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# The Methods for Prevention of Corrosion

**Semra BILGIC**
Ankara University

**Abstract:** Corrosion can be defined the deterioration of a metal by chemical and electrochemical reaction. Corrosion is unwanted phenomenon because of significant and dangerous factor for production and investment in many industries. There are several methods to prevent and/or reduce corrosion such as metallic coating, non-metallic coating, cathodic protection and adding chemical compounds called inhibitors. In metallic coating, a metal is coated with another metal which is active or inert than desired metal to be protected. In non-metallic coating, a metal is coated by painting or many polymeric materials. Cathodic protection is another method to prevent or reduce corrosion. This method is used to control the corrosion of a metal by making it the cathode of the electrochemical cell. This method is used in non-air environment. Especially buried underground pipelines. The use of corrosion inhibitors is considered one of the most effective method for the protection of many metals and alloys against corrosion. Inhibitors prevent corrosion either by being adsorbed on the surface of metals and alloys or by forming a protective layer or by causing the formation of unsoluble complex.

**Keywords:** Corrosion, Metals, Methods, Prevention

## Metallic Coating

A metallic coating should have some properties such as the protective layer must hold on the metal that is to be protected, should not be porous, should show a certain mechanical strength, and should be more resistant than that of basic metal against corrosion.

If protective metal is more noble metal and the basic metal, e.g. tin on iron (anodic coating), the effect of protective layer depends on the lack of porosity. The covering layer is broken for some reason, that is, if the original metal remains naked and there is an electrolyte, a local battery is formed there.

The negative pole of this battery becomes metal and will have a more severe corrosion than if there is no protective layer on it. Therefore, metals such as Cr, Ni should be used as the protective layer, which have high hardness and become easily passive. In this case, the overlying protective layer is less likely to corrode.

## Non–Metallic Coating

One of the most commonly used methods to protect the surface of a metal against corrosion is to form a layer that adheres to the metal surface and protects the metal from corrosion. Some metals are coated with an oxide layer in the air. This oxide layer is thickened by anodic or cathodic oxidation in a suitable electrolyte to protect the metal from corrosion. This process is particularly suitable for aluminum and its alloys. However, the layer formed on the metal surface with anodic or cathodic oxidation in a suitable electrolyte to protect the metal from corrosion. This process is particularly suitable for aluminum and its alloys. However, the layer formed on the metal surface with anodic or chemical effects is usually porous.

Thus, the liquid passes through these holes, so that a local battery can form and corrode the underlying metal.
To prevent this, the metal surface is painted with various materials. However, in order for the dye to be successful, it is necessary to remove any loose oxide, oil and impurities on the metal surface.

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## Cathodic Protection

For the application of cathodic protection to metals and alloys; alloys must be immersed in an aqueous solution or should be wrapped with wet substances. Cathodic protection is a method of reducing corrosion rate with enough negative corrosion potentials for only those artifacts buried or immersed in a liquid medium.

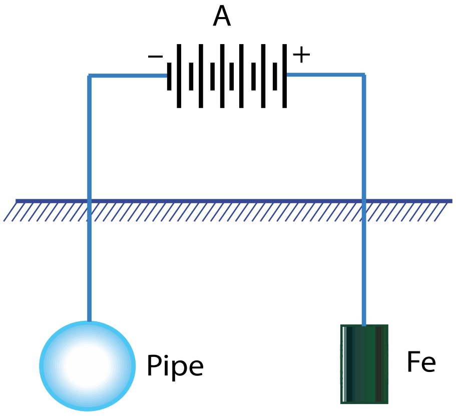


Fig 1. Cathodic protection with applied external source.

As shown in the figure 1., an anode is placed immediately close to the metal structure to be protected and a protective current is supplied to the metal surface. In the latter case, the metal to be protected is matched with a more active metal. The active metal is named as the sacrificial anode. That is, the metal that is to be protected is a cathode, the anode metal is sacrificed to protect this metal.

Zinc, magnesium and some special Al–Zn alloys can be used as anode metal. This method of protection is given as follows. Non–corrosive metal or alloy are chosen as anode such as graphite.  Usually, the anode is placed in the anode bed which provides electrical conductivity with its surrounding earth. The following figure shows this installment.

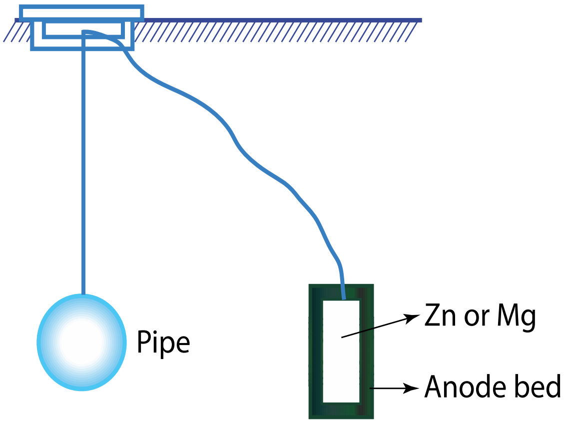


Fig 2. Cathodic protection of buried pipe helping anode bed.

Here, the current required for the cathodic protection is provided by a metal, which is placed in a suitable anode bed and which reacts at low potential or is called a sacrificial anode. This sacrificial anode metal may be zinc, magnesium or special aluminum-zinc alloy.

## Principles of Cathodic Protection

The main factors in the reduction of corrosion with cathodic protection are as follows:

i) The potential of the metal is reduced so that the reaction takes place on every side of the metal and $M - Mn^+$ reaction is prevented.
ii) By the reduction of oxygen or hydrogen ions, the near–surface electrolyte becomes more basic. The increase of pH causes the decrease of corrosion for iron metals.
iii) The increase of pH results in the precipitation of insoluble salts such as $CaCO_3$, $Mg(OH)_2$. These insoluble salts cause the formation of protective layer on metal surface.

## Inhibitors

Use of inhibitors is another method for prevention of corrosion. The use of corrosion inhibitors can be considered as the most effective method of the protection of many metals and alloys against corrosion. Inhibitors are added in several systems such as cooling systems, chemical processes, vapour generators, petroleum pipe lines. Inhibitors prevent corrosion either by being adsorbed on the surface of metals and alloys, or by forming a protective layer or by causing the formation of insoluble complex.
Inhibitors are classified as
a) Anodic inhibitors
b) Cathodic inhibitors
c) Mixed inhibitors

a) Anodic inhibitors are chemical substances that form a protective layer of oxide film on the surface of metal causing resistance to corrosion. These inhibitors are generally anions. As the concentration of these inhibitors increases, inhibitors react with the strong anodes, forming a passive layer. Therefore, this inhibitors are also known as passivators can be given as examples for anodic inhibitors.

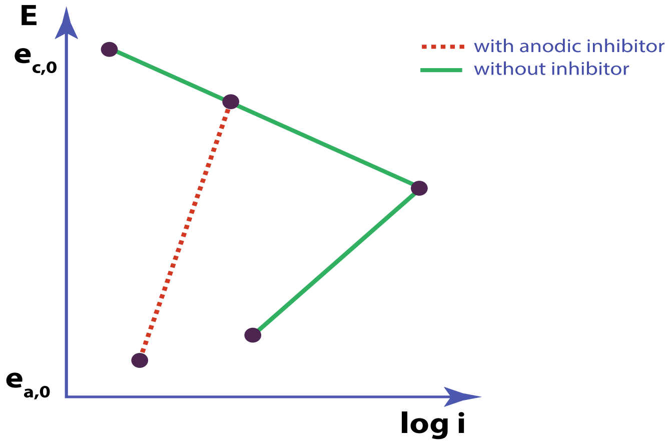


Fig 3. Anodic inhibitors: chromate ($CrO_4^-$), molybdate ($MoO_4^-$), benzoate ($C_7H_5O_2^-$), silicate ($SiO_4^{4-}$)

b) Cathodic inhibitors show the reaction at the cathode. Generally cathodic inhibitors are cations. Cathodic inhibitors affect the cathodic reaction rate. These inhibitors affect the reduction of hydrogen in acidic media or the reduction of oxygen in neutral and/or alkali media.

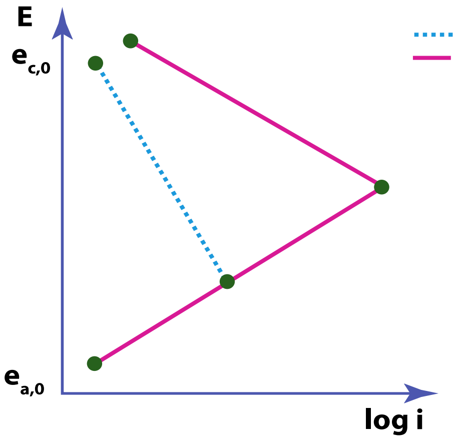


Figure 4. Cathodic inhibitors: calcium bicarbonate ($Ca(HO_3)_2$), Antimon ($Sb^{3+}$), (on iron)

c) Mixed inhibitors reduce the corrosion rates both anodic and cathodic reactions.

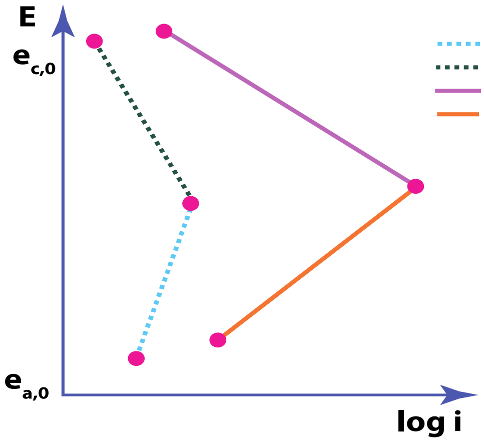


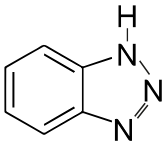
Figure 5. Mixed inhibitors are organic compounds (contain nitrogen and sulphur)

The inhibitor efficiency could be calculated by the following equation

$$\eta\% = \frac{i_0 - i_1}{i_0} \times 100$$

$\eta$: inhibitor efficiency
$i_0$: corrosion rate of metal without inhibitor
$i_1$: corrosion rate of metal with inhibitor

In another classification is as follow:
i) Inorganic inhibitors
ii) Organic inhibitors
i) Inorganic inhibitors contain inorganic ions such as $NO_2^-$, $CrO_4^-$
ii) Organic inhibitors contain oxygen nitrogen sulphur and heterocyclic compounds.



Benzotriazole

These inhibitors are adsorbed on the metal surface blocking the active corrosion sites.

Some examples are amines, aldehydes, heterocyclic nitrogen compounds, sulphur–containing compounds.

The efficiency of organic inhibitors depend on

- the chemical structure, like the size of organic molecule
- aromacity and conjugated bonding as the carbon chain length
- type and number of bonding atoms or groups in the molecule (p or s bonds)
- type of electrolyte solution like adequate solubility in the environment.

However it is important to choice of inhibitor, ascertain the subsequent effects of this towards the environment.

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## Author Information

**Semra Bilgic**
Ankara University Science of Faculty Ankara University,
Department of Physical Chemistry
Beşevler - Ankara 06100, TURKEY
Contact e-mail: *bilgic@science.ankara.edu.tr*