Applied Chemistry

Assignment - 1

M. Sravani
20JG1A0557
CSE - 1

1. Explain on (i) Tacticity (ii) Different types of moulding techniques involved in preparation of plastics.

A:- (i) Tacticity :

The orientation of monomeric units in a polymer molecule can take place in an orderly or disorderly fashion with respect to the main chain. The difference in configuration do affect their physical properties.

Types of Tacticity :

1. Isotactic : The head-to-tai configuration in which the functional groups are all on the same side of the chain is called isotactic polymer.
   Eg: polypropylene

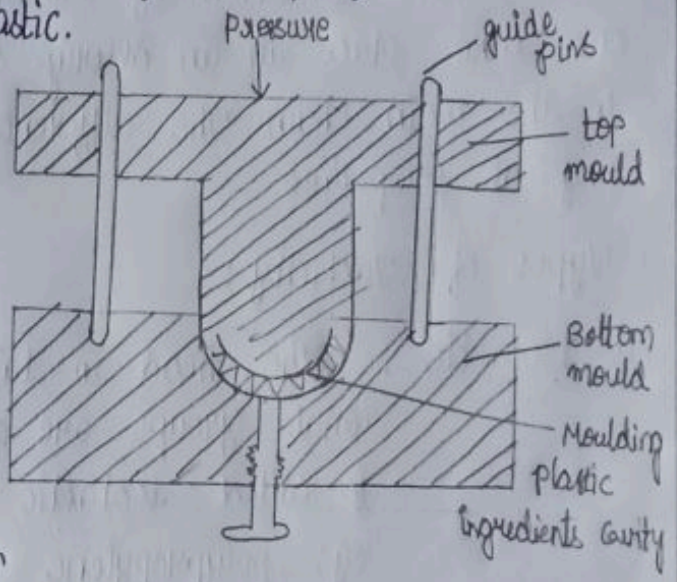
2. Atactic : If the arrangement of functional groups are at random around the main chain, it is called as atactic polymer.
   Eg : polystyrene

3. syndiotactic : If the arrangement of functional groups are at alternating fashion, it is called syndiotactic polymer.
   Eg : gutta percha used as filling in cavities due to its inertness.

(ii) Types of moulding techniques :

1. Compression Moulding :

This is applicable to both thermoplastic and thermosetting resin. A known quantity of compounded plastic resin is filled in the cavity present in the bottom mould. Top mould and bottom mould are capable of being moved relative to each other when heat and pressure are applied according to specifications. The cavities get filled with the plastic.



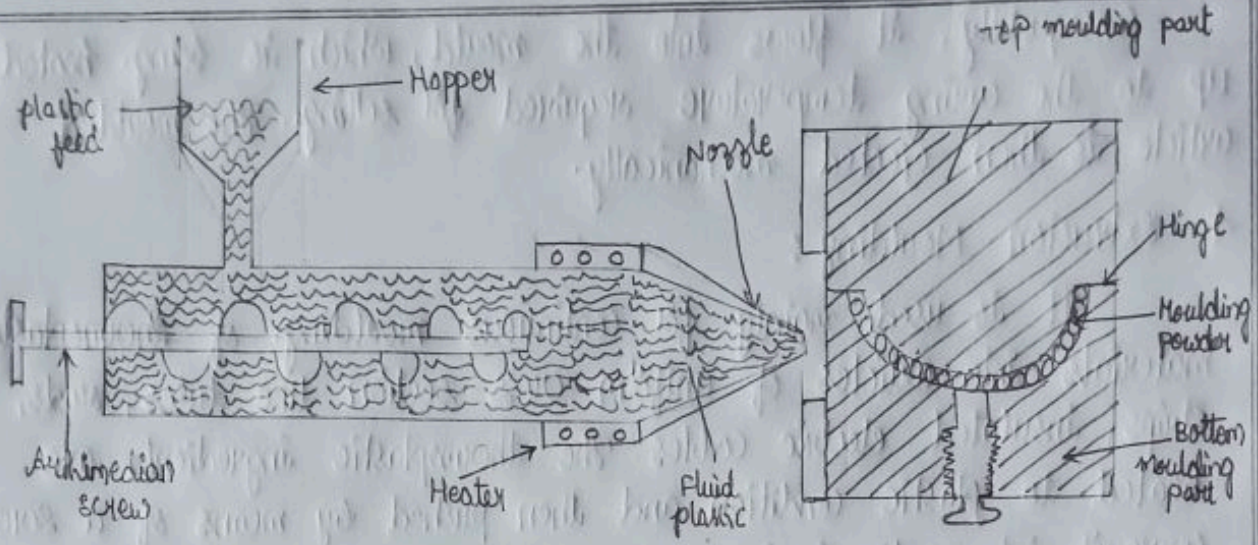
The two moulds are closed tightly and curing is done either by heating in case of thermoplastic resins or by cooling in case of thermoplastic resins.

After curing the moulded article is taken out by opening the mould.

2. Injection Moulding :

This is applicable to thermoplastic resins. The moulding plastic powder is fed into the cylinder from a hopper from where it is injected at a controlled rate into tightly locked mould by means of screw arrangement or by piston the mould is kept cold to allow the hot plastic to cure and become rigid.

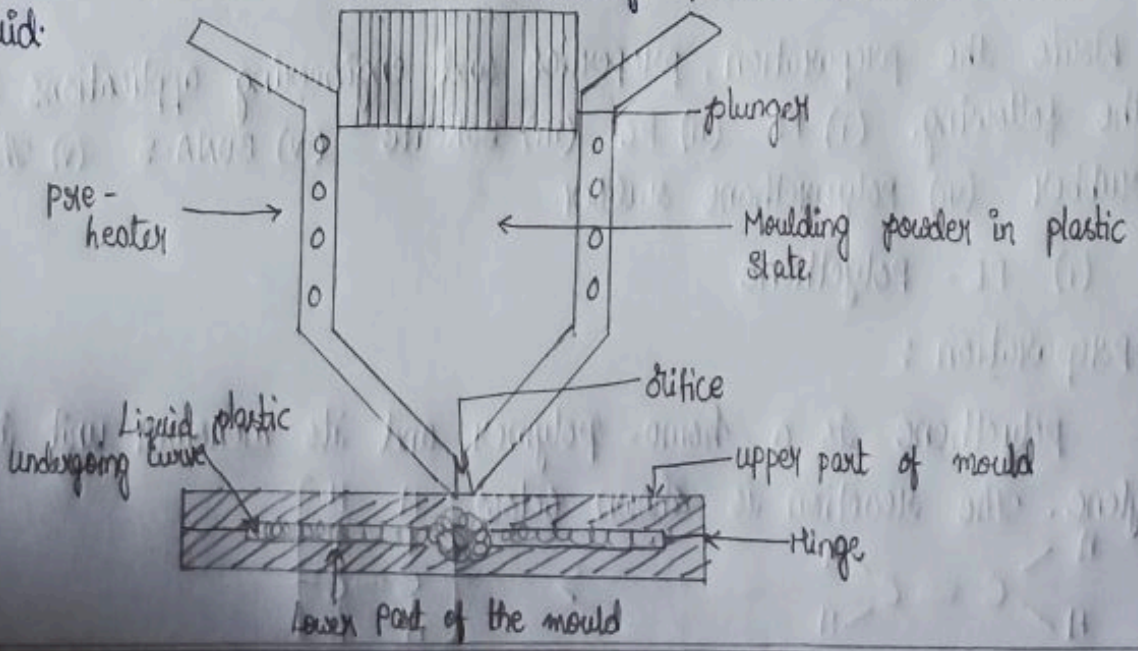
When material have been cured sufficiently, half of the mould is opened to allow the injection of finished article without any deformation. Heating is done by oil or electricity



Injection Moulding

3. Transfermoulding :

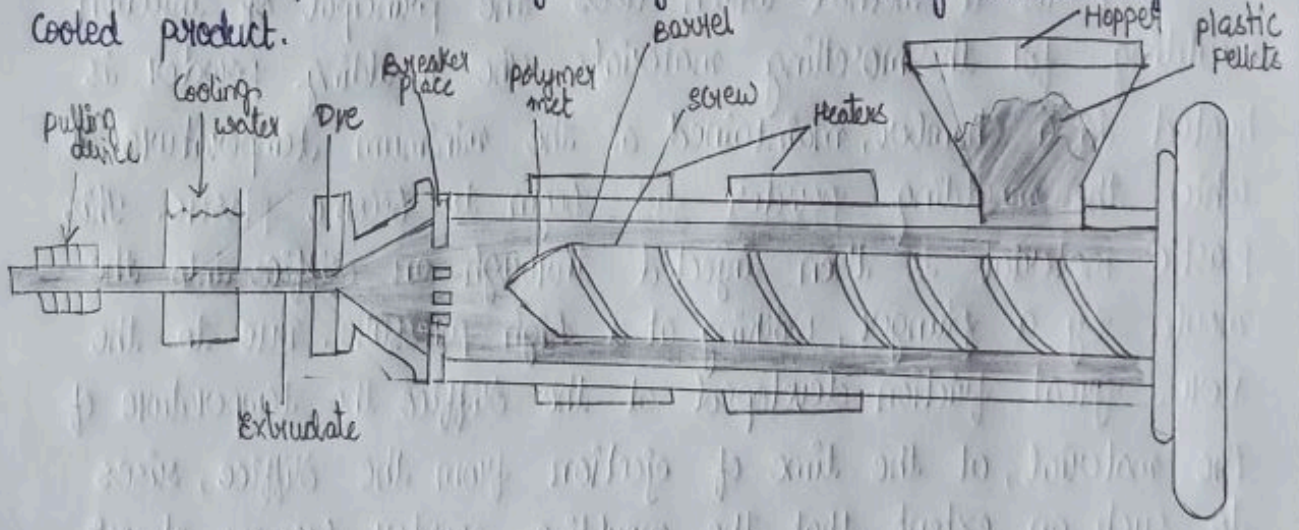
It is a method which uses the principal of injection moulding for thermosetting materials. The moulding powder is heated in a chamber, maintained at the minimum temperature at which the moulding powder just begin to become plastic. This plastic material is then injected through an orifice into the mould by a plunger, working at a high pressure. Due to the very great friction developed at the orifice, the temperature of the material, at the time of ejection from the orifice, rises to such an extent that the moulding powder becomes almost liquid.



Consequently, it flows into the mould, which is being heated up to the curing temperature required for setting. The moulded article is then ejected mechanically.

4. Extrusion Moulding :

It is used mainly for continuous moulding of thermoplastic materials into articles of uniform cross-section like tubes, rods, strips, insulated electric cables. The thermoplastic ingredients are heated to plastic condition and then pushed by means of a screw conveyor into a die, having the required outer shape of the article to the manufactured. Here the plastic mass gets cooled, due to the atmospheric exposure. A long conveyor carries away continuously the cooled product.

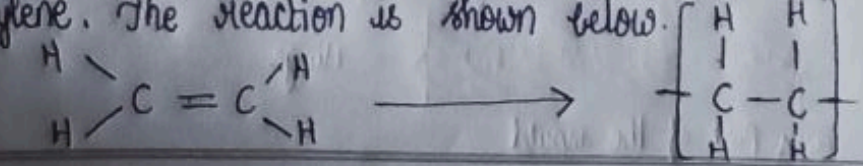


2. Write the preparation, properties and engineering applications of the following (i) PE (ii) PC (iii) Bakelite (iv) BUNA-S (v) Thiocol rubber (vi) Polyurethane rubber.

A:- (i) PE - Polyethene

Preparation :

Polyethene is a homo-polymer and its monomer unit is ethylene. The reaction is shown below.



Polyethene is broadly classified into 2 types

1. Low Density polyethene (LDPE)

Preparation :

It is prepared by the free radical mechanism at a temperature of 80-350°C under high pressure (1000-3000 atm) in presence of a oxygen peroxide (Benzoyl peroxide) as initiator, where in extensive branch formation takes place and the density of the resultant polymer is very low in the range of 0.91-0.94 g/cm³.

Properties :

1. It is a waxy transculent material, exhibits high impact strength, low brittleness, film transparency and outstanding electrical insulating properties.
2. It is chemically inert and has good resistance to acids.
3. It is flexible over a wide temperature range.

2. High Density polyethene (HDPE)

Preparation :

It is prepared by the ionic mechanisms at a low temperature of 60°-70°C and very low pressure (6-7 atm), wherein little & no branch formation takes place and the density of the resultant polymer is high in the range of 0.945-0.965 g/cm³.

Properties :

1. The molecules are linear and their packaging is easy.
2. It is a good electrical insulator and resistant to strong acids, alkalis and salt solution at room temperature.
3. It is a soft flexible polymer.

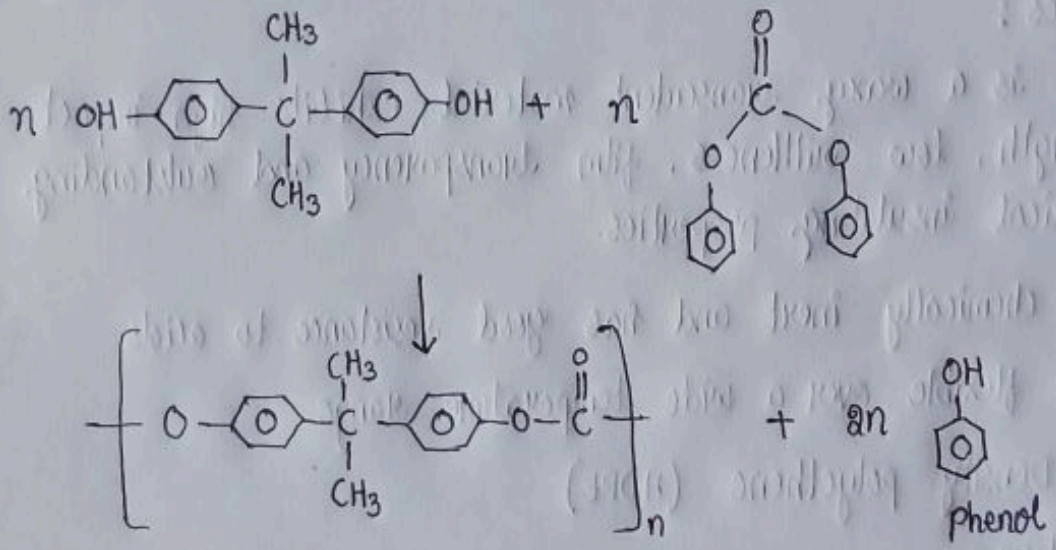
Engineering Applications :

It is used for making high frequency insulator parts, bottle caps, packing materials, tubes, coated wires, in chemical plants for kitchen and domestic appliances.

(ii) Polycarbonate (PC) :

Preparation :

Merlon are prepared by interaction of diphenyl carbonate with bisphenol.



polycarbonate

Properties :

1. High impact and tensile strength of wide range of temperature
2. Soluble in Organic solvents and alkalis.

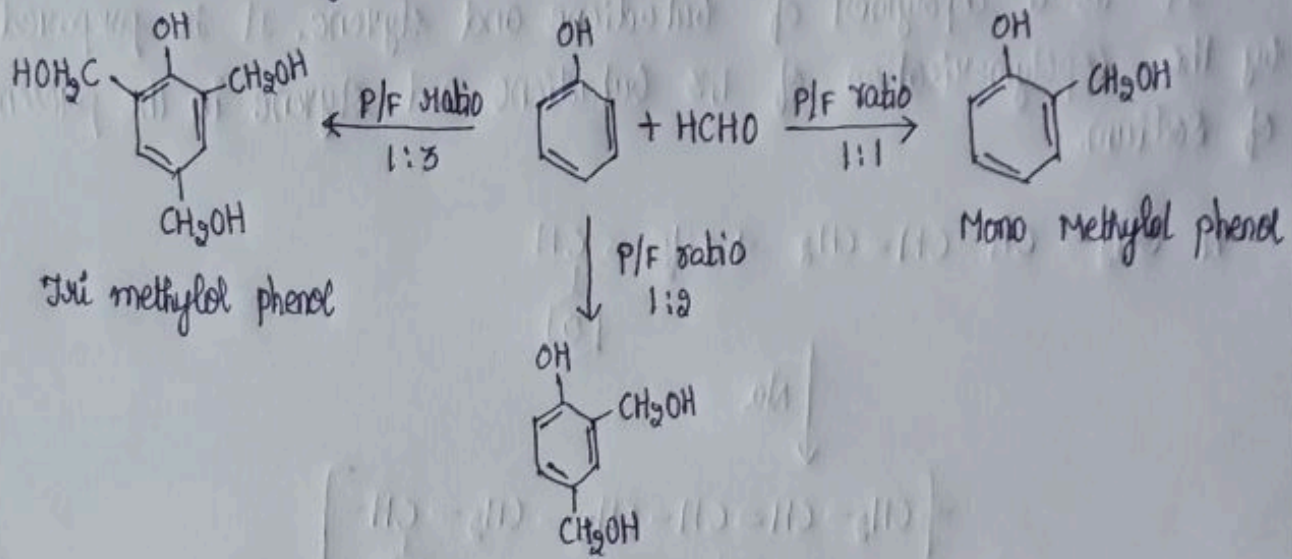
Applications :

It is used for preparing moulded domestic ware, housing for apparatus, electric insulator in electronic and electrical industries.

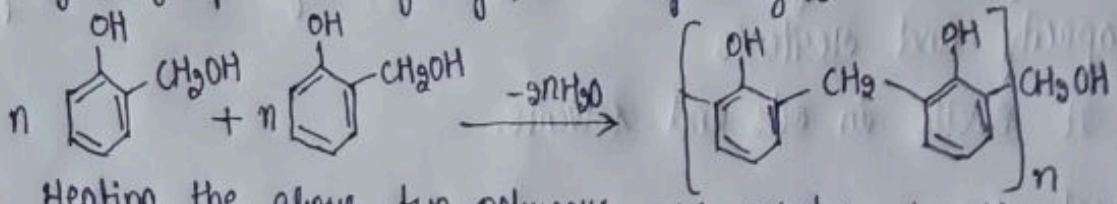
(iii) Bakelite :

Preparation :

1. phenol reacts with formaldehyde in presence of acid or alkali produces mono, di and tri Methylol phenols depending on phenol formaldehyde ratio.



2. The mono, di, and tri methylol phenols are heated to produce two types of straight chain resins by Condensation of the methylol group with hydrogen atom of benzene.



Heating the above two polymers will produce bakelite.

Properties :

phenolic resins set to rigid, hard, scratch resistant, water resistant, insoluble solids, which are resistant to non-oxidizing acids and many organic solvents.

Applications :

a. for making electrical insulator parts like switches, plugs etc.

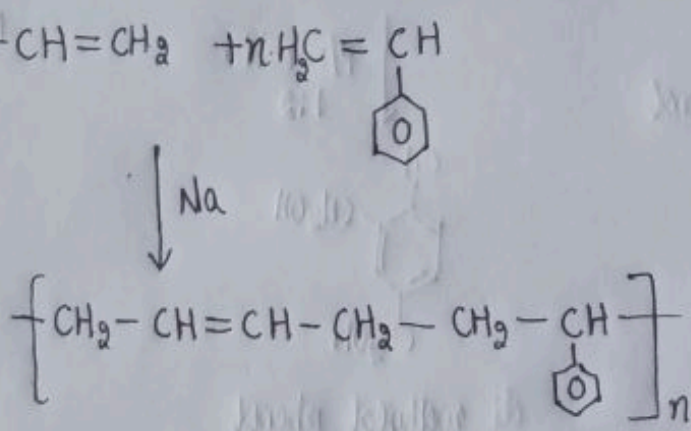
b. As adhesives for grinding wheels.

c. for moulding articles like telephone parts.

(iv) BuNa-S :

Preparation :

It is a copolymer of butadiene and styrene. It is prepared by the copolymerisation of 1,3 butadiene and styrene in the presence of sodium.



Properties :

1. It resembles natural rubber in processing characteristics.
2. It possess high abrasion-resistance, high load-bearing capacity and resilence
3. It swells in oils and solvents.

Applications :

1. Used for manufacturing tyres
2. Used as floor tiles, shoe soles, gaskets, footwear components, wire and cable insulations, adhesives etc..

(v) Thiokol Rubber :

Preparation :

It is prepared by the copolymerisation of sodium polysuphide and ethylene dichloride.

$$Na_2S_{(aq)} + S_{(x)} \longrightarrow Na_2S_{x\,(aq)}$$

$$Cl-R-Cl + Na_2S_x \xrightarrow{70^\circ C} HS\left[R-S_x\right]_n R-SH + 2NaCl$$

Properties :

1. Strength impermeable to gases.
2. Good resistance to mineral oils, oxygen, solvents, ozone and sunlight.
3. Low abrasion resistance.

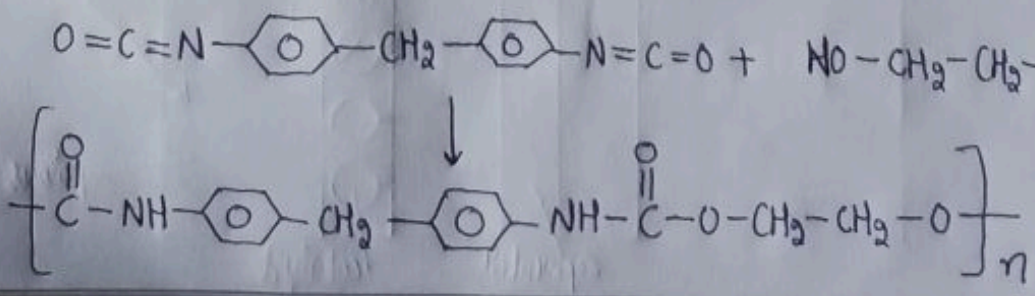
Applications :

1. Fabric coated with thiokol used for barrage balloons, lift rafts and jackets which are inflated by CO_2.
2. Lining hoses for conveying gasoline and oil.

(viii) Poly urethane :

Preparation :

It is obtained by treating diisocyanate and diol. perlon-U is obtained by the reaction of 1,4 - butane diol with 1,6 hexane diisocyanate.



Properties :

1. They are excellent resistance to abrasion and solvents.
2. They are less stable polyamides at elevated temperatures.

Applications :

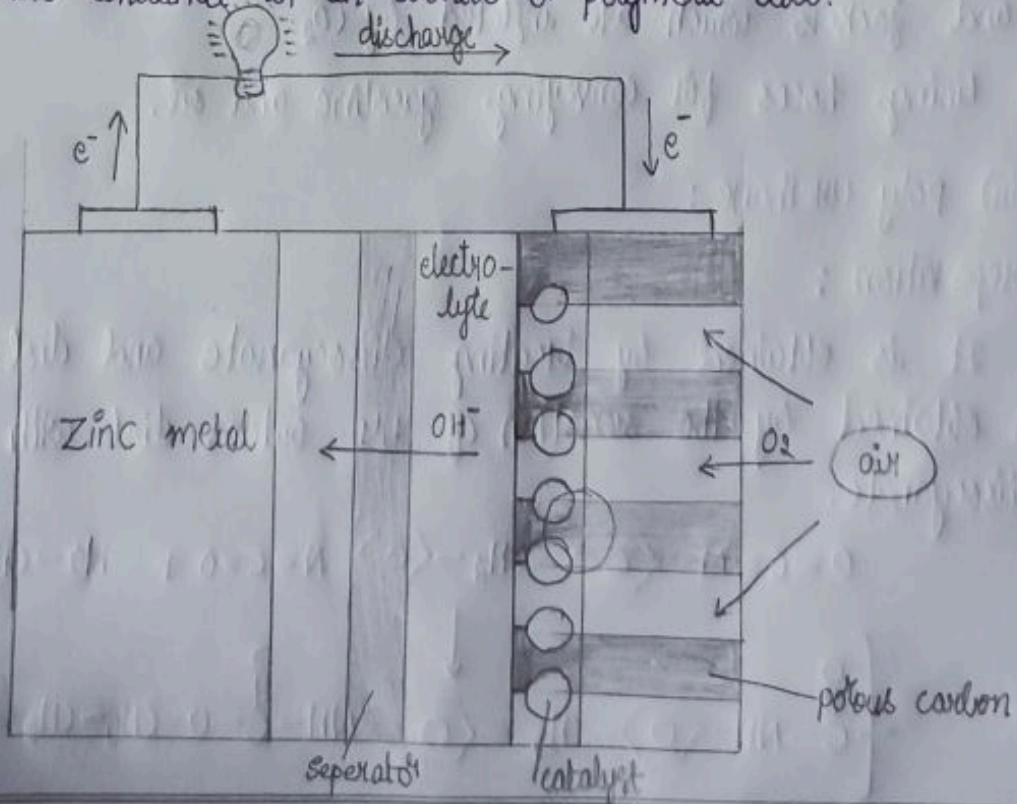
1. used as coatings, films, foams and adhesives.
2. used as leather substitute (carfoam)

3. Explain the Construction and working of zinc-air cell battery and Molten carbonate fuel cell. write the involved reactions in each half-cell?

A:- Zinc-air cell battery :

Construction :

In zinc-air battery, the anode is made up of zinc plate, a perforated carbon plate treated with water repelants acts an cathode. NaOH & KOH is used as electrolyte. The anode and cathode and the electrolyte are contained in an ebonite & polymeric case.



Working :

At anode, zinc reacts with electrolyte to form zincate ions which decay into zinc oxide and water. The electrons released at the anode travel towards cathode where oxygen of the air accepts the electrons to form hydroxide ions.

The cell is represented as $Zn | NaOH(5M) | Air | C$

Cell Reactions :

$$2Zn + 4OH^- \longrightarrow 2ZnO + 2H_2O + 4e^-$$

$$O_2 + 2H_2O + 4e^- \longrightarrow 4OH^-$$

overall cell reaction is $2Zn + O_2 \longrightarrow 2ZnO$

At anode : $Zn \longrightarrow Zn^{2+} + 2e^-$

$$Zn^{2+} + 4OH^- \longrightarrow [Zn(OH)_4]^{2-}$$

$$[Zn(OH)_4]^{2-} \longrightarrow ZnO + H_2O + 2OH^-$$

At cathode : $O_2 + 2H_2O + 4e^- \longrightarrow 4OH^-$

or

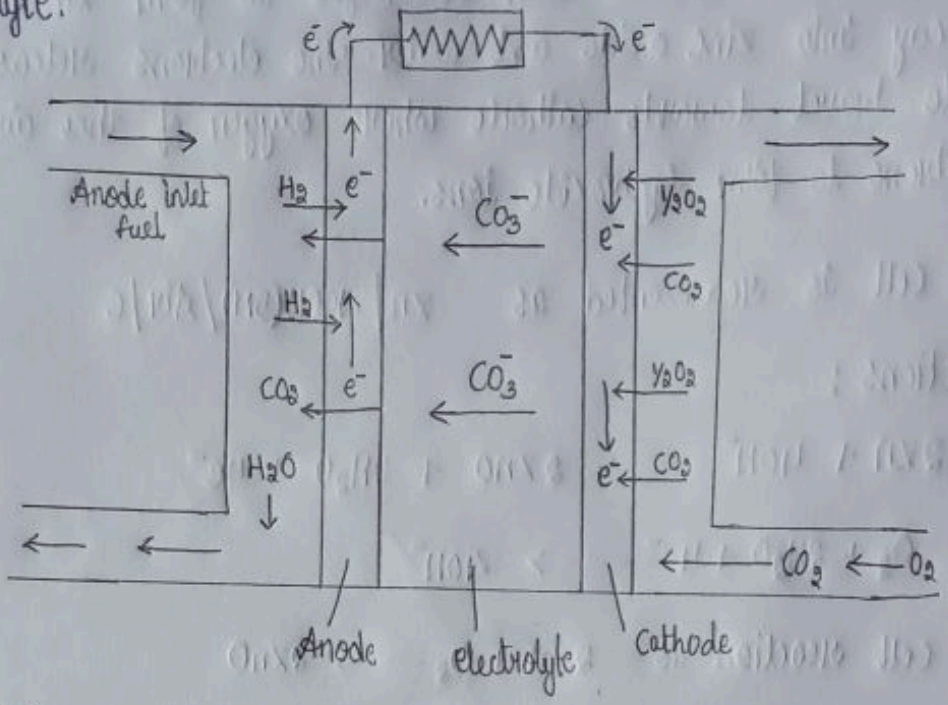
$$O_2 + H_2O + 2e^- \longrightarrow HO_2^- + OH^-$$

Molten Carbonate fuel cell :

Construction :

The fuel-cell consists of an anode made up of a porous structure of nickel treated with oxides to prevent sintering. The cathode is made up of lithiated sintered nickel oxide. A molten mixture of carbonate salts like lithium carbonate Li_2CO_3, potassium carbonate and sodium carbonate is used as an electrolyte. The electrolyte is suspended in a porous, chemically inert ceramic $LiAlO_2$

matrix. The cell operates at the very high temperature of 650°C to enable to melt and to increase ionic mobility through the electrolyte.



Working :

At high temperature, natural gas, methane and steam are converted into hydrogen rich gas inside the fuel cell. The cell reacts with the carbonate ions at anode to form CO_2 and water. The electrons pass to the cathode through the external circuit where the oxygen from the air and CO_2 from the anode reacts with electrons to form carbonate ions.

The cell reactions are

$$CO_3^{2-} + H_2 \longrightarrow H_2O + CO_2 + 2e^-$$

$$CO_2 + \tfrac{1}{2}O_2 + 2e^- \longrightarrow CO_3^{2-}$$

overall reaction is $H_2 + \tfrac{1}{2}O_2 \longrightarrow H_2O$

Due to the use of corrosive electrolytes and high temperature, these cells are less durable. They are not easily poisoned by CO and CO_2

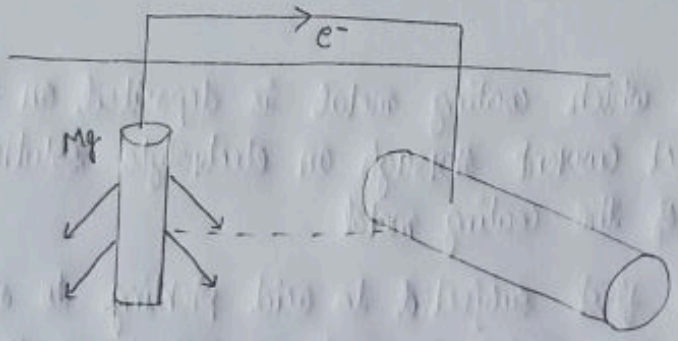
4. Illustrate the following (i) cathodic protection (ii) electroplating and electroless plating [nickel] (iii) paints (constituents and functions).

A: (i) Cathodic protection :

The principle involved in this method is to force the metal to be protected to behave like a cathode thereby the corrosion does not occur. There are two types of cathodic protection.

a. Sacrificial anodic protection method :

In this method the metallic structure to be protected is connected by a wire to more anodic metal, so that all the corrosion is concentrated at this more active metal implies the more active metal itself gets corroded slowly. While the parent structure which is cathode is protected. The more active metal so employed called as "sacrificial anode". whenever it is consumed completely, it is replaced by the fresh one. Mg, Zn, Al and their alloys are commonly used as sacrificial anodes.



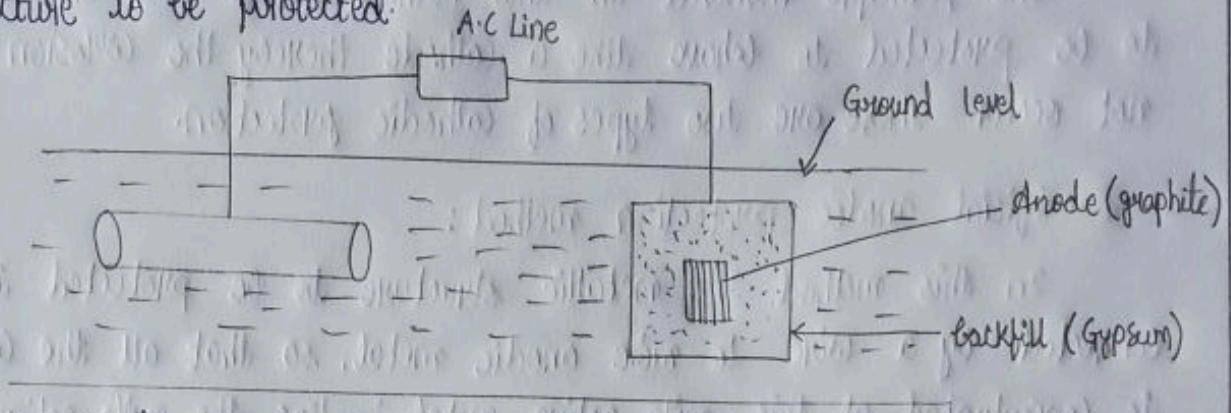
Sacrificial anodic protection

Eg: A ship-hull which is made up of steel is connected to sacrificial anode which undergoes corrosion leaving the base metal protected.

b. Impressed current :

In this method, an impressed current is applied in opposite direction to nullify the corrosion current and current the corroding

metal from anode to cathode. usually the impressed current is derived from a direct current source with an insoluble anode, like graphite, scrap iron, stainless steel and platinum. usually sufficient d.c is applied to an insoluble anode, buried in the soil and connected to the metallic structure to be protected.



The anode is buried in a backfill such as coke breeze & gypsum to increase the electrical contact between itself and surrounding soil.

Applications :

This type of protections are used in buried structures such as tanks and pipelines, transmission line towers etc..

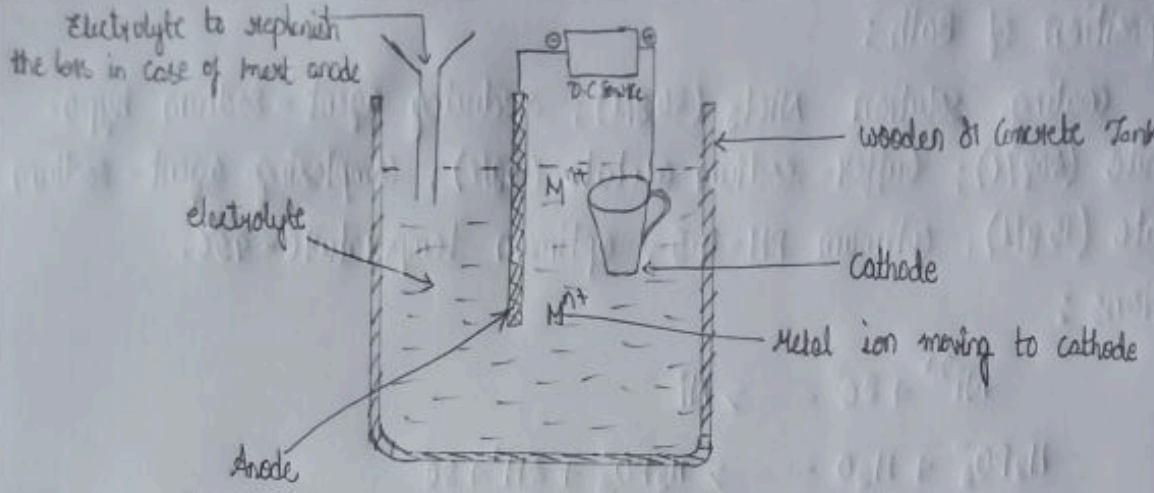
(ii) Electroplating :

a. It is a process in which coating metal is deposited on the base metal by passing direct current through an electrolyte solution containing the soluble salt of the coating metal.

b. The base metal is first subjected to acid pickling to remove any scales, oxides etc. The base metal is made as cathode of the electrolytic cell and coating metal is made as anode.

c. The two electrolytes are dipped in the electrolyte solution which contains the metal ions to be deposited on the base metal.

d. When a direct current is passed from an external source, the coating metal ions migrate towards cathode and get deposited over the surface of the base metal in the form of a thin layer.



Low temperature, medium current density, low metal ion concentration conditions are maintained for better electro-plating.

Eg: Copper plating :

Electrolyte - $CuSO_4$

Anode - Pure Copper

Cathode - Base metal article.

$$Cu\,(s) \longrightarrow Cu^{2+}\,(aq) + 2e^-$$

$$2e^- + Cu^{2+}\,(aq) \longrightarrow Cu\,(s)$$

Electroless plating :

A technique of depositing of noble metal on a catalytically active surface of a less noble metal by employing a suitable reducing agent without using electrical energy.

Metal ion + Reducing agent $\longrightarrow$ Metal + oxidation products.

electroless Nickel plating :

The surface to be plated is first degreased organic solvents followed by acid treatment.

(i) Metals and alloys like Al, Cu, Fe etc

(ii) Activation of dil H_2SO_4

Composition of Bath :

Coating solution $NiCl_2$ (20 g/l); reducing agent - sodium hypophosphite (20g/l); buffer - sodium acetate (10g/l); complexing agent - sodium succinate (15 g/l); optimum PH - 4.5; optimum temperature - 95°C.

Reactions :

$$Ni^{2+} + 2e^- \longrightarrow Ni$$

$$H_2PO_2^- + H_2O \longrightarrow H_2PO_3^- + 2H^+ + 2e^-$$

Overall reaction is $Ni^{2+} + H_2PO_2^- + H_2O \longrightarrow Ni + H_2PO_3^- + 2H^+$

Paints :

paint is a mechanical dispersion mixture of one or more pigments in a vehicle. The vehicle is a liquid consisting of non-volatile film forming material, drying oil and a highly volatile solvent thinner, when paint is applied to a metal surface the thinner evapolates, while the drying oil slowly oxidizes forming a dry pegmented film.

Constituents :

a. pigment : It is a solid substance which is an essential constituent of paint it provides.
b. capacity to paints
c. strength to paint
d. desired colour to paint
e. esthetic appeal to the paint film.
f. protection to the paint film by reflecting harmful UV light
g. Resistance to paint film by reflecting against abrasion
h. impermeability of paint film to moisture
i. increases the weather resistance of the film.

Important pigments used are white - such as white lead, zinc oxide, litho phone, titanium oxide.

Red - read lead, ferric oxide, chrome red etc.

Green - Chromium oxide

Blue - prussian blue

Black - carbon black

Brown - Brown umber etc.

Vehicle or Drying oil :

It is a film forming constituent of the paint. These are glyceryl esters of high molecular-weight fatty acids generally present in animal and vegetable oils. The most widely used drying oils are linseed oil, soya bean oil and castor oil.

Functions of drying oil :

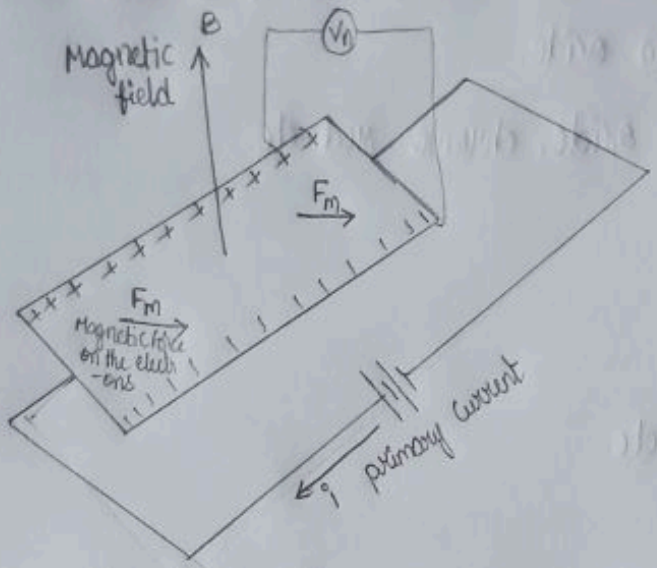
Drying oil supplies (i) Main Film-forming constituent (ii) vehicle or medium (iii) Toughness (iv) adhesion (v) Durability and (vi) Water proof.

5. What is hall effect ? Write down its important applications.

A:- Hall effect :

The Hall effect is the production of a voltage difference across an electrical conductor, transverse to an electric current in the conductor and a magnetic field perpendicular to the current.

When a magnetic field is present, these charges experience a force, called the Lorentz force. When such a magnetic field is absent, the charges follow approximately straight line. At equilibrium a voltage appears at the semiconductor edges.



Applications:

(i) Hall probes are used as magnetometers to measure magnetic field.

(ii) Hall effect sensors have mass application and analog to digital convertors.

(iii) It is useful in space craft applications.

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6. Write short notes on (i) FRP plastics (ii) Conducting polymer (iii) Bio-polymers.

A:- (i) Fibre Reinforced Plastics (FRP):

Combination of plastic material & solid fillers give hard plastic with mechanical strength & impact resistant is known as reinforced plastics.

The fibre polymers with solid fillers to impart mechanical strength & hardness without losing plasticity are known as Fibre Reinforced plastics (FRP).

Fillers like corborandum, quartz & mica - impart hardness.

Asbestos provide heat & corrosion resistant for FRP.

Nature of polymers used for FRP:

Composition:

1. 50% of the mould able mixture contain fillers
2. Addition of carbon black to natural rubber increase the 40% strength of rubber & used in the manufacture of tyres.
3. China clay improves the insulation property of PVC, Teflon.
4. When $CaCO_3$ is added to PVC, then they are used for insulation of tubing, sea covers & cables.
5. FRP has good shock and thermal resistances, mould ability, dimensional stability & reparability.

Applications:

FRP find extensive use in space crafts, aeroplanes, boat hulls, acid storage tanks, motor cars and building materials.

(ii) Conducting polymers:

Those polymers which conduct electricity are called conducting polymers. The conduction of the polymers may be due to unsaturation or due to the presence of externally added ingredients in them. The conducting polymers can be classified as

Intrinsic conducting polymers:

It is a polymer whose backbone or associated group consists of delocalized electron pair or residual charge. Such a polymer essentially contain conjugated π-electrons backbone. Conducting polymers having π electrons are (i) polyacetylene polymers, poly-p-phenyene, polyquinone etc.

Doped Conducting polymer :

It is obtained by exposing a polymer to a charged transfer agent in either gas phase or in solution. Conductivity of ICP can be increased by creating either positive or negative charges on the polymer backbone by oxidation or reduction is of two types.

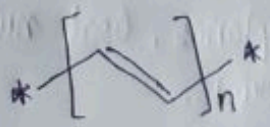
P-doping :

Involves treating an intrinsically conducting polymer with a lewis acid, thereby oxidation process takes place and positive charge on the backbone are created.

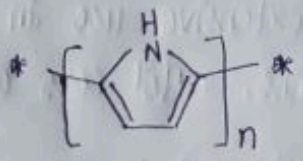
P-dopant used are I_2, Br_2, AsF_5, PF_6 & Naphthylamine.

$$(C_2H_2)_n + 2FeCl_3 \longrightarrow (C_2H_2)_n^{\bullet+} + FeCl_4^- + FeCl_2$$

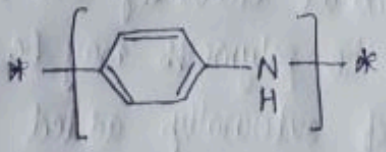
$$2(C_2H_2)_n + 3I_2 \longrightarrow 2[(C_2H_2)_n I_3^-]$$



polyacetylene



polypyrrole



polyaniline

n-doping :

Involves treating an intrinsically conducting polymer with a lewis base, thereby reduction process takes place and negative charge on the backbone are created.

Eg: Li, Na, Ca, $FeCl_3$ etc..

$$\ldots\!-CH=CH-CH=CH-\ldots\!. + B \longrightarrow \ldots\!-CH=CH-\underset{\displaystyle B^+}{CH^-}=CH-\ldots\!.$$

Extrinsically Conducting polymers :

The conductivities of these polymers is due to the presence of externally added ingredients in them. They are of two types.

1. Conducting element filled polymers :

The polymer acting as a binder to hold the conducting element such as C - black, metallic fibres. The minimum concentration of conducting filler is added so that it starts conducting.

2. Blended conducting polymers :

The conventional polymer is blended with a conducting polymer to improve physical, chemical, electrical and mechanical properties along with processing properties.

Applications :

1. Used for electron beam lithography.
2. In non-linear optical material.
3. In telecommunication system.
4. In photo voltaic devices
5. In electromagnetic screening materials.

(iii) Bio polymer :

polymers are not attacked by environmental conductions including biological attack. polymers in which the degradation results from the nature of naturally occuring microbiganisms such as bacteria, fungi and algae. Such polymers are called biodegradable polymers.

The biodegradable polymers may be naturally occurring or they may be synthesized to chemicals. Naturally occurring biodegradable polymers are classified into 4 groups. The rate of degradation depends on the structure and environmental conditions.

Synthesized biodegradable polymers:

Polymers derived from petrochemicals or biological sources. They are used in dissolving suture material in medical field, and bio-polyesters.

Eg: 1. polyalkaline esters
2. polyamide esters
3. polyvinyl esters

Applications:

1. These are synthesized from the processing of crops or from petrochemical feed stock with normal or conventional processing methods.
2. The compostable bags help in the disposal of vegetable matter being converted to CO_2 and CH_4
3. The problem of landfills by solid waste can be reduced.