Corrosion & Protection Methods – Cheat Sheet (Theory Only)

---

1. Introduction to Corrosion

Corrosion is the **deterioration of metals** due to chemical or electrochemical reactions with the environment.
Leads to **structural damage, economic loss, and reduced efficiency** in industrial applications.
Common in **marine structures, pipelines, bridges, and vehicles**.

---

2. Factors Affecting Corrosion

1. Environmental Factors

Moisture & Humidity → Increases corrosion rate.
Temperature → Higher temperatures accelerate corrosion.
Oxygen Concentration → More oxygen leads to faster corrosion.

2. Metal Properties

Electrode Potential → More reactive metals corrode faster.
Surface Roughness → Rough surfaces trap moisture and promote corrosion.

3. Chemical Factors

pH of the Environment → Acidic conditions increase corrosion.
Presence of Salts & Pollutants → Enhances electrical conductivity and speeds up corrosion.

---

3. Types of Corrosion

1. Chemical Corrosion

Occurs due to **direct reaction between metal and environment** (e.g., dry oxidation).
Examples:

- Rust formation on iron.
- High-temperature corrosion in gas turbines.

2. Electrochemical Corrosion

Involves **electron transfer through an electrolyte**.
Types:

(a) Galvanic Corrosion

Occurs when **two dissimilar metals** are in electrical contact in an electrolyte.
The more **active metal (anode) corrodes faster**, while the less reactive metal (cathode) is protected.
Example: **Iron & Copper pipes in water systems**.

(b) Differential Aeration Corrosion

Occurs when **different areas of the same metal are exposed to varying oxygen concentrations**.
Example: **Corrosion in water tanks at the water-air interface**.

---

4. Corrosion Control Methods

1. Material Selection & Design Aspects

Use corrosion-resistant materials (e.g., stainless steel, aluminum).
Design for drainage → Avoid water accumulation.
Use uniform alloys to prevent galvanic corrosion.

---

2. Electrochemical Protection Methods

(a) Sacrificial Anode Method

A more **reactive metal (e.g., Zinc, Magnesium)** is attached to the metal that needs protection.
The **sacrificial metal corrodes instead**, protecting the main structure.
Used in **ships, underground pipelines, and offshore platforms**.

(b) Impressed Current Cathodic Protection (ICCP)

An **external power source** applies a small direct current to counteract corrosion.
Used in **large structures like bridges, pipelines, and storage tanks**.

---

3. Use of Corrosion Inhibitors

Chemicals that slow down corrosion by forming a protective layer.
Types:

- **Anodic Inhibitors** → Form oxide films (e.g., Chromates).
- **Cathodic Inhibitors** → Reduce hydrogen evolution (e.g., Organic amines).

Used in **cooling systems, boilers, and oil pipelines**.

---

5. Metallic Coatings for Corrosion Protection

1. Anodic Coating

Uses a **more reactive metal** (e.g., Zinc on Iron → Galvanizing).
Protects the underlying metal **even if the coating is damaged**.
Used in **roofs, bridges, and car bodies**.

2. Cathodic Coating

Uses a **less reactive metal** (e.g., Tin on Iron → Tin plating).
Does not protect if scratched.
Used in **food containers and electrical components**.

---

6. Advanced Coating Methods

1. Metal Cladding

A **thin layer of corrosion-resistant metal is bonded** to a base metal.
Example: **Stainless steel-clad cookware**.

2. Electroplating of Copper

Uses **electric current to deposit a thin layer of Copper** onto a metal surface.
Steps:

- **Metal object (Cathode) is placed in a Copper sulfate bath.**
- **Anode (Copper plate) dissolves and deposits Copper onto the cathode.**

Applications: **Electrical wiring, decorative coatings, corrosion protection**.

3. Electroless Plating of Nickel

A **chemical process (without electricity)** deposits a uniform Nickel layer.
Steps:

- **A reducing agent (e.g., Sodium Hypophosphite) triggers metal deposition.**

Advantages:

- Uniform coating on **complex shapes**.
- High **wear resistance**.

Used in **electronics, aerospace, and medical devices**.

Applications of Corrosion Control

Construction → Preventing rust in bridges and buildings.
Automobiles → Protective coatings on car bodies.
Oil & Gas Industry → Corrosion-resistant pipelines.
Marine Industry → Protecting ships from saltwater corrosion.

This **Corrosion & Protection Methods Cheat Sheet** covers **types of corrosion, electrochemical protection, inhibitors, metallic coatings, electroplating, and electroless plating**. Let me know if you need further explanations!