

CORROSION AND ITS CONTROL

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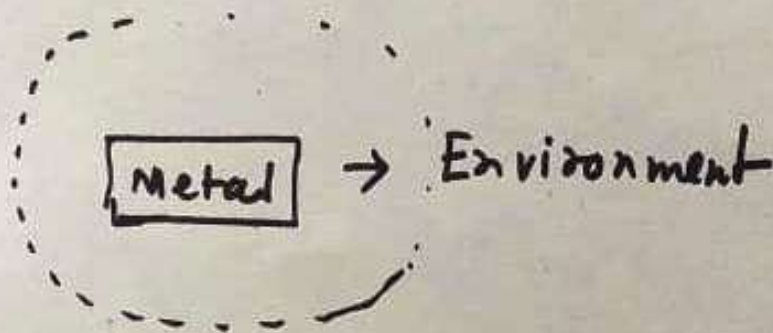
Lecture No 1

Dt: 24-April 2020

Introduction:

Def: Reaction between metal and Environment leading to deterioration of metal.

- It is unwanted & undesirable Reaction
- It can be a chemical or electro-chemical Reaction.



Example: Rusting of Iron
(Formation of hydrated ferric oxide)

Cause of Corrosion

Q: Why metals corrode?

= Metals exist in a combined state

→ Ores

- "ORE" has Low Energy and is

this thermodynamically stable state of Metal.

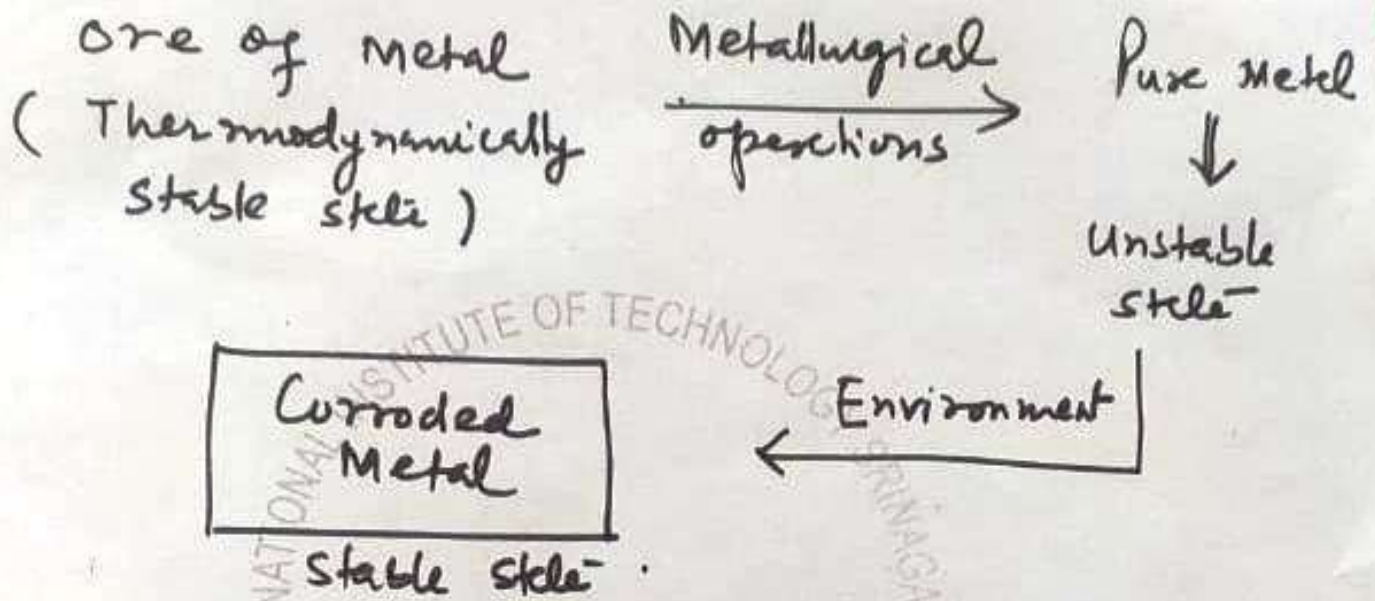
On ^{during} extraction lot of energy is consumed.

Extracted metal - in the isolated form has higher energy and therefore is

thermodynamically unstable.

Q: Any unstable state has got a tendency to go/change into a stable state. For acquiring this,

metal interacts chemically or electrochemically with their environment



Importance: of understanding Corrosion

1. Affects Economy
2. Loss of useful properties of metal.
3. Loss of Efficiency
4. Decrease in production rate
5. Replacement of corroded equipment is time consuming.
6. Increase in maintenance & production cost.
7. Contamination of product.

A significant portion of Economy is wasted. Corrosion can ^{NOT} be removed, however it ^{can be} controlled. Its rate can be slowed down by appropriate means & ways.

TYPES AND MECHANISM OF CORROSION

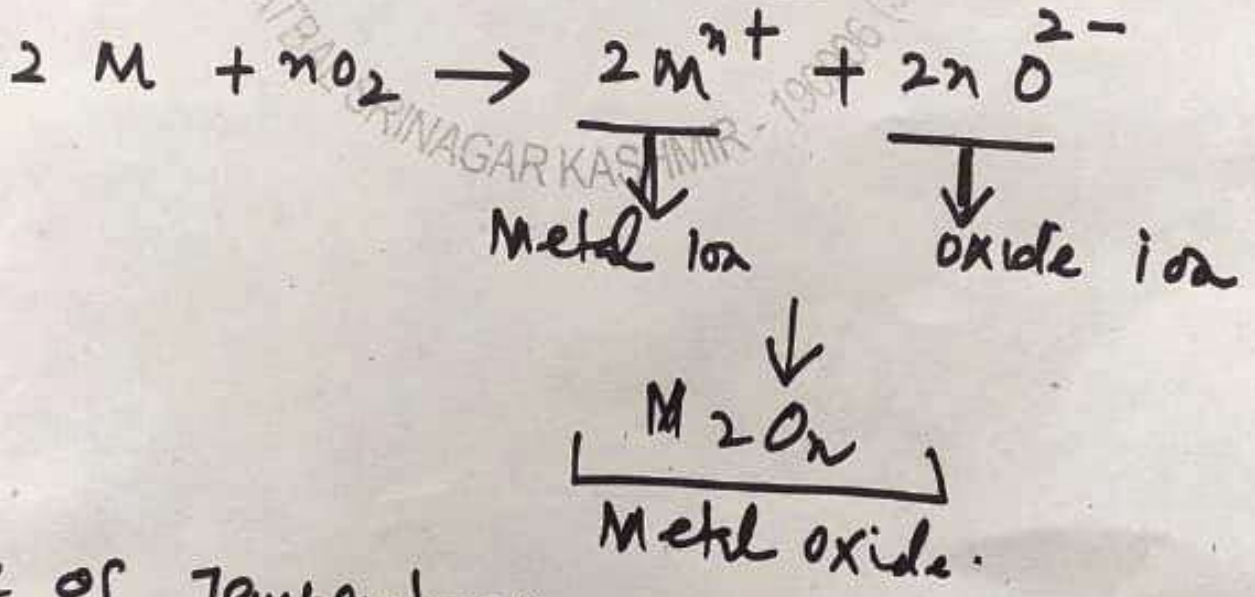
1. Chemical or DRY CORROSION
2. WET or Electrochemical Corrosion

DRY OR CHEMICAL CORROSION

- Metal reacts/ in immediate proximity of atmospheric gases
- Direct interaction of metal with Atmospheric gases.

Corrosion by O₂

Oxidation corrosion.



Role of Temperature:

Low Temp: Alkali & Alkaline Earth metals react.

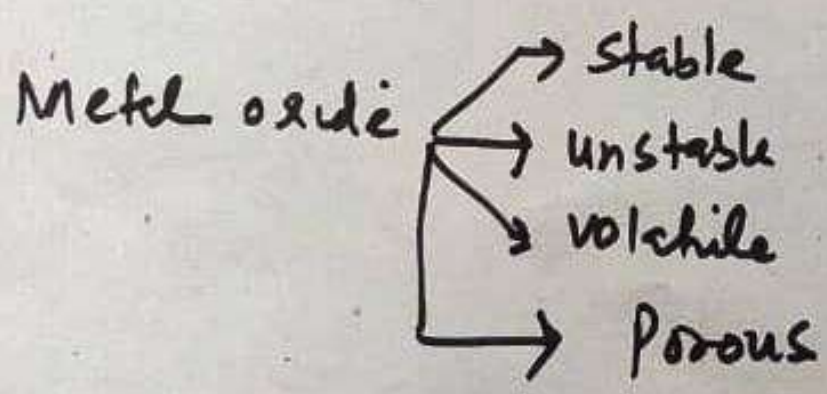
High Temp → All metal except Ag, Au and Pt.

Question: Metal interacts with Environment, forms an oxide layer ...

→ Oxide Layer formation - [Consumes Metal Surfaces [Destructive]
It can be protective or non-protective]

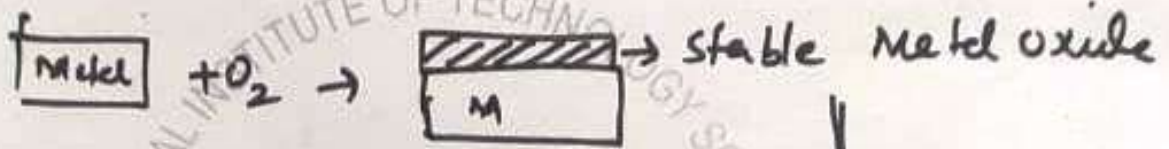
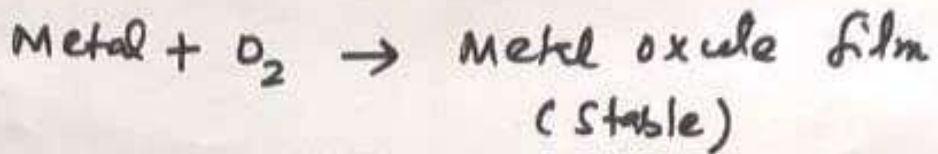
Above options can decide whether corrosion will be a faster one or a controlled one?
How?

Metal + Environment → Metal oxide



↓ Nature of this metal oxide will decide the rate of corrosion

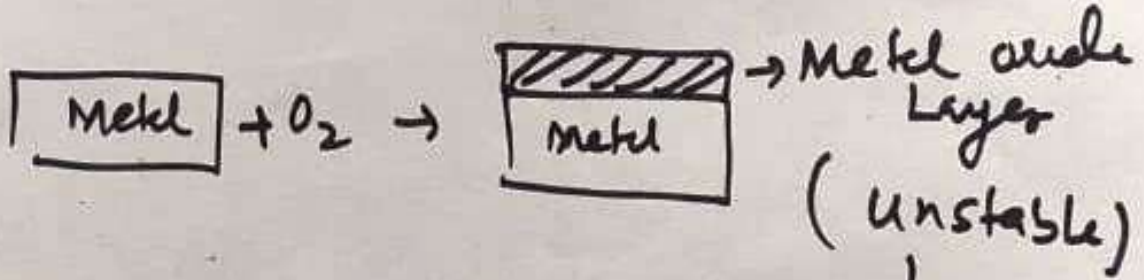
1) Stable:



↓
Can Act as a protective
Cover, therefore can prevent
further corrosion.

Corrosion is there but is
Controlled. e.g. Al & Cu.

2) Unstable

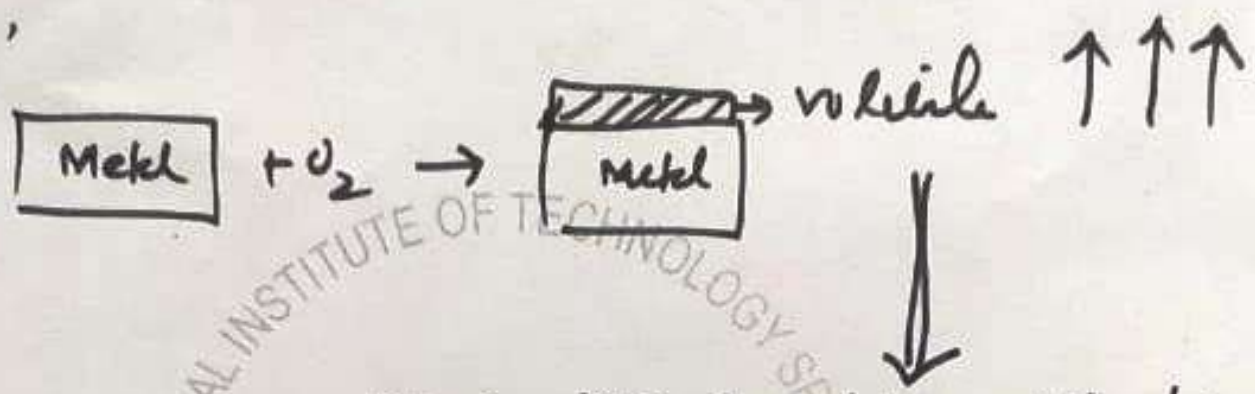


→ So there is no
corrosion in this condition
e.g. Ag, Pt. & Au

← Go back to
Metal + O₂

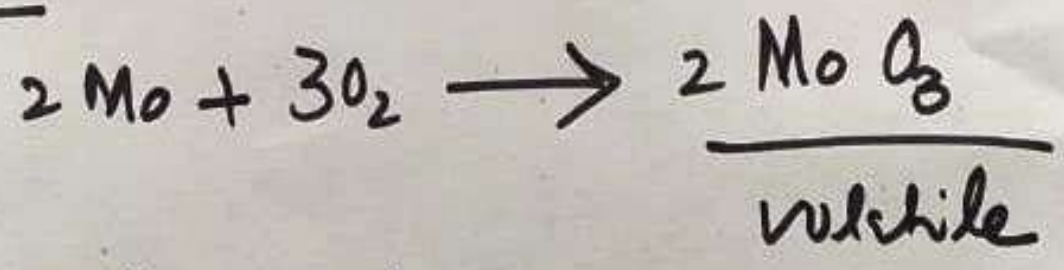
3) volatile:

If metal oxide layer is volatile.



More Metal oxide will be formed & consumed. More metal is consumed. Fresh surfaces get exposed to react with O₂. Therefore Corrosion will be FAST here.

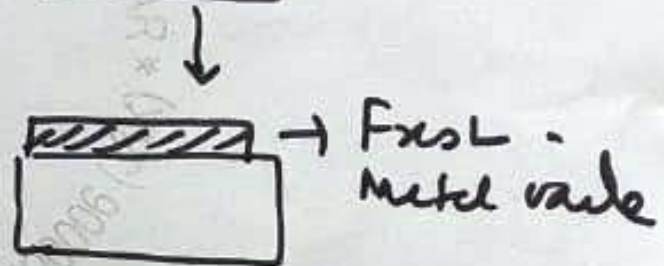
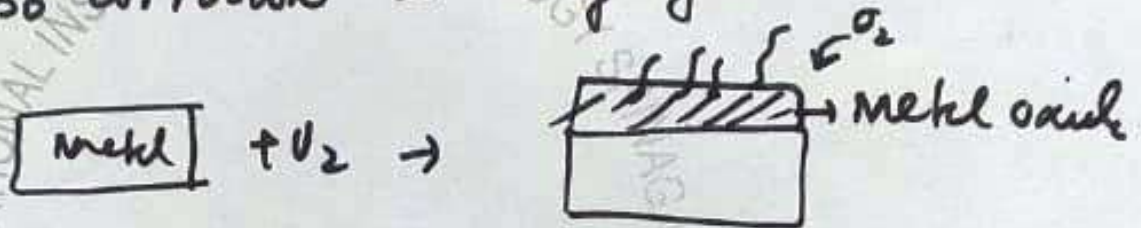
eg.



Hence Mo gets excessive corrosion.

4) porous:

If metal oxide formed undergoes cracks or pores, O_2 / medium makes its way to interact with metal. Here also corrosion is very fast.



Corrosion is deep, & localised, hence can be fast in this case

Pilling - Bedworth Rule :-

⇒ This rule decides the fate of further corrosion rate.

Smaller the Specific Volume Ratio
($\frac{\text{Volume of Metal oxide}}{\text{Volume of Metal}}$),

greater is oxidation corrosion.

Here oxide film → (Porous), will allow diffusion of oxygen & can lead to further corrosion

Specific Volume Ratio (SVR)

of W, Cr & Ni
↓ ↓ ↓
3.6 2.0 1.6 (→ More Corrosion).

↑
Less corrosion even at Higher Temp.

P II

So we have following cases:

Case 1. volume of oxide \geq volume of
the parent metal \Rightarrow Non-porous
Metal oxide
(Controlled Corrosion)

Case 2. volume of oxide $<$ volume of
Parent metal

Oxide layer faces stress and
strain & hence cracks & pores
develop in its structure. This
can lead to fast corrosion.

Al & Cu follow Case 1 \rightarrow
Controlled corrosion

Li, Na, K & Mg follow Case 2 -
Increased Corrosion \Rightarrow
faster Corrosion