ENGINEERING CHEMISTRY

Department of Science and Humanities

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Corrosion Chemistry

Class content:

- ***Types of electrochemical corrosion***
  - ***Waterline corrosion***
  - ***Pitting corrosion***
  - ***Stress corrosion***

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Waterline corrosion:

- A special case of **differential aeration corrosion**

- Observed when metal is **half immersed in water**

- The part **immersed in water** is exposed to less O_2, hence acts as anode and **gets corroded** while the **part not in water** is exposed to more O_2 and acts as cathode; **remains unaffected** by corrosion

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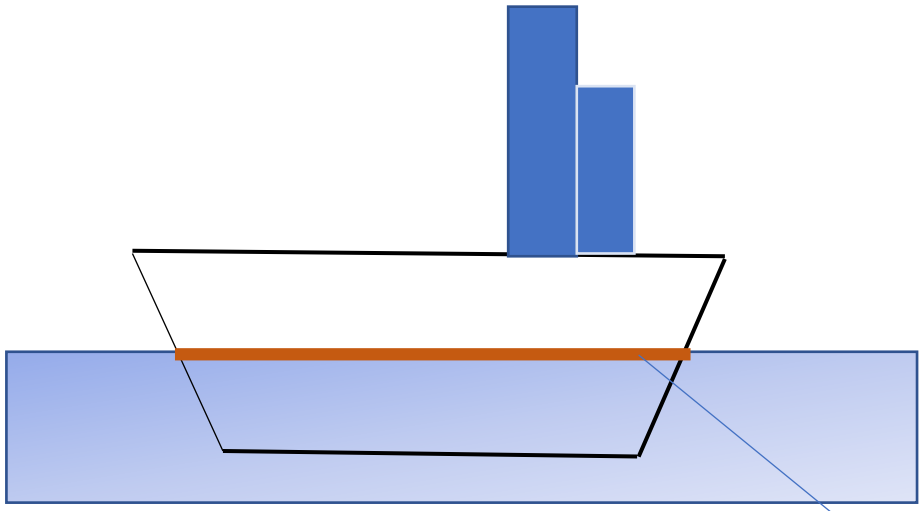
Examples:

•Ship sailing in the sea or docked in the yard for a long time



Brown line
(corrosion product)

A **distinct brown line** is formed just below the water line due to the deposition of rust

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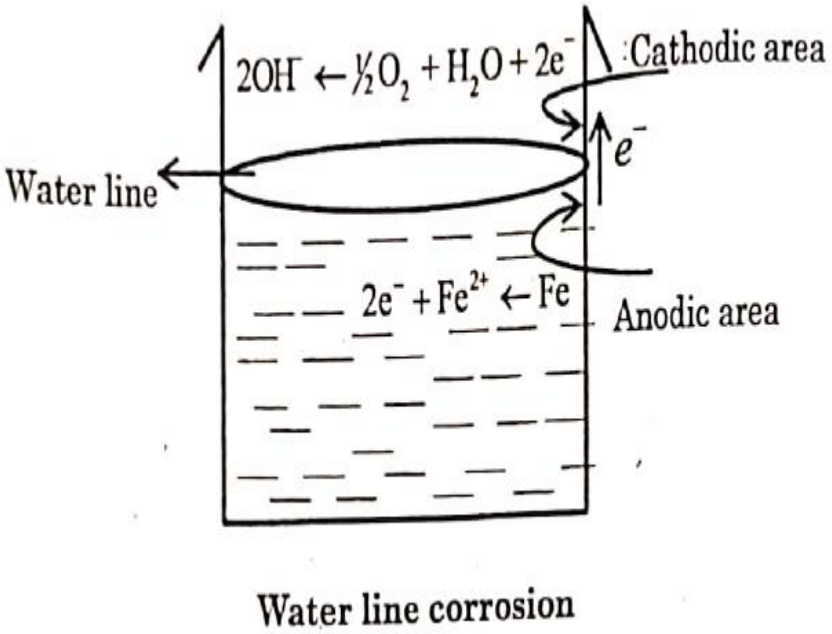
- A steel tank is partially filled with water for a long time



Water line corrosion

Source: Basuchandra's Engineering chemistry, Banbayalu (2014)

- The portion below the water line acts as anode and undergoes corrosion. The upper portion acts as cathode and remains unaffected

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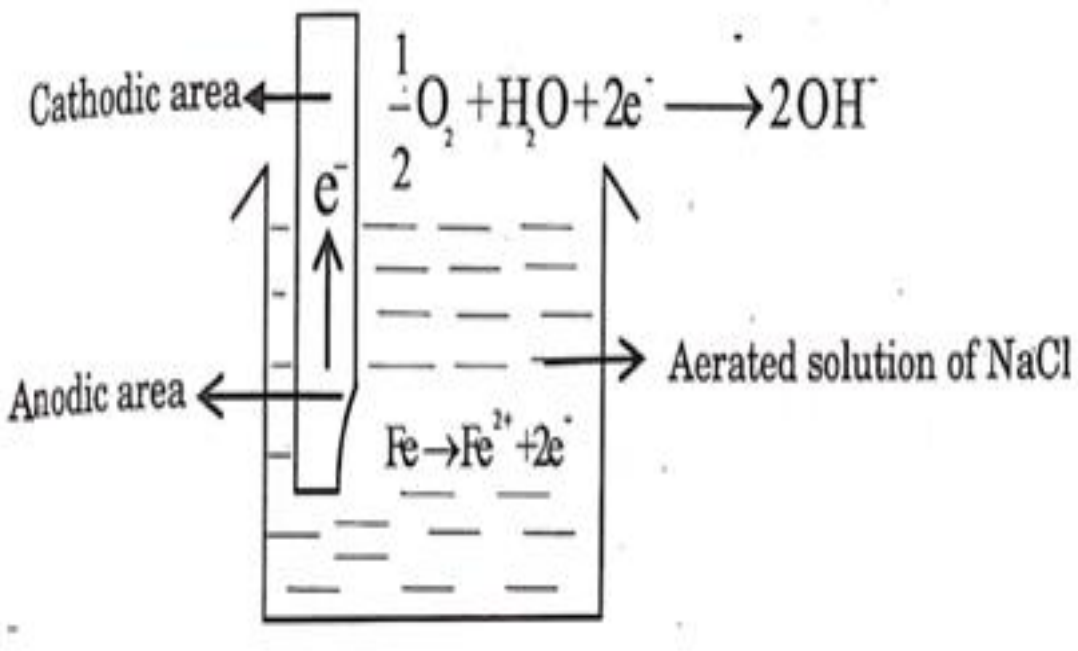
- Iron rod partially dipped in NaCl solution



Source: Basuchandra's Engineering chemistry, Banbayalu (2014)

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Pitting Corrosion:

- A **localized and accelerated corrosion**
- Results in formation of **pits or pin holes**, around which the metal is relatively unattacked
- One of the most **destructive** forms of corrosion
- Characterized by **small anodic area and large cathodic area** resulting in accelerated corrosion at the anodic area

https://www.nuflowmidwest.com/2-types-of-corrosion-that-occur-in-industrial-piping-systems/

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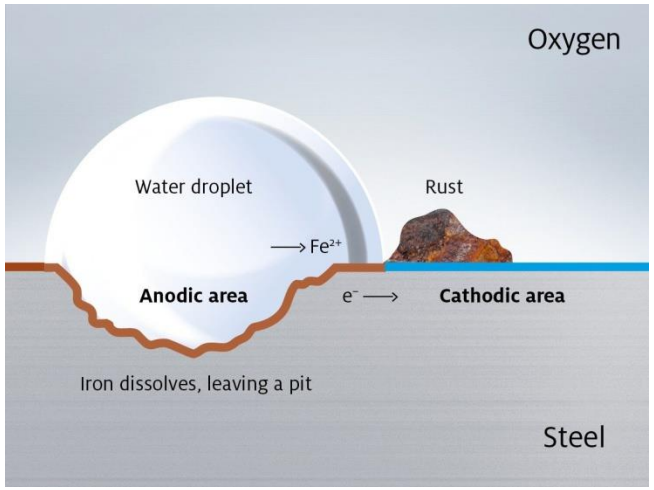
- **Case 1**

- When **dust particles or oil drops** get deposited over the metal surface
- The portion of the metal covered by dust which is less aerated becomes anodic
- The adjacent area of the metal which is exposed to higher concentration of O_2 becomes cathodic



https://www.bonderite.com/en/technologies/pretreatment/corrosion-protection.html

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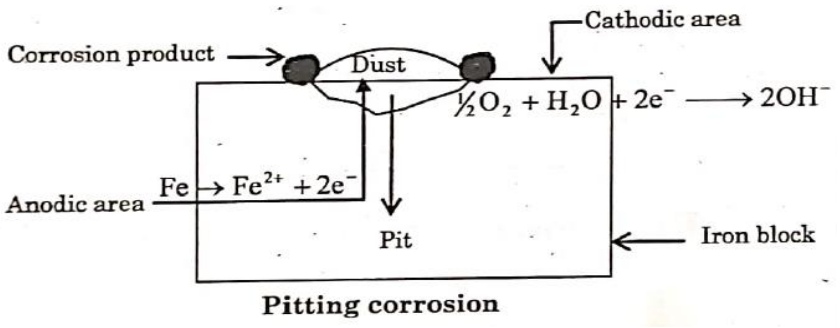
Module 6- Corrosion Chemistry

- A **small anodic region surrounded by a large cathodic region** is formed
- The **demand for electrons** is high from the cathode
- Metal underneath the surface of dust particle being anode undergoes accelerated corrosion forming a **deep and narrow pit**

•Reactions:

At anode: $M \rightarrow M^{n+} + ne^-$

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



Source: Basuchandra's Engineering chemistry, Banbayalu (2014)

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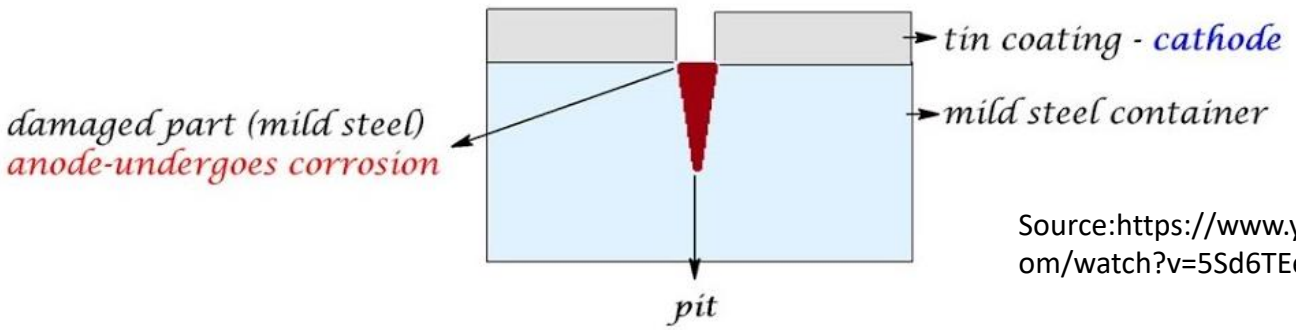
- **Case II**

•The **break down of the protective film** on a metal surface

• Peeling off of a small **tin coating on iron** gives rise to a small anodic area (Fe) and large cathodic area (Sn)



Source:https://www.youtube.com/watch?v=5Sd6TEenwEE

Reactions:

At anode: $Fe \rightarrow Fe^{2+} + 2e^-$

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

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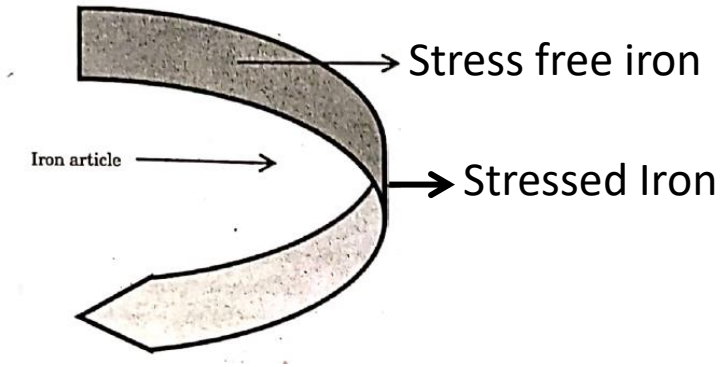
Stress Corrosion:

- Also called **Stress Corrosion Cracking**(SCC)
- A type of corrosion that occurs when some part of the metallic material is **under stress** and exposed to **specific corrosive environment**
- During the manufacture or fabrication of the articles, when the metals are subjected to **mechanical operations** such as pressing, hammering, rolling, bending, quenching, welding and riveting
- The stress can be **external stress** acting on the metal during service conditions **or residual stress or both**



Source: Basuchandra's Engineering chemistry, Banbayalu (2014)

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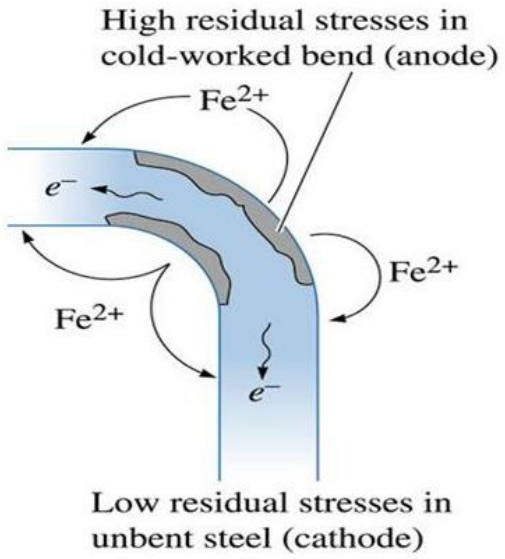
•Due to stress a **crack is initiated**

•The metal atoms under stress are always at **higher energy levels** therefore becomes **more reactive** than the stress free part

•As a result, a corrosion cell is formed with the **stressed part acting as anode** and the **stress free part acting as cathode**



Source:https://slideplayer.com/slide/8594552/

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- **Conditions for stress corrosion:**
  - **Tensile stress**
  - **Specific corrosive environment**

- Under **specific corrosive environment** the stressed part undergoes corrosion
- The crack deepens and results in the breakdown of the structure

- **Specific corrosive environment :**
  - **Brass** - ammonical solution or ammonia vapours
  - **Steel** – NaOH and chloride ions

- **Causes serious damage** – air crashes, bridge collapses, boiler explosions

THANK YOU

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