

UNIT - II

classmate

Date _____

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CORROSION AND ITS PREVENTIONS.

The process of slow destruction of metals due to chemical or electrochemical attack of the environment at their surfaces resulting into the formation of compounds such as oxides, carbonates, sulphides, phosphates etc is called corrosion.

Ex - rusting of iron, tarnishing of silver, development of green coating of basic carbonate ($\text{CuCO}_3 + \text{Cu(OH)}_2$) on copper and bronze etc.

Metals react with gases and moisture and atmospheric gases to form a mixture of $[\text{Cu}(\text{O}_2) + \text{Cu(OH)}_2]$

⇒ Different types of corrosion

Types of corrosion

Dry & Chemical
By other gases
By liquid metal

Wet or
Electro-chemical

Soil

Other forms
↓
Microbiology

Microbial
Stress

Galvanic

Conc cell or
differential area

Waterline

4. Dry air chemical corrosion

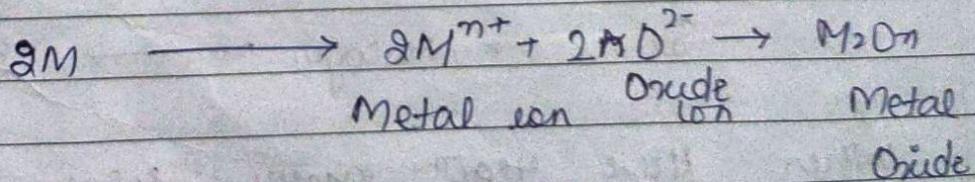
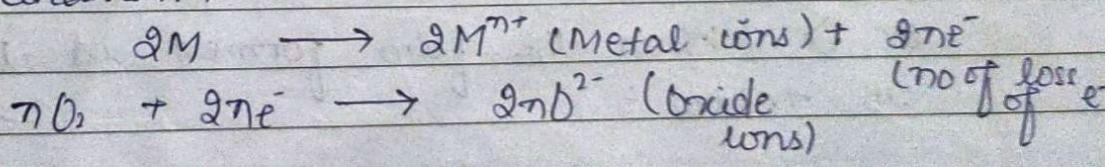
The direct chemical action of atmospheric gas such as Oxygen, halogens, sulphur dioxide and hydrogen sulphide on metals resulting into the formation of compounds such as oxides, halides, sulphates and sulphides is referred to as chemical corrosion.

Corrosion by oxygen ("oxida" corrosion).

Atmospheric O₂ reacts with metals in the absence of moisture forming their respective oxides.

Alkali metals (Li, Na, K etc) and alkali earths (Be, Ca, Sr etc) are oxidized at low temp. whereas other metals (except Ag, Au and Pt) are oxidized at high temp. (silver, gold, platinum). (Due to chemical reaction with O₂ or O₃)

Mechanism:



Mn - Manganese
M - Metal.

Overall effect

* Different types of surface corrosion / Films
 (complex of organic chemicals and microorganisms that aggregate at the water-air interface on the surface w/o. bulk water/metas etc)

ii)

(iii)
 film form
 stable
 in nature

The product is formed on the metal surface. The nature of the surface film helps in predicting that whether the rate of corrosion will further ↑ or ↓. Following steps are.

i) Attack by O₂ gas and nature of oxide film formed.

(Tin)

ex - Al, Cu, Sn and Pb. (lead)
 Aluminum Copper,

b) Corrosion by Other gases : Fluorine
 Besides CO₂, Cl₂ / Br₂, SO₂, H₂S, Hydrogen sulphide, CO₂ and F₂ also react with metals. These gases are depend on the oxygen to chemical affinity of the metal and also upon the nature of compound

ex i) When the film formed is protective in nature :-



When these react occur silver form a protective (non-porous) film of silver halide which prevents further corrosion

(Agr Sn Cl₂ molecule atm p_{Cl₂} present
 be react no jaye
 Sn + 2Cl₂ → SnCl₄ (Volatile) to vapor
kjagae
 (easy evaporated at
 in these corrosion is occurs normal temp)

iii) ^{Film formed} Dry chloride attacks the iron metal at >100°C
 Stable and forms FeCl₃ c u non-volatile solids and
 (not vaporizing properly / readily)
 protect the rest of the metal.

iv) H₂S gas at high temperature reacts with
 Fe and forms a porous FeS film and
 Film formed it further corrodes iron.
 porous in nature

c) Liquid Metal Corrosion.

When " " flows over solid metal at high temperature. Corrosion takes place & is called liquid metal ".

Corrosion of
 ex - Cadmium rods taking place due to
 sodium metal acting as coolant in nuclear
 reactions

protect
 form heat
 to mean
 (With miles sodium metal to metal hai
 age nuclear reactor mai chale jaye
 to cadmium rod rusting hone se
 Ganga left hai)

(When cadmium rods are inserted in the core of a nuclear reactor, cadmium absorbs neutrons, preventing them from creating additional fission events, thus controlling amount of reactivity)

Means dry mean mai

2

Wet or Electrochemical corrosion.

" more common than dry
It occurs mostly under moist condit's through the forma" of Electrochemical cells () and so called "

corrosion.

The mechanism of Electrochemical corrosion involves :

Meh aga loha nam pani mai sekh dete hai to Iron Fe hote hai wo \rightarrow O pani mai molecule present hote hai more react hake rust ban jata hai)

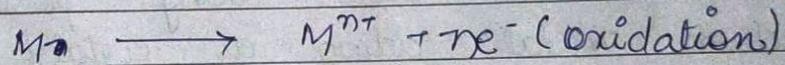
IV
a

7
metal no
yo bari
zarega

(i) Oxidation (loss of electrons) take place at the anodic area and the metal is destroyed (negative in electrochem) by their direct or combina" with oxygen. Hence corrosion always takes place at the anode

[H⁺ release and
ions and
water]

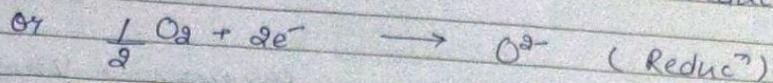
+ (electron
from p₄₊₁₀
no sign)
configur. may



M^{n+} forms compounds such as oxides or dissolves in soln.

(ii) Reduction (gain of electrons) take place at the cathode. The e⁻'s from the anode are accepted by the dissolved O₂ forming ions such OH⁻ or O²⁻ ions

Vine
vines

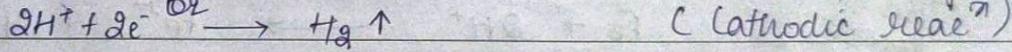
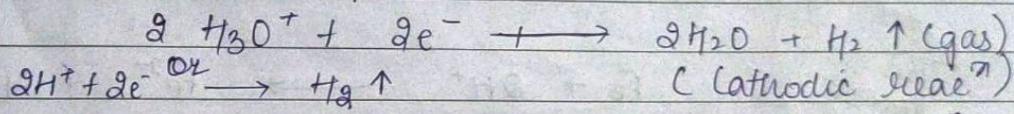


iv) The metallic ions formed at the anode and anions formed at the cathode diffuse through the conducting medium and combine to form the corrosion product some where b/w anodic (-) and cathodic area (+)

v) Evolution of hydrogen (Means hydrogen gas release b/w)

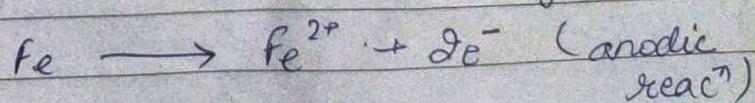
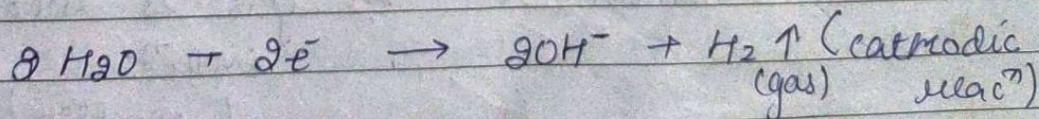
~~metal has
+ve charge
so b/w
anode~~ In process of corrosion where H^+ is liberated. This type " take place in acidic environment (when H^+ ions release $\xrightarrow{\text{absence of O}_2}$ b/w)

(Hydroxonium ion)



In these anodic metals atoms loose their e^- 's to the environment and pass into soln. in the form of the ions.
(In these oxidation is occur)

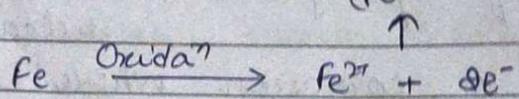
In neutral and alkaline medium (in the absence of oxygen) the reacⁿ will be -



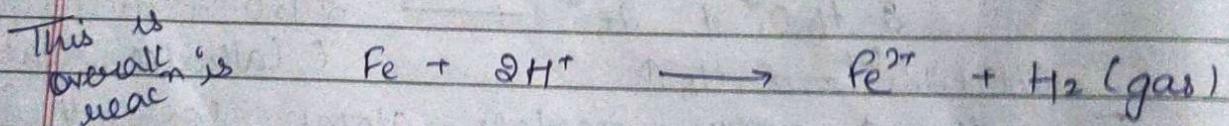
These electrons flow through the metal from anode (-ve) to cathode (+ve)

e.g. if iron metal is used, the dissolving metal (at an acidic interface) increases

of iron as Fe^{2+} ions & the liberation of electrons in anodic area (cathode) ↓ (previous)



These electrons are flow through the metal from anode to cathode, where H^+ ion of acidic soln eliminated as H_2 .



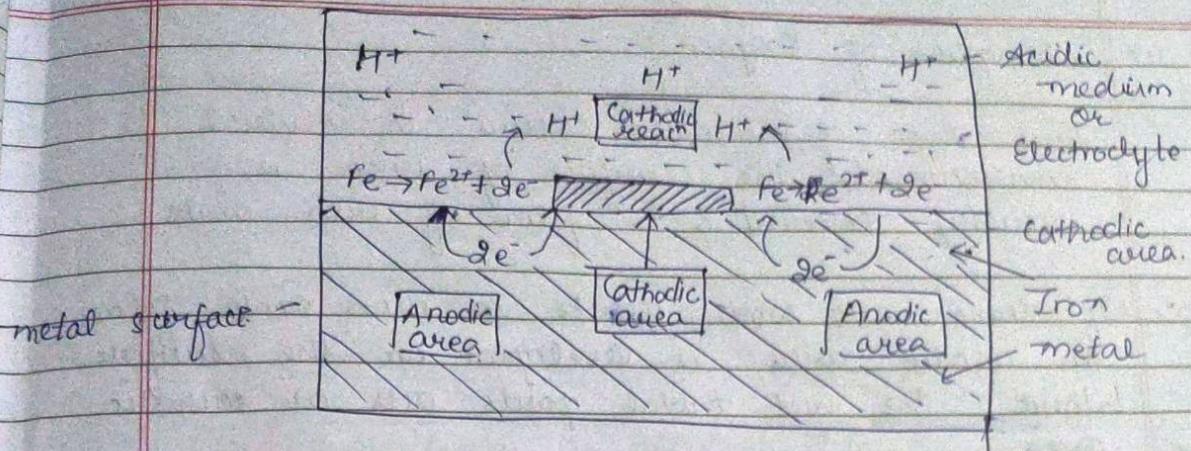
The above statements can be easily understood by fig

At anode - H dissociates (oxidation) (large size - must leav.

At Cathode → H_2 gas is released evolution.

(smaller)

Acidic medium men H^+ release hoga classmate
Page



Anodic area is large acc to cathodic area. Hydrogen in electrochemical series have a tendency to get dissolved in acidic soln due to such corrosion.

- (i) Conducting liquid is in contact with metal
- ii) Two dissimilar metals or alloys are present
→ either those are emerged or dipped partially in a soln

two area formed - cathodic area is small

Anodic area is larger.

deposit hoga waha)

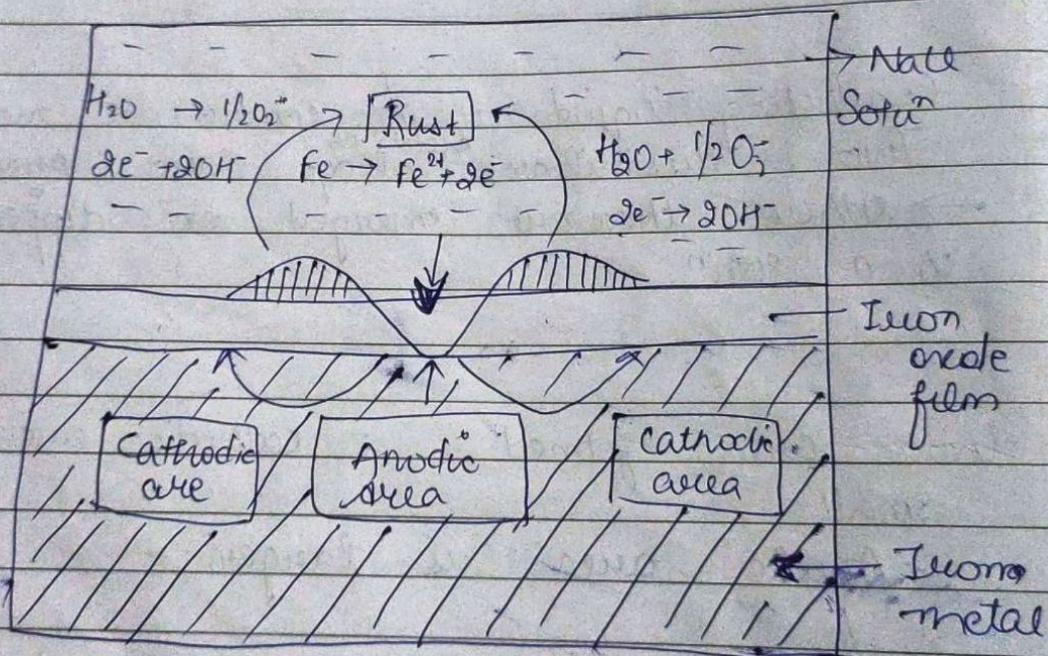
electrons are move from anode to cathode then reacts with H^+ ions
(electrons are release from anode and at consumes.)

iv) Absorption of Oxygen:

These type of corrosion occurs in neutral environment. The surface of iron is usually covered by a film of iron oxide.

If there are some cracks in iron oxide film, an anodic area is developed on the surface. Where, the wet metal parts acts as cathodic area.

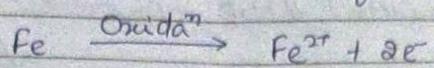
In this cathodic area is much more large in comparison to anodic area.



(Wall is neutral)

OH^- release Raiga
is neutral environment

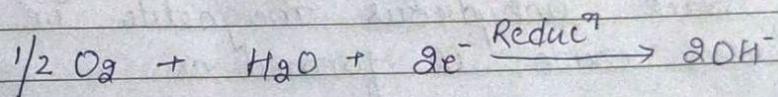
Step 1 At the anodic area, iron metal dissolves in the "liberation" of electrons as



(Mile agar Iron oxide ki film break hogi) to Iron ki reacⁿ ho jaegi)

→ [Fir kya liya jo electrons ^{bare} hai anodic area pe wo mere kiske cathode se chala jayega or cathodic pe reacⁿ ho jaegi]

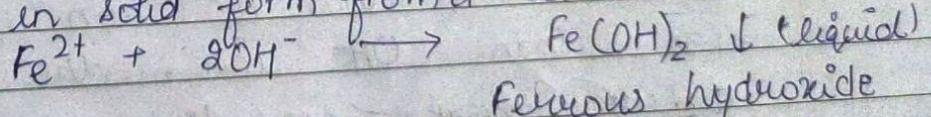
The above ~~reacⁿ~~ evolved electrons flow from cathode areas through iron metal and are taken up by the dissolved system at cathodic area



The OH⁻ ions formed at cathode as well as Fe²⁺ ions are formed at anode combine and forms ferrous hydroxide Fe(OH)_2 precipitate ↓

(cause to be

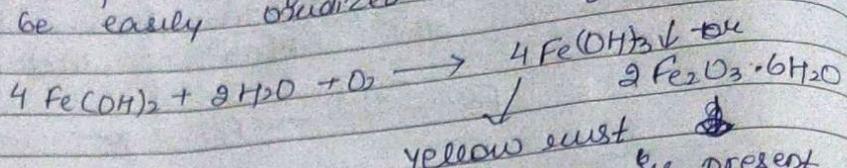
deposited in solid form from a soln.)



Ferrous hydroxide

→ [Kyuki large amount mai O₂ present ha to oxidized easily ho jaega]

In the presence of sufficient oxygen, $\text{Fe}(\text{OH})_2$ can be easily oxidized into ferric hydroxide.



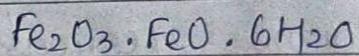
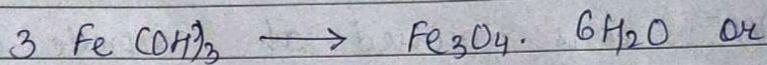
yellow rust

(" ") See present metals that are found in large amounts of standing water. This type of rust is usually formed on a saturated (stated), commonly found near sinks and bathtubs)

Actually $2\text{Fe}(\text{OH})_3$ corresponds to $\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$
(hydrated ferric oxide)

→ (dissolve O_2 Ram no to)

If the supply of oxygen is limited then black anhydrous magnetite i.e. ferric-ferric oxide is formed as



As we know that Fe^{2+} ion is smaller in size than OH^- ion, the Fe^{2+} ion will diffuse more rapidly, so corrosion occurs at anode, but rust is deposited at the cathode or near the cathode.

Difference / comparison
and Electrochemical
corrosion.

Chemical Corrosion

1. It occurs in dry conditn
2. It involves the chemical attack of O₂ or other gases.
3. It occurs at homogeneous as well as hetero " metal surfaces
4. It is uniform in nature throughout the surface of the metal.
5. It is a slow process taking place by chemical reacⁿ of atmospheric gases
6. Corrosion products accumulate at the place where corrosion occurs i.e. at the anode.
7. Its mechanism is explained on the basis of absorptⁿ.

Electrochemical Corrosion

- It occurs in wet conditn in the presence of moisture or electrolyte.

- It involves electrochemical attack of corrosive environ^m on the surface of the metal

- It occurs only on heterogeneous metal surface.

- It is not uniform. If the area of anode is small, pitting corrosion takes place.
(pitting) = make a hollow or indent^e in the surface.

- It is a fast electrochemical process. It proceeds through the cells.

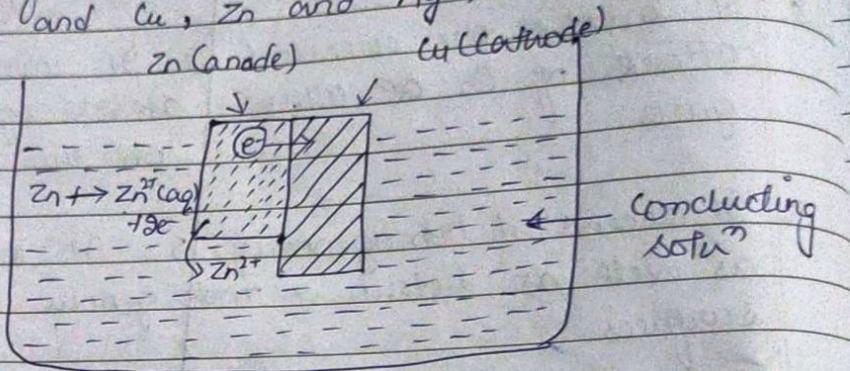
- Corrosion products accumulate somewhere b/w the area of anode and cathode.

- Its mechanism is explained on the basis of Electrochⁿ reacⁿ's.

* GALVANIC CORROSION

GALVANIC CORROSION.

When two different metals are in contact and jointly exposed to atmosphere, the metal having lower "reduc" potential i.e. higher position in the electrochemical series get corroded. This type of corrosion is called galvanic corrosion. e.g. Zn and Cu, Zn and Ag, Fe and Cu.
Zn (Anode) Cu (Cathode)



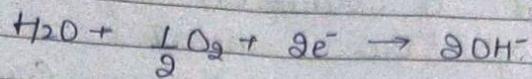
Galvanic corrosion (The less noble metal zinc acts as anode and undergoes corrosion, whereas the more noble copper remains protected)

Zinc has lower "reduc" potential than copper acts as anode (Gr) and electrons flow from anodic metal (Zn) to cathodic metal (Cu). The " " metal is corroded, while cathodic metal remains protected.

In acidic soln, the corrosion occurs by the evolutⁿ of Hydrogen as under:



In neutral or slightly alkaline medium, O₂ absorption takes place.



Some common examples of Bimetallic corrosion are :

- i) Steel screws in brass or bronze equipment.
- ii) lead - antimony solder around copper wire.
- iii) Steel - pipe connected to copper plumbing.

Hence the corrosion may be controlled by the following factors :

- i) avoiding the suitable medium for corrosion.
- ii) minimizing " potential difference of metals i.e., avoiding the galvanic couples.
- iii) By Polishing the metals.

↓
 Electrochemical Series
 mai posī jada hogi
 to corrosion hogi

* Galvanic Series:

- The extent of corrosion depends upon the position of the metal in the Electrochemical series and Galvanic Series.
- The rate and severity of corrosion depends upon the difference in their position and greater is "the faster" the corrosion of the anodic metal or alloy.
- However, some exceptions to this generalisation have been noticed. For instance, Zn c is below Al in the Electrochemical series is corroded faster than Al. Similarly Ag c is below than Ti in the series is corroded faster than Ti. These observations contrary to that predicted in G.S. on the basis that metal like Al and Ti form strongly adhering oxide layers on their surface, c result corrosion. Due to formation of oxide layer, their effective electrode potential become positive or less negative.
- Electrochemical series do not account for the corrosion behaviour of alloys metals, but Galvanic series c provides a reliable information about the corrosion of metals and alloys also.

Electrochemical Series

1. This series predicts the relative displacement tendencies of metals and non-metals in electrolyte containing particular conc. ($1M$) of salts of the same metal.
- 2) It comprises metals and non-metals.
3. The posⁿ of the metal in the series is permanently fixed.
4. The electrode potentials are measured by using (SHE) Standard Hydrogen Electrode as a reference ele. ".
5. It gives no informaⁿ regarding posⁿ of alloys.

Galvanic Series

1. This series predict the common tendencies of metals and non-metals in actual environment.

2. It comprises metals and alloys.

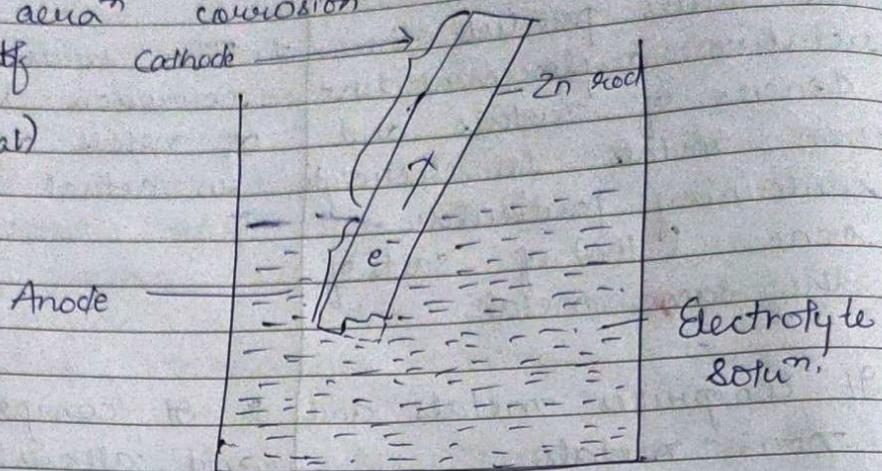
3. The posⁿ of a given metal may shift in this series. The posⁿ of a metal, when present in the form of alloy is different from that of pure metal.

4. The electrode potential are measured by using calomel electrode as a reference ele. ".

5. The corrosion behaviour of alloys can also be studied from their posⁿ in - this series.

* Concentration cell corrosion or Differential area corrosion

(introduce Hf
air into
material)



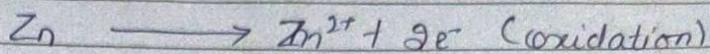
It has been observed that poorly oxygenated parts become anodic and are corroded, where more oxygenated (Ryuki electrons waha ko more kare mae mai) portion acts as cathode.

Consider a metal Zn is partially immersed in a dilute solution has less access to O₂ of NaCl and solution is not agitated — for long. The part of the metal immersed in soln has less access to oxygen and act as a anode, whereas the part above and closely adjacent to the waterline is more strongly

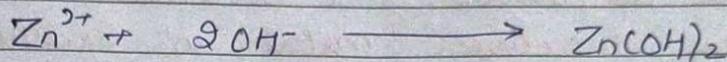
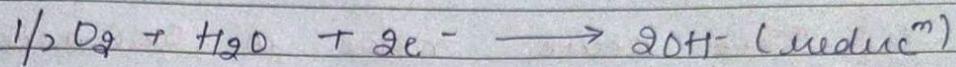
aerated and act as a cathode.

i.e.

At anode



At cathode :



[Agitaⁿ] is the movement of one or more component of a mixture to improve contact.]