding process are commonly use:

① **butt welding:**

→ In this process heat is generated by the contact resistance between two components.

→ The places of the components should be machined or age prepaired.

→ The two parts are brought to gether & the process is applied along the axial direction by a spring a heavy current is pass from the welding transformer.

→ which reacts necessary heat at the joint due to high resistance at contact area the metal at the joint are melted and fuse together.

Application:

→ The main application of butt welding are where the parts are joint end to end jointing pipes, rods etc

Flash welding: Date: 29.10.2022

→ This is similar to butt welding except for the difference that in this case current is applied to the parts before there butt together so that they meet arcing takes place.

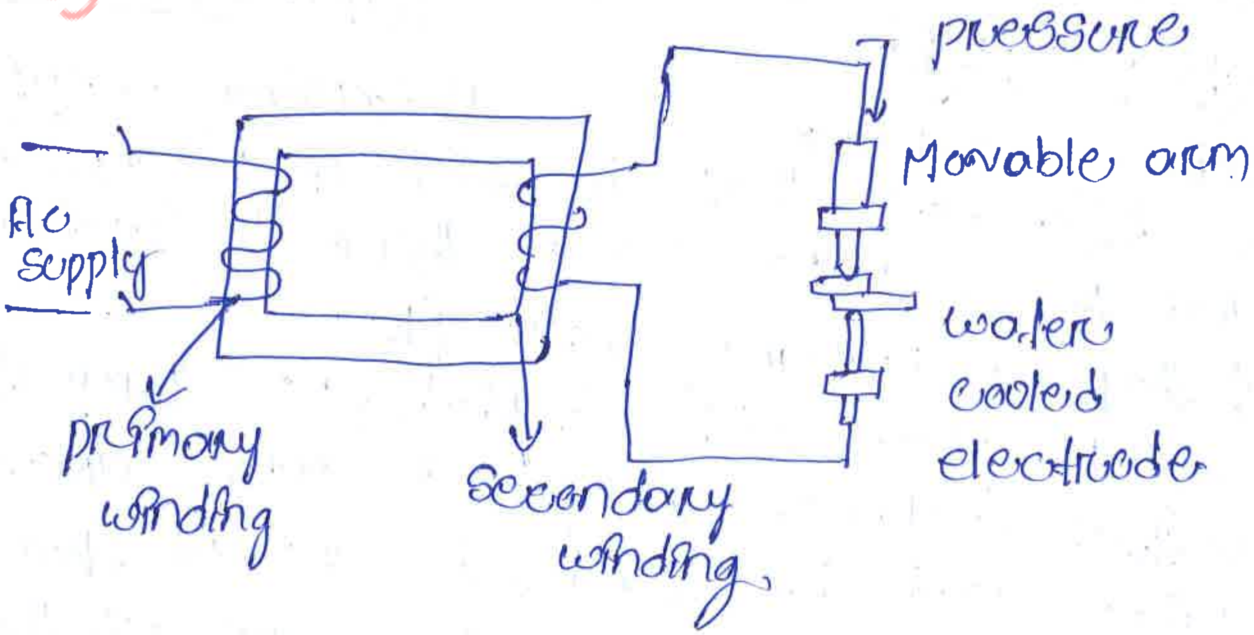
→ The two pices to be welded are clamp strongly in a flash welding machine the parts are broght together and resistance to current flow heats the contacting surface As soon as the current is shortup and pieces are rapidly butt with melting temperature by which the squch molten metal give some sparks or flash.

Application:-

→ This method of welding is extremely used in production work particularly welding rod & pipes together.

Spot welding:-

→ It is the simplest method & universally accepted methode of welding in sheets upto 12.7 mm thickness. In simplest form the spot welding machine consist of a transformer to produce high current at low voltage. electrodes are connected to the ends of the secondary winding for leading the ~~current~~ current to the work & apply nessesary mechanical pressure.



→ Transformer, electrode, electrical control switch.

→ It is used to provide clamping on primary winding of transformer to regulate secondary voltage & current.

Application:

→ This applied to welding of sheets.

→ It is used to fabricating all types of sheet metal structure.

→ It is applied to all types of boxes cores are enclosing cases etc.

Seam welding:

→ It is similar to spot welding except that series of spots are produced by roller of electrodes. Insted of tipped electrode. Most seam welding produces a continious or intermited seam welding nearly age of two over lap metal by using & 2 rolor electrode as these rollor travel over the metal pieces under ~~PROCESSOR~~ pressur & current passing between them heats the 2 pieces of the metal 2 fussion point the spaces can be timed to over lap between the spots.

→ 2 types of seam welding.

① continious.

② Inter linked.

Applicatation :

→ It is used for making lap for butt wells.
→ It quicker that spot welding operation.
→ It is used of many types of pressure type tanks containeous etc.

* projection welding :

→ It is modifyied from of spot welding of projection welding consist of forming slid projection on the sheet of metal by a special set of dies. after the projection forms the rest position one piece are rest into contact with another piece while at the same time a heavy current is passed through the two pieces. when these raised portions touched the second sheet of metal is current is applied a fuses 2 pieces togetherer

projection welding as following.

Advantages over spot welding :

→ More than one spot or welding can be done at a time.
→ due to low current density and low pressure the electrolyte is increased good thickness appearance is obtained because surface rain by the electrodes.

Applications

3. → It is advantages is assembly parts made by punching or stamping & for welding studs not flex.

ILLUMINATION

Date:- 05.11.2022

photon:-

→ Existance of descript quintity of energy is known as photons.

→ Radian energy is always emited or absorbed in discript manner instant of quantity of values.

→ The valency electron in responsible for the production of radiation in visible region.

→ The energy of atom is constant as long as electron space in a stating or bit. and the atom is set to be in stely stop when electron falls from and outer stationary orbit to inner orbit a quantom of the energy is the least. when an atom is excited energy is add to the atom by colision with the high moving particle atom state is exciting state. for very short period of time then reverse back to normal stage by emmiting radiation energy wavelength. of rediation velocity & frequency is releted by eqn $\boxed{v = \lambda f}$

v = velocity

λ = wave length

f = frequency.

Spectrum:-

Frequency	Nature of wave	wavelength
3×10^{22} Hz	cosmic ray	10^{-14}
3×10^{20}	γ-ray	10^{-12}
3×10^{18}	x-ray	10^{-10}
3×10^{16}	uv ray	10^{-8}
3×10^{14}	visible light	10^{-6}
3×10^{12}	Infrared ray	10^{-4}
3×10^{10}	short radio waves	10^{-2}

Visible light spectrum:-

		Frequency (Hz)
4100 A°	violet	7.5×10^{14}
4700 A°	Blue	6.0×10^{14}
5500 A°	Green	5.0×10^{14}
5800 A°	yellow	4.3×10
6100 A°	orange	4.3×10
6200 A°	Red	3.75×10^{14}

* Important terms:-

light:-

(i)> light is defined as the radiant energy from h... body causing visual sensation.

(ii)-Flux:-

→ It is known as luminous flux defined as total quantity of light energy radiated or emitted per second from. of waves..

→ It is measured in lumen & denoted by F or Q of Q lumen hours is luminous output of sources & energy radiating for Thours $\phi = \frac{\phi}{t}$

light energy:-

→ energy obtain individual radiation in given time, & express in lume hour & its denoted by Q.

luminus efficiency:-

→ Radiant efficiency is defined as the out put in become per watt of power consumed by source measure in lumen per wattage of E = energy radiated at wave length λ.

→ relative sensitivity of I at wave length λ.

K = Maximum possible of efficiency = 6 lumen/watt

efficiency at wave length ⇒ λ' = MK

Total energy converted into vidual effect

$$= K \int_{\lambda_1}^{\lambda_2} E \eta \, d\lambda$$

Total energy radiation = $\int_0^\infty E \cdot d\lambda$

$$\text{Luminus efficiency} = \frac{K \int_{\lambda_1}^{\lambda_2} E \eta \, d\lambda}{\int_0^\infty E \, d\lambda}$$

* Plane Angle:-

→ It is the angle subtained at a point in the same plane by 2 converging line. This is measured in redian or degree

$$\theta = \left(\frac{Arc}{Radiance}\right)^c = \left(\frac{180}{\pi}\right) \times \theta) \text{ degree}$$

Luminous Intensity:-

→ luminous ~~Intent~~ Intensity in any perticular direction is the luminous flux emmited per unit solid angle by a point source it is denote by

I (Steradian) $I = \frac{F}{\omega}$ lumen/steredian

→ It is defined as to the amount of luminous flux in space by me unit of solid angle by source at the intensity of one candle power in all direction.

lumen = one candle power × Solid angle

$cp \times \omega$

Solid angle:

→ Solid angle is the angle generated by the line passing through the point in space and the periphery of the area.

or

→ A solid angle enclose a volume by an infinite number of lines lying on a surface & meeting at a point.

→ It is measured in steradians and is denoted by 'ω' and

$$\omega = \frac{\text{Area}}{(\text{Radius})^2} \text{ steradians.}$$

→ where one steradian is the angle subtended at the centre of circle is 2π radians.

→ Similarly total solid angle subended at a point in space is obtained by considering point at the centre of the sphere and the surface area of the sphere.

(Solid angle)

$$\omega = \frac{\text{area}}{(\text{radius})^2} \text{ steradian.}$$

Plane angle $\theta = \frac{\text{Arc}}{\text{Radius}} = \frac{\text{Circumference}}{\text{Radius}}$ (Total angle)

$$= \frac{2\pi r}{r} = 2\pi \text{ radians.}$$

Total solid angle, $\omega = \frac{\text{Area of sphere surface}}{(\text{Radius of sphere})^2}$

$$= \frac{4\pi r^2}{r^2} = 4\pi \text{ steradians.}$$

* Candle power (C.P.):-

→ Candle power is the light rendering capacity of a source in a given direction and is defined as number of lumens given out by the source in unit solid angle in a given direction.

→ It is denoted by symbol C.P.

$$C.P. = \frac{lumens}{\omega}$$

* Illumination:-

→ When the light falls upon any surface, the phenomenon is called illumination.

→ It is defined as the number of lumens, falling on the surface per unit area.

→ It is denoted by symbol E and is measured in lumens per square metre or lux or metre candle.

→ If a flux of ϕ lumens falls on a surface of area A, then the illumination of that surface is $E = \phi/A$

* Metre candle:-

→ It is also known as lux. It is the unit of illumination & is defined as the luminous flux falling per sq. m on the surface which is every where perpendicular to the rays of light from a source of one candle power and one metre away from it.

→ It is the illumination produced by a source of one candle power on the inner surface of one metre radius.

* Mean spherical candle power (M.S.C.P.):-

→ It is defined as the average of candle power in all directions and in all plans from the source of light

$$M.S.C.P. = \frac{\text{Total flux in lumens}}{4\pi}$$

* Mean hemi-spherical candle power (M.H.S.C.P.)

→ It is defined as the average of candle powers in all directions above or below the horizontal plane passing through the source of light.

* Reduction factor:

→ ~~It is [illegible] ge of all the candle powers in all directions in the horizontal plane containing the source of~~ .

→ Reduction factor of a source of light is defined as the ratio of mean spherical candle power to its mean horizontal candle power.

$$\text{Reduction factor} = \frac{M.S.C.P}{M.H.C.P.}$$

* Laws of Illumination:

→ There are two laws of Illumination:-

First law:

→ It is also known as Law of Inverse Square.

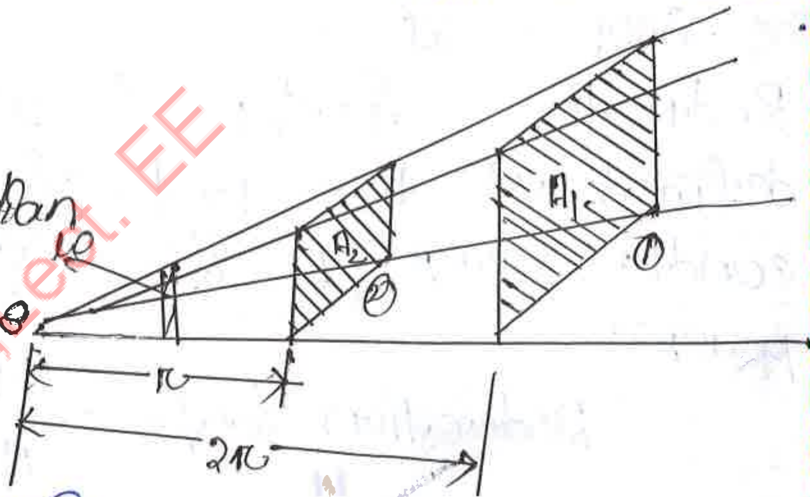
→ According to this law, the illumination of a surface is inversely proportional to square of of distance betn the source and surface provided that the distance between the surface and the source is sufficiently large so that the source can be regarded as a point source.

(1) Inverse square law: consider a point source S having an intensity I lumens/steradian.

→ Let two surface having areas A_1 and A_2 be placed at distances r & $2r$ meteres away respectively from the source.

→ The two surfaces are enclosed in the same solid angle ω.

→ Since the source gives I lumens per steradian any surface enclosed by solid angle as will receive a total flux $= I \times \omega$ lumens



$= \frac{\text{Area}}{(\text{Distance})^2} = \frac{A_1}{r^2}$ steradian

or Total flux on surface area,

$= I \cdot \frac{A_1}{r^2}$ for surface ②

Illumination E_1 on surface A_1

$= \frac{\phi}{A_1} = I \times \frac{A_1}{r^2} \times \frac{1}{A_1}$

$= \frac{I}{r^2}$ lux or lumens/m^2.

$\omega = \frac{\text{Area}}{(\text{Distance})^2} = \frac{A_2}{(2r)^2}$ steradians.

$\phi = I \times \frac{A_2}{(2r)^2}$

$E_2 = I \times \frac{A_2}{(2r)^2} \times \frac{1}{A_2}$ $\phi = \frac{I}{4r^2}$ lux.

$E_1 \propto \frac{I}{r^2}$ $E_2 \propto \frac{I}{(2r)^2}$.

2nd law:

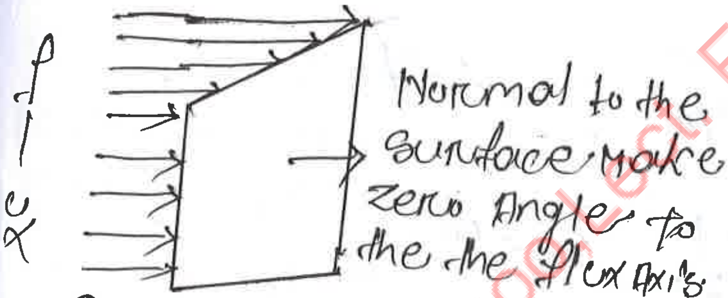
lambert's cosine law:

→ It is also known as according to this law of illumination of a surface varies directly as the cosine of the angle between the normal to the surface and direction of incident light.

$E \alpha \cos\theta$

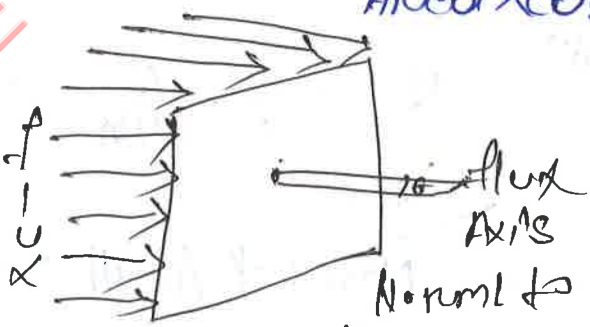
(i) In the normal surface case, $E = \frac{\phi}{Area}$

(ii) & in the inclined surface case, $E = \frac{\phi}{Area} \times \cos\theta$



(a) Normal surface

$E = \frac{\phi}{Area}$



(b) Inclined surface

$E = \frac{\phi}{Area} \times \cos\theta$

Examples:

(1). calculate the total flux from the lamp having mean spherical candle power of 35.

Soln Mean spherical c.p of lamp = 35

$M.S.CP = \frac{\text{Total flux}}{4\pi}$

Total flux = M. S. CP × 4π

$= 4\pi \times 35 = 4 \times \frac{22}{7} \times 35 = 440$ lumens ans

* A 250 volt lamp has a total flux of 3000 lumens and takes a current of 0.8 amp.

calculate (i) Lumens/watt.

(ii) M.S.C.P /watt.

Sol^n

(i) wattage of lamp.

$= 250 \times 0.8 = 200$ watts.

flux emitted $= 3000$ lumens.

$\text{Lumens/watt} = \frac{\phi}{W} = \frac{3000}{200} = 15$ Ans.

(ii)

$M.S.C.P = \frac{\phi}{4\pi} = \frac{3000}{4\pi} = 238.7$

$M.S.C.P/\text{watt} = \frac{240}{200} \times 1.2$ Ans ens

* calculation of a lighting Scheme.
→ Suppose it is desired to have E lumens/m² in a hall having area A m².
→ obviously total flux required on the working plane is E×A lumens.
→ To send this much flux the output of the sources should be higher taking into consideration the depreciation factor, coefficient of utilisation etc.
→ If the value of these coefficients is given < 1.
→ Then output of the source necessary

$$= \frac{\text{lumens required}}{\text{Depreciation factor} \times \text{coeff. of utilisation}}$$

Design of lighting Scheme:-
(i) Space-height ratio :-
→ It is defined as the ratio of horizontal of distance between lamps and the mounting height of the lamps, or space-height ratio.

$$= \frac{\text{The horizontal distance between lamps}}{\text{Mounting height of lamps.}}$$

* utilization factor:-
→ The total light flux radiated out by the source is not utilized on the working planes and its value is given as.

$$\text{utilization factor} = \frac{\text{Total lumens utilised on working planes}}{\text{Total lumens radiated by lamp.}}$$

→ The value of this coefficient depends upon the following conditions:-
(a) the area to be illuminated.
(b) height at which the lamps are fitted.

(c) the ~~ede~~ colour of surrounding walls, ceilin... fittings etc.

(d) the type of lighting - direct or indirect

* Depreciation factor :-

→ when the lamps are covered with dust d... and smoke, they do not radiate out same... amount of flux as when they do at the ti... of fitting new lamps.

Thus depreciation factor

$$= \frac{\text{Illumination under normal working conditi...}}{\text{Illumination when everything is clean.}}$$

→ Its average value is 0.8.

* Maintenance factor :-

→ The illumination produced by a lighting installa... decreases considerably after a year or tw... partly due to the ageing of lamps and th... partly due to the accumulation of dust on th... lamps, on the transmitting & reflecting fixtu... and on the ceilings and walls.

→ So at the time of calculation of lumens at... received on the working plane, this fact i... taken into account by including the main... tenance factor which may be defined as the ratio of the ultimate maintained met... candle on the working plane to the initial metre candles.

Incandescent Lamps:

Filament Materials:

→ These are of carbon & tungsten, when the temperature increases wave-lengthe decreases till it reaches 7×10^{-5} cm and falls in the visible range.

→ The light emitted is proportional to the 12^{th} power of absolute temperature & this is the reason why lamps are run at a high temperature as far as possible.

* ~~Filamen~~ construction of lamp:

→ If the space in the lamp is replaced with an inert gas, tungsten filament can reach a temp. of 2400k without evaporation.

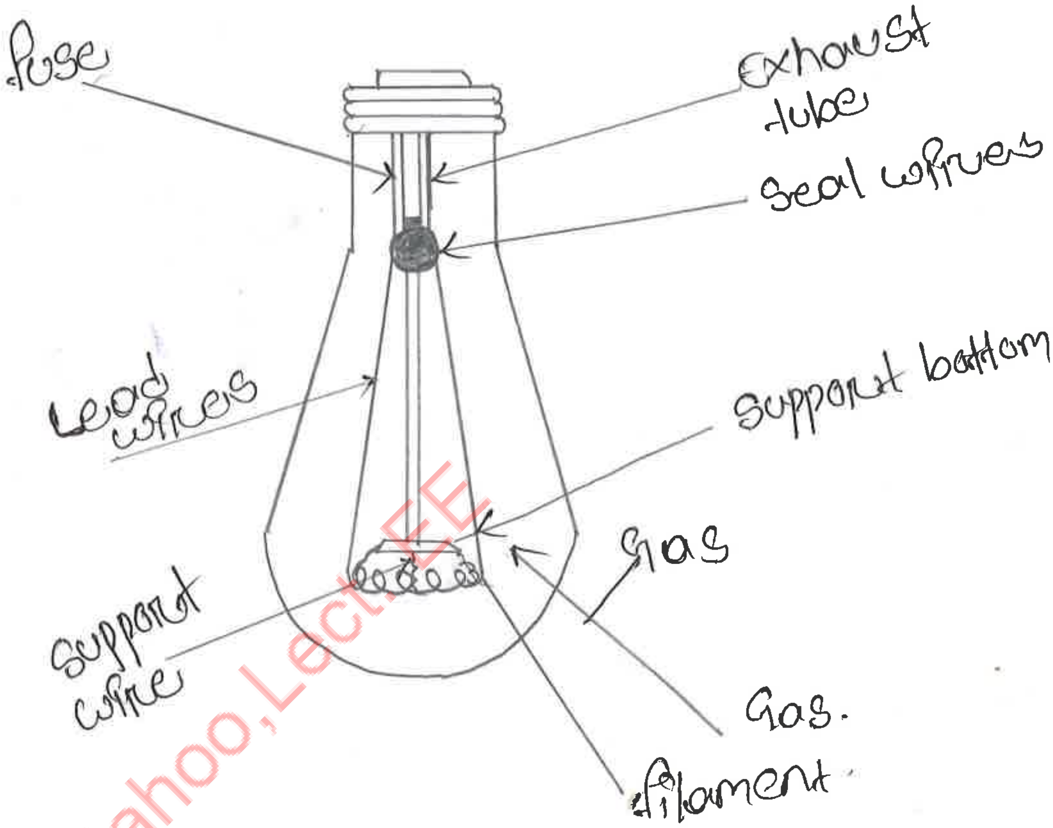
→ Due to higher temperatures loss of heat is reduced by gases like nitrogen or argon.

→ The convection loss is minimised by coiled coil filament spiral filaments are used now to prevent heat losses. the case of tungsten of filament light o/p α E^n where $n = 4$ or 5 & power i/p α E^n wherein $n = 1.8$ & E is the voltage. During manufacture all air is pumped out of glass envelope to prevent filament burning up when operating.

* ~~Effect of voltage variation on the life of the~~ ~~lamp:~~

→ Lamps larger than 40 watts are filled with inert gas: to retard evaporation are filled with of tungsten.

→ However, gradual evaporation causes a dark deposit on the inner side of the bulb blocking light.



(Incandescent lamp with filament)

* Effect of voltage variation on the life of the lamp:

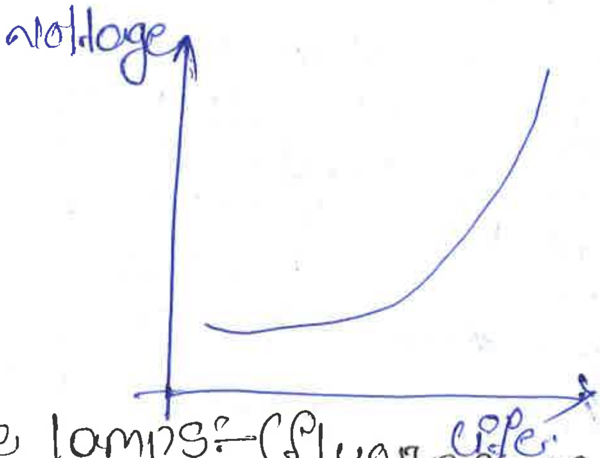
→ The filament lamps are under operation under constant supply voltage.

→ But a variation of ±6% voltage at consumers terminals is permitted under the Indian electricity Rules.

→ Further drop of voltage in the electrical wiring may occur.

→ Thus a voltage variation from +6% to -8.5% may result.

→ Hence the operating voltage varies from 212 to 220 v.

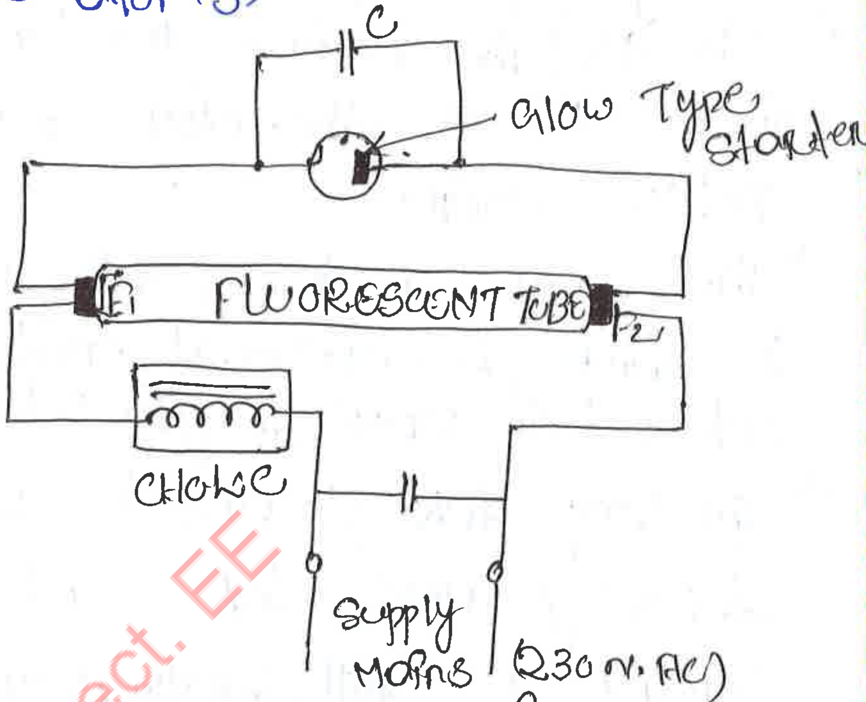


* Gaseous Discharge lamps:- (fluorescent Tube).

→ The principle of working of a fluorescent tube will be be clear from the following discussion.

→ The cathode filament emitting electrons after getting heated due to supply ~~argon~~ of current.

→ These electrons ~~after getting heated due to supply~~ while accelerating collide with argon & Mercury vapour atoms.



(Circuit for the fluorescent tube)

Sodium vapour lamp:

→ Sodium vapour lamp consists of an inner U-shaped glass tube made of high resistance glass & containing a small amount of Metallic Sodium, Neon gas and two electrodes, one anode & other cathode.

→ The inner tube is enclosed with an outer glass tube of U-shape and the space between in evacuated to minimise the heat losses from the inner tube.

→ The presence of neon gas serves to vaporise the the sodium by producing sufficient heat.

→ The glass tube is used of U-shap because long discharge paths are necessary.

→ The lamp is used horizontally to help the sodium when spread along the tube.

→ when supply is given to the lamp the discharge take place in the neon gas first and red orange glow produces.

→ The Metallic Sodium gradually vaporises and then ionises thereby producing a light of yellow colour.

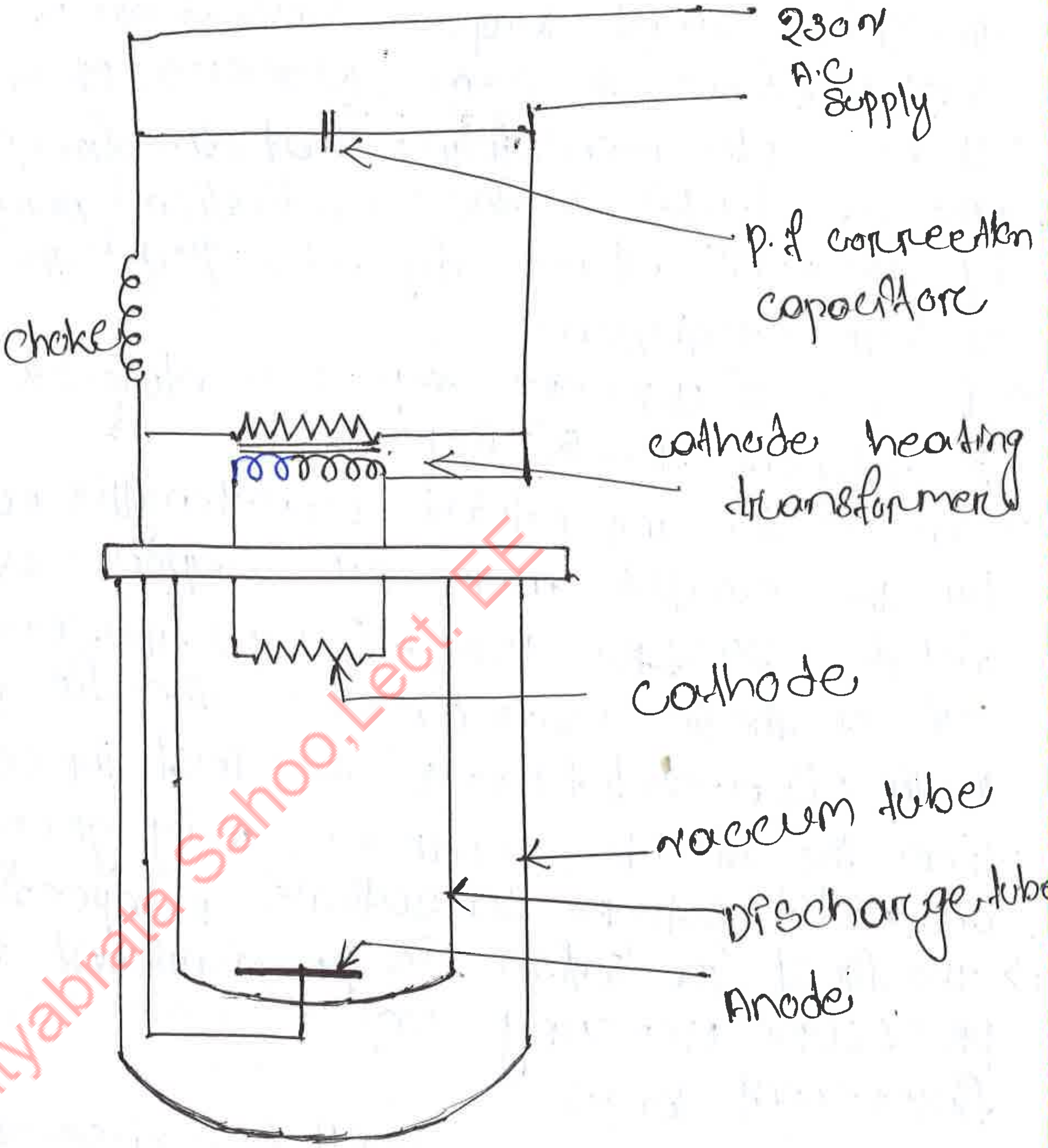
→ This lamp is also called as a Monochromatic lamp because it emits a light of yellow colour of wave length 5900 A unit.

→ The lamp takes about 5 to 6 minutes for starting and takes about 15 minutes for coming in full brilliancy.

→ The luminous efficiency of the lamp is 50 lumens per watt and its average life is about 3000 working hours.

→ These lamps are used for general outdoor lighting, and highways where colour distortion is not of much importance.

→ These lamps are not suitable for indoor lighting


230v
A.C
supply
p.f correction
capacitor
choke
cathode heating
transformer
cathode
vaccum tube
Discharge tube
Anode

* Mercury vapour lamps:

→ The operation of Mercury vapour lamp and the fluorescent lamp is based on the excitation of atoms of some gaseous medium.

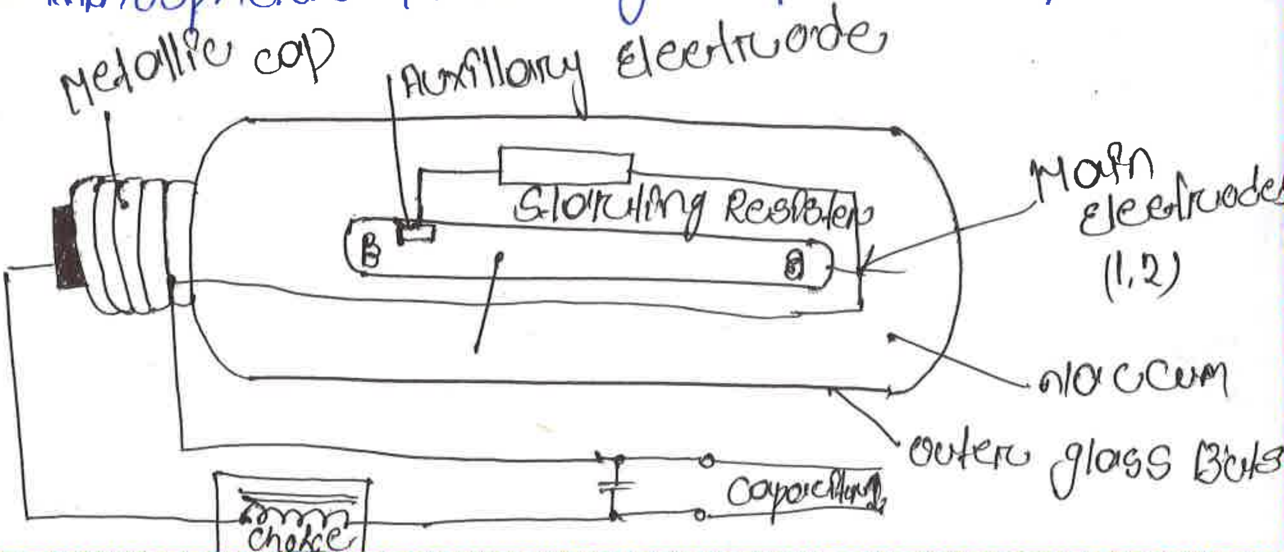
→ It is worth mentioning that the frequency and wavelength of the radiation given out by different atoms depends upon the level of their excitation.

→ In case of Mercury vapours alone excitation to different levels is possible.

→ Some of the important wavelengths radiated by the excited mercury vapour atoms include 2537 A.U, 1561 A.U, 4358 A.U. and 4047 A.U. out of these wavelengths the first falls in the ultra-violet range, the last three being from the visible spectrum giving green, blue and violet colour sensations respectively.

→ The first radiation is predominant in low pressure Mercury vapour lamps working as fluorescent lamps.

→ The last three are emitted in case of high pressure about 1.5 atmospheric pressure to 5.0 Atmospheric Mercury vapour lamps.



Construction:-

→ The tube containing mercury vapour is made of hard glass.

→ The outer glass cover protects the inner tube from coming into direct contact with the atmospheric temperature variations.

→ It also absorbs the ultra-violet radiations emitted from the lamp during working. Besides mercury the inner tube consists of a percentage of argon gas.

→ There are two main electrodes made of tungsten wire and a starting electrode which is spaced quite close to one of the main electrodes.

→ During connections to supply mains the auxiliary electrodes through a high series resistance along with the main electrode (2) is connected to say neutral of the supply.

→ The phase comes to the first main electrodes through the insulated part of the metallic cap.

Working:-

→ When the circuit is energised the supply voltage appears between the main electrode marked (1) and the starting or auxiliary electrode.

→ The argon coming between these two electrodes is immediately, ionised because distance bet

→ these two electrode is very small & a glow appears between the said electrodes. A small current starts flowing through the starting resistor in series with the auxiliary electrode.

→ This results in building up of pressure due to heating up of mercury which is originally in the condensed form.

→ The ultimately the medium between the main electrodes is ionised & the current starts flowing betn the two. It is no longer controlled by the high resistance in the starting ckt.

Neon lamps:

→ The electrodes are housed at the two ends of the tube which contains neon gas.

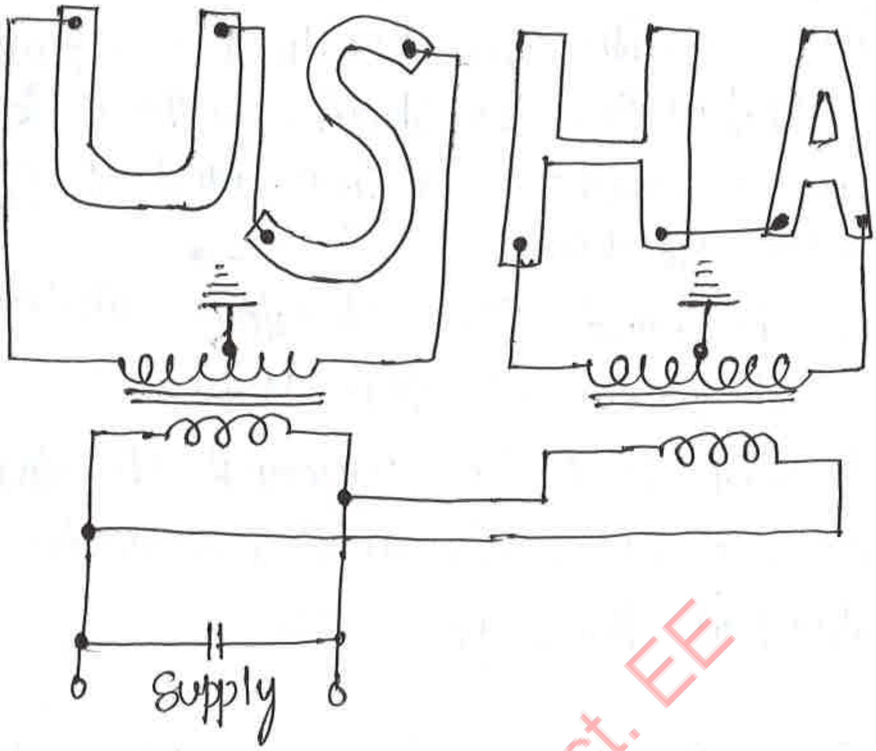
→ Neon gas discharge gives a characteristic red light.

→ Mixture of mercury vapour and argon gas gives bluish green colour, whereas mercury and neon give blue colour.

→ Voltage required for starting and maintaining the discharge may be as high as about 10,000 volts.

→ The particular voltage is required for a particular length of the tube & it may be obtained from a transformer.

→ Since the cold cathode lamps require about 1.5 to 2 times the operating voltage at the time of start so these are provided with high reactance transformer.



(Neon sign)

INDUSTRIAL DRIVE

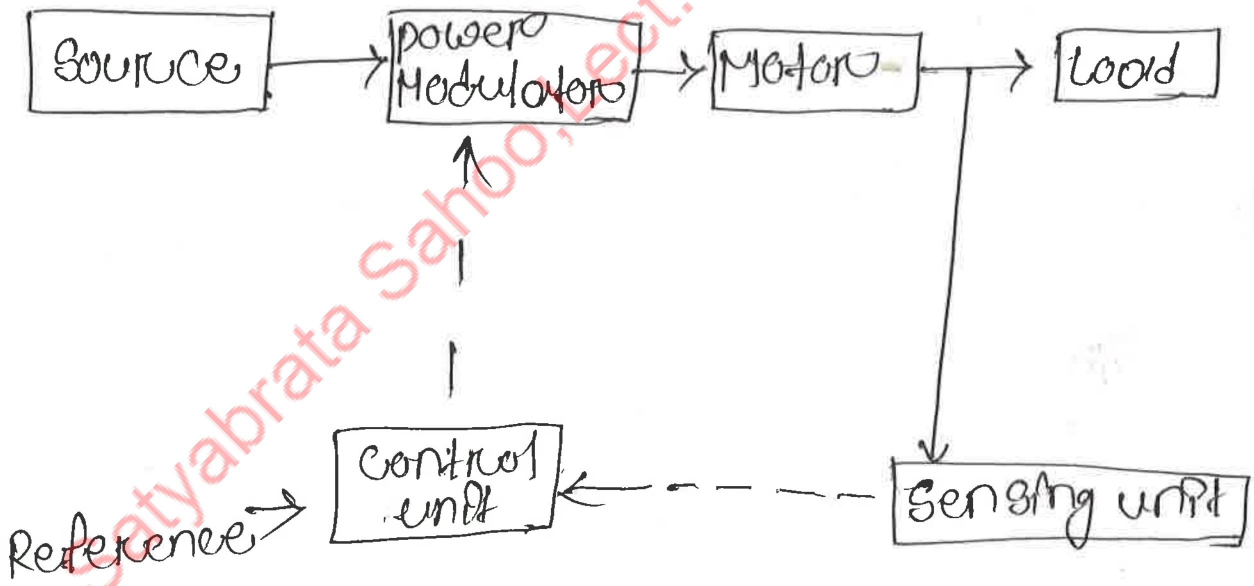
Date:- 30.11.22

Industrial Drive:-

→ The primemover with its control system & transmission system such as shafts, pulleys, belts and gears etc. is to impart motion and to operate the given working machine.

→ This combination is called the electric drive, if the primer movers used in an electric motor.

→ Mechanical equipment to design convert electric energy in to mechanical energy & provide electrical control of these process.



Types of electric Drive:-

→ electrical drives used in industrial may be devided in to 3 types.

1. group drives.
2. Individual drives.
3. Multi Motor drive.

ⓐ Group Drive:-

→ In this one Motor is used as a drive for two or More than two Machines. The Motor is connected to a long shaft, or which belt and pulleys are the connected to run other Machines. It is also the called line shaft drive.

→ This type of electric drive is economical as, a single Motor of large capacity costs less than the costs of a number of small Motors of the total capacity.

The use of this kind of drive is restricted due to the below mentioned reasons:-

i. In case of fault in the Motor, all the connected Machines to this Motor will cease to operate.

ii. If at certain instance all the Machines are not in operation then the Motor will be working at low capacity.

iii. It is not possible to install a new Machine at a far away distance.

iv. Speed control of different Machines using belts and pulley is cumbersome.

ⓑ Individual Drive:-

→ In this type of electric drive a single electric Motor is used to drive one individual Machine. Though it costs More than group drive but each operator has complete control on his Machine, which the enables him to either increase the speed of Motor or to stop it while not in operation.

→ Machines can be located at convenient places.

→ If there is a fault in one Motor, this will not effect the production of the industry appreciably.

(c) Multi-Motor Drive:

→ It consists of several individual drives each performs difference functions and are a pa of big complicated Machinery.

→ This type of drive have their application in pap Making Machines, cable Manufacturing units, me cutting Machines, rolling mills and similar other types of Machinery.

* comparison Between two drives:

Individual Drive	Group Drive
(1) Initial cost is More	(1) Initial cost is less.
(2) works at good power factor.	(2). low power factor.
(3) Efficiency is High.	(3) Efficiency is low, when t Motor works at light load.
(4) It is More reliable.	(4) If Main Motor fail whol industry will come to stan still.
(5) Machines may be fitted wherever convenient.	(5) Such arrangement is n posible in group drive.
(6) More useful where the constant speed is required.	(6) Does not give constan speed.
(7) useless, where sequence of operation is required.	(7) useful, because all the op tions are stopped simultan
(8) This is Must for driving heavy Machines eg cranes, lifts etc.	(8) This system not employe such cases.
9. Space can be fully & conveniently utilized.	(9) More space is require group drive.

Choice of electrical drives:-

Some of the important factors to choose an electrical drive are:-

(i) Steady state operation requirements:-

→ Nature of speed torque characteristics, speed regulation, speed range, efficiency, duty cycle, quadrants of operation, speed fluctuations and ratings.

(ii) Requirements related to the source:-

→ Type of source, and its capacity, magnitude of voltage, voltage fluctuations, power factor, harmonics and their effect on other loads and ability to accept regenerated power.

(iii) Transient requirements:-

→ Starting, breaking, values of acceleration and de-acceleration, reversing performance.

(iv) Capital and running cost, maintenance.

(v) Environment and location.

(vi) Reliability.

(vii) Space & weight restrictions.

* Selection of Motors:-

→ The selection of the motor is based upon:-

(i) Condition under which motor is supposed to work.

(ii) Type of load the motor is supposed to handle. So

Accordingly the factors which are considered for selection of motor for a particular service are as under:-

(1) Electrical characteristics?

(a) Running characteristics.

(b) Starting characteristics.

(c) Speed control

(d) Braking characteristics.

(2) Mechanical characteristics

(a) Type of enclosure

(b) Type of bearings

(c) Transmission of drive

(d) Noise level

3. Size and rating of Motors

(a) Rating of Motor.

(b) whether the Motor is to be used continously, intermittently or for variable loads.

(4) costs

(a) capital cost.

(b) Running cost

Types of load Torques

* Components of load Torques.

Load torque can be divided into following components:-

(a) Frictional torque (T_F).

→ Friction will be present at the motor shaft and also in various moving part of the load. T_F is the equivalent value of various friction torques to referred to the motor shaft.

(b) Windage torque (T_w):-

→ When a motor runs, wind generates torque, opposing the motion.

→ This opposing torque is termed as windag torque.

(c) Torque required to do some useful mechanical work (T_L):-

→ Nature of this torque depends upon particular application. It may be:-

(i) Constant and independent of speed.

(ii) Some function of speed.

(iii) Depend on the position or path following by load.

(iv) Time variant or time-invariant :-

(v) Vary cyclically and its nature may also change with the load's mode of operation.

* Nature and classification of Load Torques:-

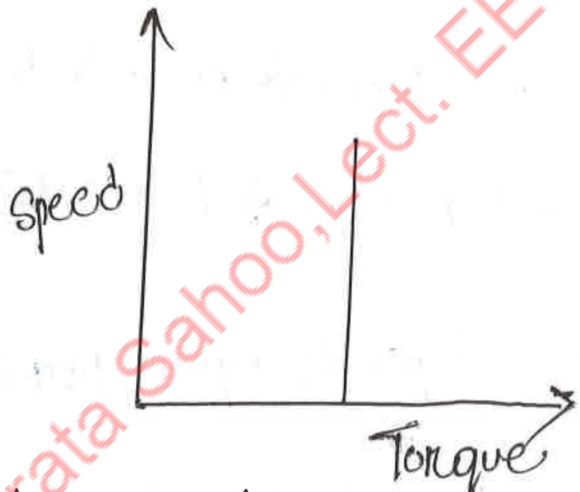
Broadly load torque can be classified into torque varying with speed with time.

(A) Variation with speed:-

→ Load torque, depending upon the speed can be classified as:-

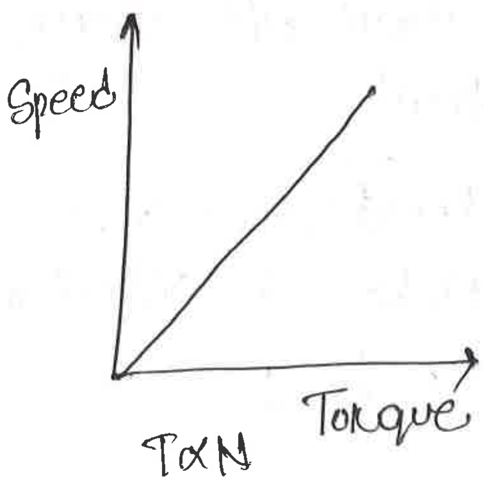
(i) Constant load torque:

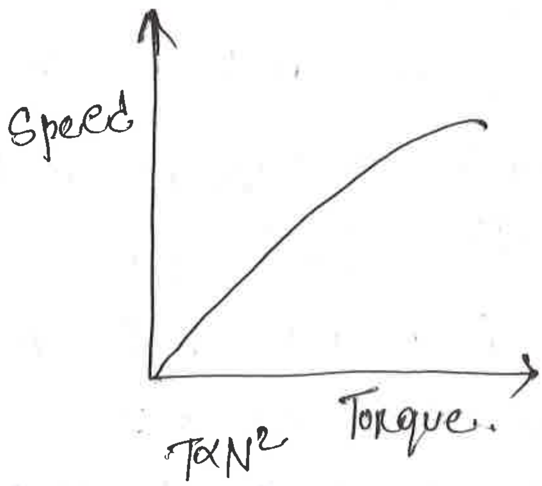
→ The torque is independent of the speed and is constant. A low speed hoist is an the example of load where torque is constant and independent of speed. At low speeds the windage torque is negligible, therefore net torque is mainly due to gravity which is constant & independent of speed e.g paper mill drive.



(ii) Load torque v/s speed:

→ The torque increases linearly with speed as shown below. This occurs in case of fluid friction where lubricant is used.





(iii) Load torque v/s Speed^2:-

→ The torque increases as a square of speed as shown in fig.

→ This occurs in case of air & fluid friction such as in fans, compressors, aeroplanes, centrifugal pumps, ship propellers, coilers, high speed hoists & traction etc.

(iv) Load torque v/s $\frac{1}{\text{speed}}$:-

→ This occurs where deformation of material takes place for example in grinding & metal drawing etc.

B. Variation with time:-

(i) continuous and constant load. for ex: in the centrifugal pumps operating under same condition for a long time.

(ii) continuous but variable loads e.g hoisting, winches conveyors etc.

(iii) Short time intermittent loads e.g excavators, cranes & hoists etc.

(iv) pulsating loads e.g reciprocating pumps and textile looms etc.

(v) Impact loads e.g. Rolling Mills, forging hammers, shearing machines etc. Such Machines have flywheel attached with them for load equalisation.

$P = E_g \times I_a$

$\Rightarrow \frac{2\pi N}{60} \cdot T = \frac{\phi 2 N}{60} \cdot \frac{P}{a} \cdot I_a$

$\Rightarrow T = \left(\frac{P}{a} \cdot \frac{1}{2\pi}\right) \cdot \phi I_a$ → constant

$\Rightarrow T = k \phi I_a$

$\Rightarrow \boxed{T \propto \phi I_a}$

$E_b = V - I_a R_a = \frac{\phi 2 N}{60} \cdot \frac{P}{a}$

$\Rightarrow N = \frac{V - I_a R_a}{\phi} \cdot \left(\frac{60 \cdot a}{2P}\right)$

$\Rightarrow N = \frac{V - I_a R_a}{\phi} \cdot k$

$\Rightarrow \boxed{N \propto \frac{V - I_a R_a}{\phi}}$

For DC Shunt Motor

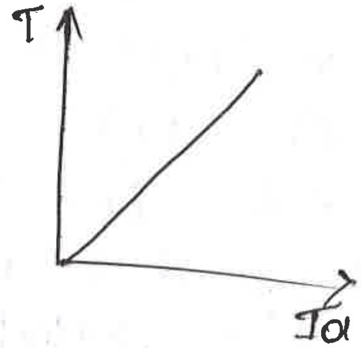
ϕ = constant

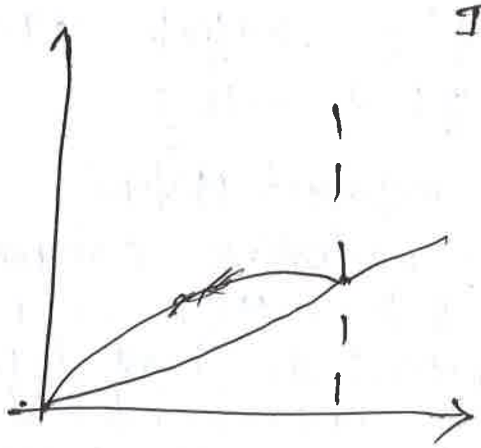
$\boxed{T \propto I_a}$

For DC Series Motor

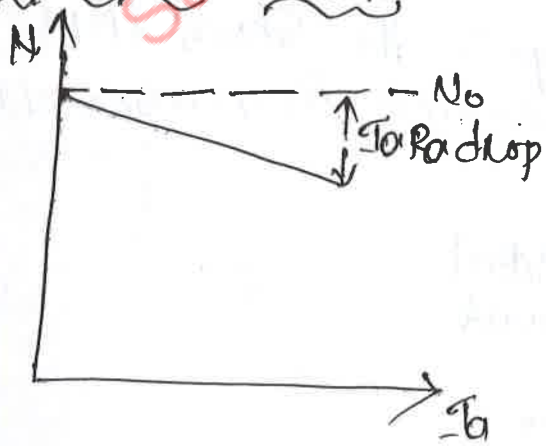
$\phi \propto I_a$ – Till saturation

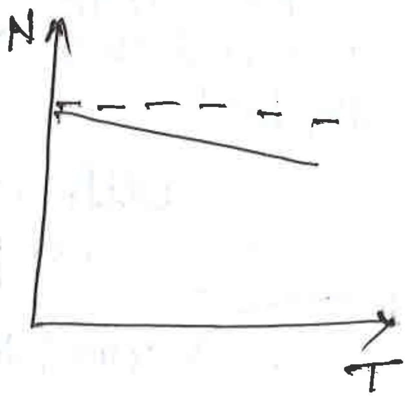
$\boxed{T \propto I_a^2}$



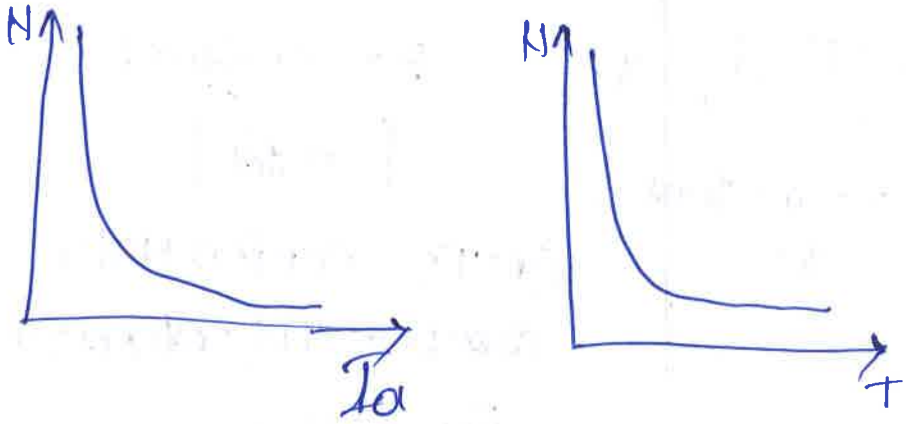


DC Shunt Motor :-





DC Series Motor :-



→ Speed of the motor decreases with the increases in torque as Hence Series Motors are best suited for services where the motor is directly coupled to the load such as in electric trains.

→ Speed in a series motor is inversely proportional to flux/pole and directly proportional to the applied voltage.

Compound Motor:-

(i) Cumulative compound Motor :-

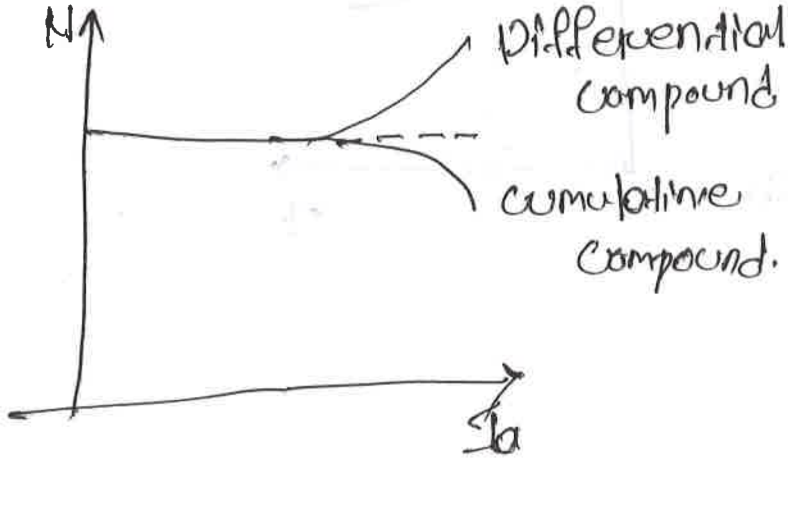
→ If these motors series field winding is connected to assist the shunt field.

→ The characteristics of such motors are the combination of series & shunt motors.

(ii) Differential compound :-

→ In this motor series field oppose the shunt field.

→ Speed remains constant & sometime increase with the increase the load.

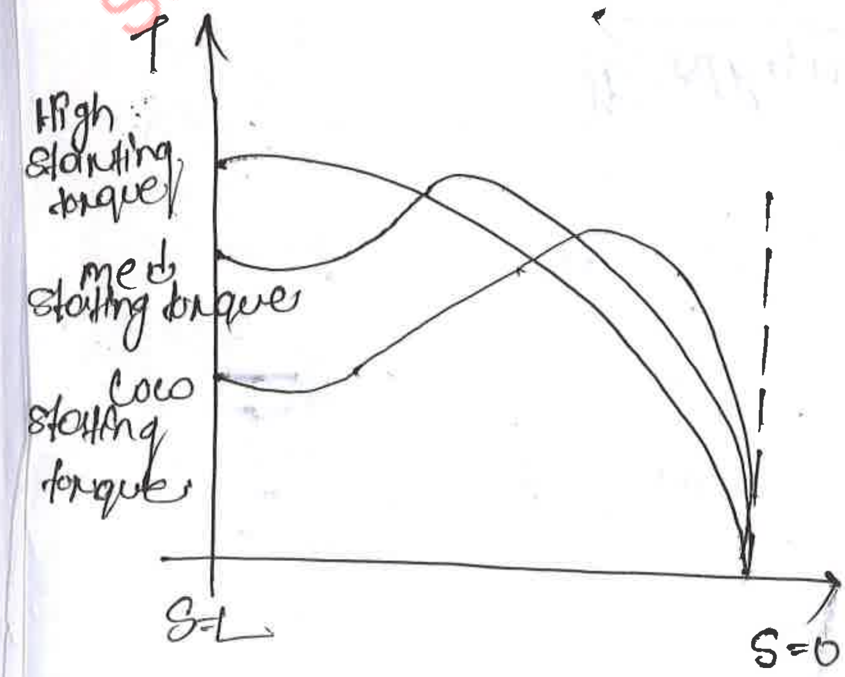


$$T = \frac{m}{\omega_s} \frac{V_2^2}{\left(\frac{R_2^2}{s} + X_2^2\right)} \cdot \left(\frac{R_2}{s}\right)$$

→ Starting torque will max. rotor resistance is make equal to leakag resistance

→ by Adding starting resistance the starting torque increases.

→ The resistance is cut out gradually as the motor picks up speed.



Synchronous Motor:

→ It runs a constant speed is called synchronous speed.

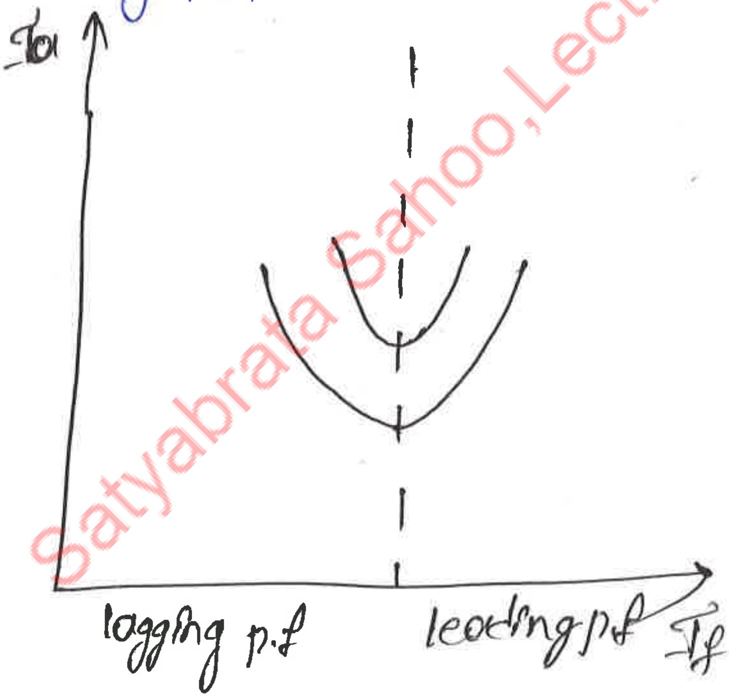
→ The speed of motor does not depend on load.

→ From the characteristic at which motor will work will depend upon

→ p.f can be change changing field current.

→ If field current at rated value It states that runs at ~~leading~~ p.f. lagging p.f.

→ If flip. current is more than normal value it runs at leading p.f.



→ If

Classification of electric drives:

→ There are three types of industrial drives indicating the trends in the form of advancement.

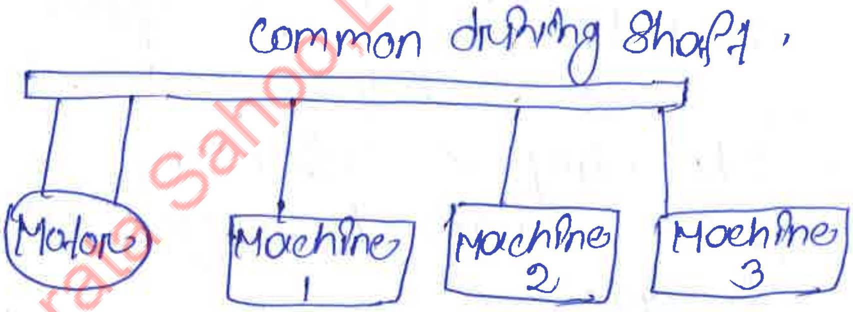
→ These are.

- Group drive.
- Individual drive.
- Multimotor drive.

① Group drive:

→ Group drive consists of a single motor which drives one or more line shafts supported on bearings.

→ The group drive system is shown in figure.



Group drive

→ The line shafts may be fitted with either pulleys & belts or gears, by means of which a group of a mechanisms may be operated.

→ The group drive is also called the shaft drive & group drive was used in the earlier days.

Advantages:

→ A single large motor can be used instead of a number of small motors.

→ The rating of the single large motor may be approximately reduced taking into account the diversity factor loads.

→ The motor normally induction type can thus work at about full load increasing the efficiency & power factor.

Dis-advantages:

→ There is no flexibility. If the single motor used develops faults the whole process will come to s[t]o[p].

→ Addition of an extra machine to the main shaft is difficult.

→ If some of the machine are not working the losses are increased, thus decreasing the efficiency & the power factor.

Individual drive:

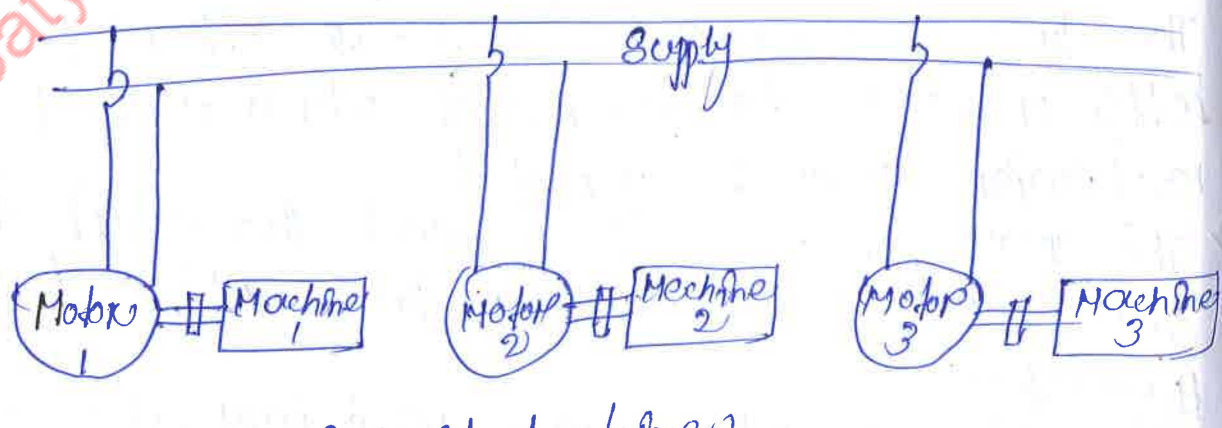
→ In individual drive, each individual machine is drive[n] by a separate motor. This motor also imparts of motion to various parts of the machine.

→ Examples of such machines are single spindle drilling machines and lathes.

→ In a lathe, the motor rotates the spindle, moves the feed and also with the help of gears transmits motion to lubricating & colling pumps.

→ A three phase squirrel cage induction motor is used as the drive.

→ The individual drive system is shown in figure.



(Individual drive)

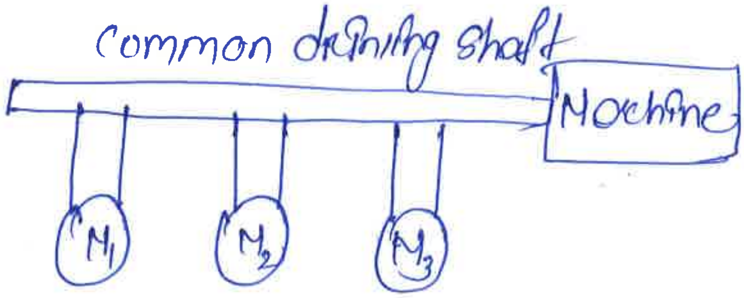
Dis-advantages:

→ The energy is transmitted to the different parts of the same mechanism by means of mechanical par[ts] like gears, pulleys etc. Hence there occurs some power loss.

* Multimotor drive:

→ The multimotor drive system, there are several drives, each of which serves to actuate one of the working parts of the driven mechanism.

→ The multimotor drive system is shown in figure.



(Multimotor drive)

→ Applications of such a drive are found in complicated metal cutting machine tools, paper making machines, rolling mills etc.

→ The drive of a crane can also be considered as an example of a multimotor drive system.

Comparison between group drive & individual drive

Group drive	Individual drive
① Requirement of initial cost is less.	① Requirement of initial cost is high.
② Large capacity (rating) of electric motor is required.	② Small rating electric motors are used based on the machines used for application.
③ Speed control of motor is difficult.	③ Speed control of motor is possible with less difficulties.
④ Good looking of the installation.	④ Good looking of the installation of individual drive is possible.
⑤ Any trouble on the main motor renders all machines idle.	⑤ Individual drive continuously running through any one motor is under repair.
⑥ It is less reliable.	⑥ It is more reliable.
⑦ It is less safe.	⑦ It is more safe.

Electric Traction

Date - 14.12.22

Electric Tractions

→ The propulsion of vehicle is called the traction & the system of traction involving the use of electricity is called the electric traction system.

→ The traction systems which involve the use of electricity at some stage or the other is called as the electric traction systems.

→ System electric traction may be further subdivided into two main groups.

→ The group consisting of vehicles which receive electric power from a distributing network fed at suitable points from either a central power station or substations suitably spaced such as tramways, trolley buses electric railways etc.

→ The group consisting of self contained locomotives such as diesel electric trains & ships, petrol electric trucks & lorries, battery-driven road vehicles etc.

Traction systems:-

→ The system that causes the propulsion of a vehicle in which the driving or force or tractive force is obtained from various devices such as electric motors, steam engine drives, diesel engine etc. is known as traction system.

* Types of traction systems:-

→ Traction systems may be broadly classified into two categories. They are electric traction system, which use.

→ Non-electric traction systems.

→ electric traction systems.

→ used in railways & internal-combustion engine drive used for road transport.

* Electric traction system:-

→ Traction system develops the necessary propelling torque, which involves the use of electric energy at any stage to drive the traction vehicle, known as electric traction system.

→ This system is used in electric trains, tramcars, trolley buses and diesel-electric vehicles etc.

→ Electric traction has many advantages as compared to other non-electrical systems of traction including steam traction.

→ They involve the use of electric energy at some stage or the other. They may be further subdivided into two groups.

→ Self-contained vehicles or locomotives.

→ The locomotives or vehicle themselves having a capability of generating electrical energy for traction purpose.

→ Examples:- Direct steam engine drive, battery-electric drive & diesel-electric drive etc.

• Electric vehicle fed from the distribution networks.

→ It consists of vehicles which receive electric power from a distribution network fed at suitable points from either central power stations or suitably-speed sub-stations.

→ Examples:- Railway electric locomotive fed from overhead ac supply & tramways & trolly buses supplied with dc supply.

Advantages of electric traction:-

• cleanliness:-

→ Since it does not produce any smoke or corrosive fumes, electric traction is most suited for underground & tube railways.

• Maintenance cost:-

→ Maintenance & repair cost of electric traction is about 50% than that of steam traction system.

* Starting time:-

→ It can be started without any loss of time whereas steam traction requires minimum 2 hours before a steam locomotive can be put into operation.

* High starting torque:-

→ electric traction system makes use of d.c. or a.c. series motor which has a very high starting torque. high starting torque make acceleration rate very high.

* Braking:-

→ In electric traction, regenerative braking is used which feeds back about 40% of the energy.

* Saving in high grade coal:-

→ Steam locomotive requires high grade coal which is deficient in our country.

→ Electric energy required for running electric of locomotive is taken either from hydropower station or from thermal power station which is run from low grade coal.

* Centre of gravity:-

→ The height of the electric locomotive is quite less so the centre of gravity is as compared to steam supply locomotive whose height is more.

→ The lower height of locomotive enables it to take curves even at higher speed.

* Dis-advantages of electric traction:-

following are the disadvantages of electric traction.

(i) Higher initial expenditure is involved in electric traction.

(ii) failure of supply is a problem to be faced in electric traction.

(iii) electrically operated vehicles have to move only on the electrified tracks.

(iv) for the achievement of electric braking & control, additional equipment is required. In case of D.C series Motor the regenerative braking can not be easily achieved.

(v) when a.c energy is utilised for traction then precautions are to be taken to prevent the distribution networks to interface with adjacent telegraph & telephone lines.

Self-contained vehicles:

Direct steam engine drive:

→ In steam electric locomotives, the steam turbine is employed for a generator is used to feed the electric Motor. Such that types of locomotives are not generally used for traction because of some Mechanical of difficulties & Maintenance problems.

Advantages:

→ It is a self-contained Motive power unit which employs a diesel engine for direct drive of a dc generator.

→ This generator supplies current to traction Motors which are geared to the driving axles.

→ Simplified Maintenance.

→ Easy speed control.

→ Low capital cost as track electrification is not required.

→ No interference with communication networks.

→ Operational dependability.

Dis-advantages:

→ It has strictly limited overload capacity.

→ It is available for hauling work for about 60% of its working days, the remaining 40% being spent in preparing for service, in Maintenance & overhaul.

→ Extensive & costly auxiliary equipment.