Corrosion Characteristics and Passive Behavioral Responses

O.D. Ogunleyea*, O.A. Odulanmi, and O.S.I. Fayomi

Chemical Engineering Department, Covenant University, Ota, Ogun State, Nigeria
Mechanical Engineering Department, Covenant University, Ota, Ogun State, Nigeria
Chemical, Metallurgical and Materials Engineering Department, Tshwane University of Technology, Pretoria, South Africa
deamayowa@yahoo.com.

Abstract
The problem of corrosion is just about as old as the history of metals. As long as metals have been refined, they have corroded. Metals are an essential part of our lives in human civilization but with their use come the problem of corrosion. It tarnishes the appearance of the metals and it greatly shortens their life span resulting in heavy costs for replacement. Corrosion has been a problem to be tackled for many centuries. Therefore, it may come as a surprise that significant breakthroughs in its reduction and control have only occurred in the past six decades. This study explore past assertion on corrosion with its refining cycle, the category of influence, and the mitigation mechanism.

1. Introduction

The word corrosion is coined from the Latin word “corrosus” which is translated as “gnawed away” in English. This ubiquitous phenomenon can be found in every environment known to man. A few definitions of corrosion are given below. Corrosion is the degradation of metals that occurs spontaneously as a result of the various types of interactions (electrochemical, biochemical, chemical) that metals undergo with their surroundings. [1]. Corrosion is the process by which materials deteriorate because of reactions with their environments [2]. Corrosion can be viewed as extractive metallurgy but in the reverse order. Consider iron for example. Carbon is heated with hematite to make it. When it corrodes, it turns to rust which is of the same composition as hematite [3]. The process is illustrated in figure 1.

![Figure 1 Refining Corrosion Cycle](image-url)
Every metal has a corrosion behaviour that is specific to it. It can range from having very high resistance to corrosion as seen in noble metals such as platinum or gold to being very susceptible to corrosion as seen in active metals such as magnesium or sodium. It is also important to note that some environments can be more corrosive to specific metals than others. Knowledge of the corrosion properties of each metal in different environments is of utmost importance in the selection of materials to be used in constructing anything. The relationship that exists between the rate at which a metal corrodes, environmental corrosivity and the resistance to corrosion of a metal is represented below:

\[
\frac{\text{Resistance of a metal to corrosion}}{\text{Environmental corrosivity}} = \text{Rate of metal corrosion}
\]

In many cases, there will be several metals that are capable of meeting the corrosion resistance requirements. The purpose of material selection will then be to select the most economical out of the options to combat corrosion and reduce cost [3-5]. This study aimed to provides a direct knowledge and clear understanding on the form, effect of corrosion in relation to the inhibitory mechanism to consider when mitigating corrosion processes.

2. CORROSION FORMS

2.1 FORMS OF GENERAL CORROSION

2.1.1 Atmospheric Corrosion:
This is the corrosive attack on metals by the pollutant components of air. It is a common occurrence in ferrous metals on which no inhibitors or protective coats have been applied. In this case, a uniform rust layer is formed over the entire surface that has been exposed to air. [4].

2.1.2 Galvanic Corrosion:
This is the type of corrosion that occurs between two dissimilar metals that are in electrical contact with one another in the presence of an electrolyte. It is referred to as a galvanic couple. One of the metals, the anode, is corroded preferentially while corrosion in the other metal, the cathode is slowed. When the same metals are put separately into the same kind of electrolyte, they corrode at their own specific rates. It is an electrochemical process and the potential difference between the two metals is the force that drives this type of corrosion. Galvanic corrosion can also be referred to as bimetallic corrosion. It is of great concern to the marine industry as well as industries which have pipes or metals in contact with salt water. Environmental variables such as temperature, salinity and humidity as well as the size of the anode in relation to the cathode and the specific types of dissimilar metals are all factors that affect galvanic corrosion [5].

2.1.3 High Temperature Corrosion:
This is the corrosive attack by molten salt and metals, solids and gases that generally occurs at temperatures above 400°C. This type of corrosion is found in places dealing with very high temperatures such as furnaces, gas turbines and diesel engines as well as other machinery that interact with hot gas containing some corrosive contaminants. Some forms of high temperature corrosion include oxidation, carburization, sulphidation, deposit corrosion and flue gas corrosion. It is possible to take advantage of some of the products of high temperature corrosion. For instance, oxides formed on stainless steels can act as a protective barrier that prevents further atmospheric attack. This is advantageous because the material can then be used for much longer in high as well as room temperatures. These kinds of products of high temperature corrosion can help reduce the warring away of materials when they slide over each other at high temperatures. [6].
2.2 FORMS OF LOCALIZED CORROSION

2.2.1 Crevice Corrosion:
Crevice corrosion refers to the type of corrosion that occurs in discrete places where two metal parts are joined together, unintentionally forming a crevice. When the crevice is of a favourable size, a difference in oxygen concentration between the outer part (which has more oxygen) and the inner part (which has less oxygen) results in the formation of a cathode and anode respectively at each site. The corrosion occurs at the anode, the inner part of the crevice consequently increasing the size of the crevice. This type of corrosion is particularly insidious because it usually occurs at sites that are hidden from sight and can remain undetected till it causes total failure or breakdown of the machine component. It is a recurring problem in situations where materials are in some form of mechanical connection. Examples of sites where this type of corrosion occur easily are crevices made by welds that are incompletely fused, gasketed joints, O-rings and riveted seams. Crevice corrosion can be affected by the geometrical features of the surface for example, how rough it is; the conditions of the environment such the oxygen concentration or the pH; the composition of the alloy and finally, whether the two materials joined are of the same metal or not [7].

2.2.2 Filiform Corrosion:
Filiform corrosion is the type of corrosion that appears under thin organic films that are used to coat metals. The films are usually about 0.1mm thick. This form of corrosion appears as worm like threads or filaments coming from one or multiple sources scattered in many different directions. It can also be referred to as underfilm corrosion or filamentary corrosion. The worm like threads are actually lines of the products formed from the corrosion of the metals underneath the coating. The force that drives filiform corrosion is a differential oxygen concentration between the anode which is the head growing under the paint and the cathode which is at the tail end. Filiform corrosion usually follows the marks left behind by the grinding or polishing of the metal and it is unaffected by the metallurgy of the material. This type of corrosion can be found where organic coatings are used on beverage cans, gaskets, flanges and even aircraft structures [8].

2.2.3 Pitting Corrosion:
Pitting corrosion is the type of corrosion that appears as holes or cavities in the metal. It is a very localized form of corrosion because it does not spread across a large area but is confined to specific often hidden spots. It is regarded as more dangerous than uniform corrosion because its detection or prediction are quite difficult. As such, it is also very difficult to design against it. It’s driving force is usually when a small area of the material stops being passive, thus creating a suitable anode. The surrounding area then becomes a cathode resulting in a much localized form of galvanic corrosion. It is a very menacing type of corrosion because a small occurrence of pitting that has not resulted in great metal loss can still result in the total failure of an entire engineering system. Important to the discussion of pitting corrosion is the pitting potential. It refers to the potential beyond which it is suitable for pitting corrosion to begin. Knowledge of the pitting potential is useful in predicting the tendency of a material to undergo pitting corrosion [8].

2.2.4 Localized Biological Corrosion:
Localized biological corrosion which can also be referred to as microbiologically induced corrosion is the type of corrosion brought about by the metabolic activities of some microorganisms. They are usually chemoautotrophs These microorganisms are able to alter the chemical environment on the surface of a metal. As a result of this, the electrochemical
processes taking place on the metal are affected, giving rise to a change in the rate of corrosion on the metal. The activities of the microorganisms are capable of affecting both the type and rates of electrochemical processes occurring on the metal resulting in a large variety of outcomes. It can give rise to very severe localized corrosion and it can also cause a significant reduction in the rate at which the metal corrodes. It can result in crevice corrosion, pitting corrosion, selective dealloying, acceleration of the erosion rate and enhancement of galvanic corrosion. Some microorganisms can carry out their activities in the absence of oxygen (Anaerobic) giving rise to products like hydrogen sulfide resulting in sulfide stress cracking. They can also carry out their activities in the presence of oxygen (Aerobic), directly oxidizing iron into oxides and hydroxides. Microorganism is ever present in fluid systems so as a result, this kind of corrosion is common in marine environments [9].

2.3 FORMS OF METALLURGICALLY INFLUENCED CORROSION

2.3.1 Intergranular Corrosion:
Intergranular corrosion is the type of corrosion characterized by corrosion of the grain boundaries or areas that are close to the grain boundaries with little or next to no corrosion occurring on the grains. It is usually the result of precipitation or impurities present at grain resistance is depleted. These factors cause the grain boundary to be anodic to the remainder of the surface resulting in an increased corrosion rate of just the grain boundary and nearby areas. The occurrence of intergranular corrosion is greatly influenced by the properties and microstructure of the metal. This type of corrosion moves along the grain boundary in a narrow path. In severe cases of this type of corrosion, the total breakdown of the grain boundary can lead to entire grains of metal being dislodged causing failure of machine systems [10].

2.3.2 Dealloying Corrosion:
Dealloying corrosion refers to the type of corrosion in which one component of an alloy which is anodic to the remainder of the alloy components is corroded preferentially. It is also referred to as selective leaching. In this type of corrosion, the more reactive metal in an alloy experiences accelerated galvanic corrosion with respect to the more noble metal. The kind of alloys most susceptible to this form of corrosion are those which contain metals which are far apart in the galvanic series. A good example of this is brass. Brass contains copper and zinc. Zinc is more reactive than copper and as such, zinc is the anode in the alloy. Copper is more noble and is the cathode in the alloy. As a result of this, the zinc is corroded selectively and the copper is enriched causing the colour of the brass to turn from yellow to red. This form of dealloying corrosion is referred to as dezincification. Other forms of dealloying corrosion are graphitization, destannification, decobaltification and so on [11].

2.4 FORMS OF MECHANICALLY ASSISTED DEGRADATION

2.4.1 Erosion Corrosion:
Erosion corrosion, also referred to as impingement corrosion is a cyclic process that involves a combination of erosion as well as corrosion that leads to a faster deterioration of a metal. This type of corrosion occurs as a result of the motion of fluids carrying abrasives on metals. These abrasives wear away and eventually deplete the passive layer, exposing the metal to corrosive attack. Even if a passive layer is formed again, the fluid in motion will continue to wear it away until the bare metal is exposed again to corrosive attack. The rate of erosion corrosion is greatly affected by the amount of abrasive particles contained in the fluid as well as the rate of flow of the fluid. Almost all equipment types which come in contact with fluids in motion are susceptible to this type of corrosion. Examples of such equipment include inlet pipes, blades of steam turbines, steam condenser tubes, pump impellers and so on.
2.4.2 Fretting Corrosion:
Fretting corrosion is the type of corrosion which occurs between two metals in close contact which undergo small but continuous relative motion. The small relative motion can be caused by vibration or some other similar force. This motion causes the wearing away of the surfaces in contact, creating debris that remain at the point of contact. These debris as well as the exposed surfaces are then corroded. The products of corrosion formed from the debris are usually harder than its source material and can act as abrasive, further worsening the amount of fretting corrosion. This kind of corrosion shows up as grooves which are lined with corrosion products. The severity of fretting corrosion is affected by factors such as the amplitude and frequency of the relative motion, the temperature and corrosivity of the surroundings as well as the contact load between the two materials. This kind of corrosion is commonly found at surfaces like the bolted tie plates on rails or in rolling contact bearings. [12].

2.4.3 Cavitation and Water Drop Impingement
This is the type of material degradation that occurs when vapour bubbles are formed and collapse immediately on a metal surface. The formation and collapse happen when the operational pressure of a fluid falls below the vapor pressure. This can occur in a very explosive manner, with the collapsing bubbles producing pressures of up to 60,000psi. This extreme amount of pressure is capable of resulting in plastic deformation in metals. Furthermore, this process can result in the formation of an airlock. This will hamper the flow of any incoming fluid, further worsening the problem. The surface damage that occurs as a result of cavitation closely resembles that of pitting corrosion. This type of corrosion is found in pump impellers, hydraulic turbines, ship propellers. [12].

2.4.4 Corrosion Fatigue:
This refers to the material degradation that occurs when metals undergo repeated stress while being in a corrosive environment. It must be separated from the concept of fatigue because fatigue is restricted to when there is no corrosive environment (As is the case in dry inert gas or if the metal is surrounded by a vacuum). Corrosion fatigue is similar to stress corrosion cracking and can be considered as environmentally assisted cracking. However, the effects of environmentally assisted cracking are more narrowed down unlike corrosion fatigue which is generalized. Most structures undergo repeated stress and have a life span regardless but when a metal is in a corrosive environment, its life span is greatly reduced. Corrosion fatigue is a common occurrence in acid solutions and saltwater. [13].

2.5 FORMS OF ENVIRONMENTALLY INDUCED CRACKING
2.5.1 Stress Corrosion Cracking:
This is the type of corrosion characterized by the appearance of cracks on a metal as a result of stress (Mostly static or tensile) and a corrosive environment acting simultaneously on the metal for extended periods of time. The stress resulting in this type of corrosion may come about as stresses applied directly or as residual stresses. Residual stresses may be the effect of process like machining, grinding, heat treatment and cold deformation. The effect of this type of corrosion may appear as dry cracks in the microstructure of the metal or a general reduction of the fatigue threshold of that metal. It is a chemically specific form of corrosion. This is because it is prevalent in metal alloys rather than in pure metals. Furthermore, only some specific alloys of metals can undergo stress corrosion cracking and only when they are exposed to a limited range of chemical environments. The chemical environment capable of causing stress corrosion cracking in an alloy is usually mildly corrosive to that alloy. As a
result of this, it is possible for the metals to maintain a lustrous appearance while it is filled with numerous microscopic cracks. As such it often undetected before the total breakdown of the machine or structure affected. This type of corrosion is that observed in the cracking of brass cartridge cases of rifles when ammonia is in the environment as well as that observed in riveted boilers made of steel used in steam driven locomotives. [14].

2.5.2 Hydrogen Embrittlement:
Hydrogen embrittlement is the type of corrosion that is characterized by a loss of strength as well as the ductility of a metal as a result of the presence of atomic hydrogen in the lattice of the metal. Hydrogen can find its way into a metal lattice through many ways but the most common of these is the exposure of metal alloys during early metallurgical processes such as chemical cleaning, cathodic protection, casting, pickling and various welding operations. This is due to the fact that hydrogen in able to enter the alloy more easily in its molten form than when it has cooled and solidified. The entry of hydrogen into the metal lowers its ductility and the amount of load it can bear before failure. It can induce cracking and brittle failure at stresses which are far below the normal yield stresses of the affected metals. It is important to note that some metals are more prone to this form of corrosion such as nickel, iron and titanium while others are much less prone for example, aluminium and copper. [12].

2.5.3 Metal Ion Concentration Cell Corrosion:
Concentration cell corrosion is the type of corrosion that occurs when a metal surface is in contact with an electrolytic solution at different points with varying concentration at each point. This corrosion occurs because the same metal in different concentrations of the same electrolytic solution will possess varying electrochemical properties. Metal ion concentration corrosion takes place at areas where there are two surfaces in contact at a joint in the presence of water. This is because when water is present, a relatively high concentration area of metal ions will be under the two surfaces in contact while a relatively low concentration area of metal ions be near the crevice made by the two surfaces in contact. This difference in concentration will cause an electric potential between the areas. The low concentration area will be protected from corrosion as it will be cathodic while the high concentration area will experience accelerated corrosion as it will be anodic. This type of corrosion can be observed in pipelines passing through swampy areas that are close to dry areas or that passing through different type of soils. [15].

2.5.4 Soil Corrosion:
This is the type of corrosion that affects concrete or metals located deep in the soil or bedrock. The soil is made up of numerous chemical constituents. These constituents are capable of reacting with metals and even other construction materials such as concrete. The phenomenon is complex in nature, involving numerous variables. However, the rate at which a soil corrodes materials varies significantly depending on the location. For example, cast iron pipes used for the transport of water may be used in the highly corrosive Southern California soil for just 20 years before experiencing failure while the same pipe can be used for the same purpose in the less corrosive New England soil for up to 50 years before experiencing failure. Some properties of soil can be used to predict the tendency of a soil to corrode ferrous metals such as the pH, its electrical resistivity as well as the chloride content of the soil. [16].

2.6 EFFECTS OF CORROSION
Corrosion is an omnipresent challenge that cuts across every facet of life. Some major effects include:
2.6.1 Safety Effects

Corrosion is a problem that affects important structures and devices. It wears away important components of these structures, reducing their integrity. If these structures are to undergo total failure as a result of corrosion, it can lead to severe injuries and even a great loss of lives. This is because these structures are constantly in use by several people at a time. Example of some of these structures and devices are bridges, aircrafts, pipelines, automobiles and so on. [17].

2.6.2 Health Effects

Medical advancements have reached the level at which metal prosthetic devices can be inserted into the body for various uses. These prosthetic devices may be hearing aids, pacemakers, plates, pins, hip joints and so on. Even though newer alloys and more sophisticated methods of implantation have been devised, corrosion continues to pose a serious problem. It can result in the fracture of prosthetic devices which are involved in bearing weight as in hip joints. Products of corrosion can also cause inflammation of the tissue surrounding the implants from which they are generated. Corrosion can even degrade the electrical connection contained in delicate devices such as pacemakers. [18].

2.6.3 Technological Effects

Technological advancements in virtually every facet of life are hampered by the problem of corrosion. This is technology aims at producing devices with materials that are capable of operation in environments with more hostile conditions such as stronger pressures, hotter temperatures and more highly corrosive environments. A prominent example of this issue is that faced when designing futuristic oil drills for sea and land. It involves surmounting several forms of corrosion such as soil corrosion, microbiological induced corrosion as well as sulfide stress corrosion among others. These hurdles hamper the development of economically viable systems. [19].

2.6.4 Cultural Effects

All over the world, there are monuments erected for symbolic purposes. They may be in the form of statues, busts, stone symbols and so on. They are usually left out in the open where the environment if free to act upon it without ceasing. Materials with even the highest amount of protective coating are bound to corrode eventually upon daily action of the sun, rain and other atmospheric elements especially with the increased rates of pollution over the years. Even when these cultural treasures are stored in museums, they have to undergo continuous restoration in order to remove traces of corrosion. [20].

2.6.5 Economic Effects

According to the most recent international study carried out by the National Association of Corrosion Engineers in 2013, the global cost of corrosion is alarming indeed. It was estimated that the global cost of corrosion is USD2.5 Trillion. That value represented up to 3.4% of the entire global GDP as of 2013. It was pointed out however, that by employing the corrosion control techniques available, savings in the range of 15% - 35% of that value could be made.
That amounts to between USD375 billion and USD875 billion annually. This goes to show that a significant amount of funds goes to the combating and mitigation of corrosion.[21].

3. CORROSION INHIBITORS
An inhibitor is the name given to a chemical substance or combination of various chemical substances that are added in low concentrations to a corrosive environment with the aim of significantly reducing or totally preventing the occurrence of corrosion while having little or no effect on the original process being carried out in the environment. Inhibitors act in two ways. The first is through the formation of an adsorbed layer on the metal, preventing the metal from coming in contact with corrosive agents. The other is through the retardation of either the cathodic or anodic corrosion reactions. There are even some inhibitors used in practice that are capable of retarding both reactions. [22]. Inhibitors are most effective in closed systems that have adequate circulation. This ensures the stability of the require inhibitor concentration. Examples of such systems include those used for acid pickling, refining of oil and water recirculation systems. One of the most popular applications of inhibitors is the use of antifreeze or engine coolant for radiators of automobiles. [23]. Broadly speaking, corrosions can either be organic or inorganic, are classified based on three major criteria:
- The environment
- The mechanism
- The mode of protection

3.1 TYPES OF CORROSION INHIBITORS ACCORDING TO ENVIRONMENT
Based on the environment in which the inhibitors are applied, they are classified into the following:

3.1.1 Acidic Inhibitors
These are inhibitors which have been found to be most effective in reducing corrosion in acidic corrosive media. They combat corrosion by lowering the rate at which electropositive ions are deposited on the surface of the metal. This results in the reduction of the voltage that occurs as a result of the depolarization reaction at the cathode. [24]. As₂O₃ and Sb₂O₃ have been found to be effective acidic inhibitors. Recent studies also show that inhibition of corrosion in iron in acidic media can be achieved by adding heavy metal ions such as Mn²⁺ and Cd²⁺. [25].

3.1.2 Alkaline Inhibitors
These are inhibitors which have been found to be most effective for the reduction of corrosion in alkaline media. They are effective because they are able to form metal complexes on the surfaces of metals in alkaline solutions. They are most often used to protect metals that form both acidic and basic oxides. These types of metals are the most prone to corrosion in alkaline media. Example of such inhibitors includenaphthol, thiourea and substituted phenols. [26].

3.1.3 Neutral Inhibitors
Corrosive media that are neutral or near neutral in nature require inhibitors different to those that are acidic and alkaline. This is because the mechanism required to retard corrosion is different. [27]. Neutral inhibitors retard the reduction of oxygen that occurs at the cathodic sites. As a result, the surface of the metal is protected from corrosion. Chelating inhibitors is an example of inhibitors that are efficient in neutral solutions. [28].


3.2 TYPES OF INHIBITORS ACCORDING TO MECHANISM

Based on the mechanism of inhibition, which is the electrode process which they act upon, corrosion inhibitors are divided into the following:

3.2.1 Anodic Inhibitors

This is the type of inhibitor that retards corrosion by increasing the polarization of the anodic region. This shifts the corrosive potential towards the cathodic region. The increased anodic polarity is as a result of the formation of a protective barrier on the anodic region. [29]. As a result, the reactions that cause corrosion are significantly slowed down. Anodic inhibitors are also referred to as passivation inhibitors. The most common anodic inhibitors are ions of transition elements which have an abundant content of oxygen. Examples include tungstates, chromates, phosphates, orthophosphates, silicates and so on.

Although anodic inhibitors can be effective, they can also be dangerous. If the concentration of the inhibitor in the corrosive environment falls below the required level, areas of the surface of the metal will remain unprotected. This can result in the stimulation of pitting corrosion. [23].

Anodic inhibitors are of two types:

- Non-Oxidizing ions: This type of anodic inhibitors requires the presence of oxygen to function properly. Examples include molybdates, tungstates and phosphates.
- Oxidizing ions: This type of anodic inhibitors functions properly in the absence of oxygen. Examples include nitrates, nitrites and chromates.

3.2.2 Cathodic Inhibitors

This type of corrosion inhibitor is able to reduce corrosion by retarding the reduction reaction that occurs at the cathodic sites in a corrosive environment. The ions of the inhibitors form precipitates at the cathodic regions. This results in a shift in the corrosive potential from the cathodic region, to the anodic region. [30]. The inhibition action occurs through 3 means:

- Cathodic Precipitation: These inhibitors form precipitates in the cathodic region which serves as a protective layer for the surface of the metal. Examples include magnesium, and calcium.
- Oxygen Scavenging: These inhibitors react with the environmental oxygen, forming various products and reducing corrosion in the process. Example include Sb^{3+} and As^{3+}.
- Cathodic Poisoning: These inhibitors hinder the hydrogen recombination reaction that occurs at the cathode, reducing corrosion in the process. However, these inhibitors have the disadvantage of making the metal more susceptible to hydrogen induced cracking. Examples include arsenic, antimony and bismuth.

3.2.3 Mixed Inhibitors

This type of corrosion inhibitor has the unique property of being able to hamper the reactions that occur at both the cathodic and anodic regions. They are able to make protective films formed by the deposition of precipitates on the metal. This blocks the reactions at both the cathodic and the anodic indirectly, reducing the rate of corrosion. [23].

3.3 TYPES OF INHIBITOR ACCORDING TO MODE OF PROTECTION

Based on the mode of protection carried out by corrosion inhibitors, they are divided into the following:
3.3.1 Adsorption Inhibitors
Adsorption inhibitors are the most commonly used type of corrosion inhibitors. They are generally organic and they work by getting adsorbed unto the surface of the metal. This forms a protective layer over the entire surface, including both cathodic and anodic regions. They are known to affect both regions equally but that may not be the case in all situations. A common use of adsorption inhibitors is in the removal of black mill scale that is formed in pickling processes. Adsorption inhibitors are mostly compound which have lone pairs of electrons. For example, Oxygen in aldehydes, nitrogen in amines. [31].

3.3.2 Chemical Passivators
Chemical passivators are substances which possess a small over potential and a high equilibrium potential (also known as electrode potential). Their specific chemical properties enable them to reduce corrosion rate by attaining passivity. [32]. Some applications of this type of corrosion inhibition are the use of Zinc Molybdate in paints and the use of chromates in cooling waters.

3.3.3 Film Forming Inhibitors
Film forming inhibitors reduce the rate of corrosion in metals with formation of a protective barrier on the surface of the metal. They differ from adsorption inhibitors due to the fact that the protective layer formed by film forming inhibitors are made of materials other than the inhibitors themselves. The materials formed are usually specific to either the cathode or the anode. For example, Salts of Zinc and Calcium are film forming specific to cathodes while benzoate is film forming specific to anodes. [33].

3.3.4 Vapour Phase Inhibitors
Although, vapour phase inhibitors are usually substances of low vapour pressure, the vapour pressure is significant. This vapour pressure enables them to carry out their function well. Vapour phase inhibitors are most commonly used in spaces that are closed. For example, in a parcel when it is being shipped or stored. They are also referred to as volatile inhibitors. They adsorb onto the surface of the metal and are hydrolysed by the moisture. Protective ions are then released, reducing corrosion in the process. Examples of vapour phase inhibitors include benzotriazole used for inhibiting corrosion of copper and phenyl thiourea used in protecting brass. [34].

Conclusion
This review study has practically looked into the general corrosion mechanism, the potentials and the direct possible mitigation progresses. The fundamental refining circle which leads to several form of corrosion was established with relationship governing equation. The mechanism of inhibition, which is the electrode process which inhibitor act upon are classified and the adsorptive progresses were discussed for general metal dissolution.

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