Chapter - 1

Introduction

CHAPTER I
INTRODUCTION

Researchers and practitioners in the field of corrosion engineering apply more attention to metallic corrosion than was done earlier due to increasing use of materials in all fields of technology. In view of modern age of technological development and use of metallic materials in all aspect of technology, corrosion phenomena, their prevention and control have become a perpetual struggle between man and nature. Corrosion is a spontaneous process occurring predominantly without the application of external force. It is a degenerate phenomenon that affects almost every metals and nonmetals including plastics and ceramics.

ISO 8044 defines corrosion as physiological interaction, which usually of an electrochemical phenomenon between man and his environment, which result changes in properties of metal and which may often lead to the impairment of function of metal in the environment or technical system of which these form a part.

The continuous growth of world population together with the expected decline in high grade ores and energy source will necessitate a more efficient utilization of metal based construction of materials. The rapid industrialization of many countries indicates that the competition for and the price of metal resources will increase. It is obvious that metals are extremely important in modern engineering yet many can be badly affected by corrosion. Corrosion protection is required for a long life and economical use of equipment in technical processes.

1.1 ELECTROCHEMICAL PRINCIPLE OF CORROSION

Virtually all corrosion reactions are electrochemical in nature, at anodic sites on the surface the iron goes into solution as ferrous ions, this constituting the anodic reaction. As iron atoms undergo oxidation to ions they release electrons whose negative charge would quickly build up in the metal and prevent further anodic reaction, or corrosion. Thus this dissolution will only continue if the electrons released can pass to a site on the metal surface where a cathodic reaction is possible.

At a cathodic site the electrons react with some reducible component of the electrolyte and are themselves removed from the metal. The corroding piece of metal is described as “mixed electrode” since simultaneous anodic and cathodic reactions are proceeding on its surface. The mixed electrode is a complete electrochemical cell on the metal surface.

The most common and important electrochemical reactions in the corrosion of iron are thus

Anodic reaction (corrosion)

$$Fe \rightarrow Fe^{2+} + 2e^{-} \quad (1)$$

Cathodic reactions (simplified)

(or) $$2H^{+} + 2e^{-} \rightarrow H_2 \quad (2a)$$

$$H_2O + ½\,O_2 + 2e^{-} \rightarrow 2OH^{-} \quad (2b)$$

Reaction (2a) is most common in acids and in the pH range 6.5 – 8.5 the most important reaction is oxygen reduction (2b). In this latter case corrosion is usually accompanied by the formation of solid corrosion describes from the reaction between the anodic and cathodic products.

$$Fe^{2+} + 2OH^{-} \rightarrow Fe(OH)_2, \text{ (iron (II) hydroxide)} \quad (3)$$

Pure iron (II) hydroxide is white but the material initially produced by corrosion is normally a greenish colour due to partial oxidation in air

$$2Fe(OH)_2 + H_2O + ½\,O_2 \rightarrow 2Fe(OH)_3, \text{ (hydrated iron (III) oxide)} \quad (4)$$

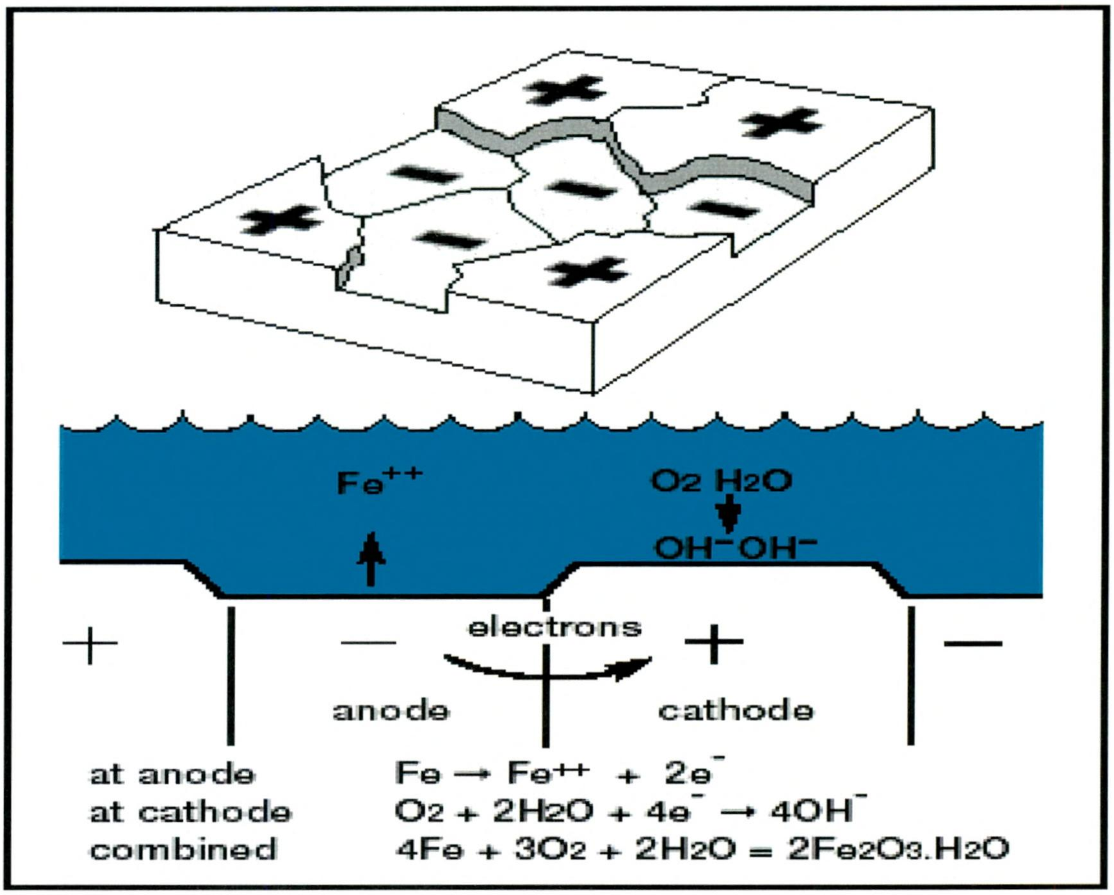


Figure -1 Schematic representation of electrochemical corrosion process

Further hydration and oxidation reactions can occur and the reddish rust that eventually is a complex mixture whose exact constitution will depend on other trace elements which are present. Because the rust is precipitated as a result of secondary reactions it is porous and absorbent and tends to act as a sort of harmful poultice which encourages further corrosion. For other metals or different environments different types of anodic and cathodic reactions may occur. If solid corrosion products are produced directly on the surface, as the first result of anodic oxidation, these may provide a highly protective surface film which retards further corrosion, the surface is then said to be “passive”. An example of such a process would be the production of an oxide film on iron in water, a reaction which is encouraged by oxidizing conditions or elevated temperatures as shown in the figure-1.

$$2Fe + 3H_2O \rightarrow Fe_2O_3 + 6H^+ + 6e^- \quad (5)$$

1.2 FORMS OF CORROSION

Corrosion occurs in several widely differing forms. Classification is usually based on one of three factors:

- *Nature of the corrodent:* Corrosion can be classified as “wet” or “dry.” A liquid or moisture is necessary for the former, and dry corrosion usually involves reaction with high-temperature gases.
- *Mechanism of corrosion:* This involves either electrochemical or direct chemical reactions.
- *Appearance of the corroded metal:* Corrosion is either uniform and the metal corrodes at the same rate over the entire surface, or it is localized, in which case only small areas are affected.

Completeness requires further distinction between macroscopically localized corrosion and microscopic local attack. In the latter case, the amount of metal dissolved is minute, and considerable damage can occur before the problem becomes visible to the naked eye. Macroscopic forms of corrosion affect greater areas of corroded metal and are generally observable with the naked eye or can be viewed with the aid of a low-power magnifying device. Classification of macroscopic and microscopic forms of localized corrosion.

Macroscopic Corrosion

- Galvanic
- Erosion-corrosion
- Crevice
- Pitting
- Exfoliation
- Dealloying

Microscopic Corrosion

- Intragranular
- Stress-corrosion cracking
- Corrosion Fatigue

Classification by appearance, which is particularly useful in failure analysis, is based on identifying forms of corrosion by visual observation with either the naked eye or magnification. The morphology of attack is the basis for classification. Figure 2 illustrates schematically some of the most common forms of corrosion. Eight forms of wet (or aqueous) corrosion can be identified based on appearance of the corroded metal. These are:

1. Uniform or general corrosion
2. Pitting corrosion
3. Crevice corrosion, including corrosion under tubercles or deposits,
4. Filiform corrosion, and poultice corrosion
5. Galvanic corrosion
6. Erosion-corrosion, including cavitation erosion and fretting corrosion
7. Intergranular corrosion, including sensitization and exfoliation
8. Dealloying, including dezincification and graphitic corrosion
9. Environmentally assisted cracking, including stress-corrosion cracking, corrosion fatigue, and hydrogen damage

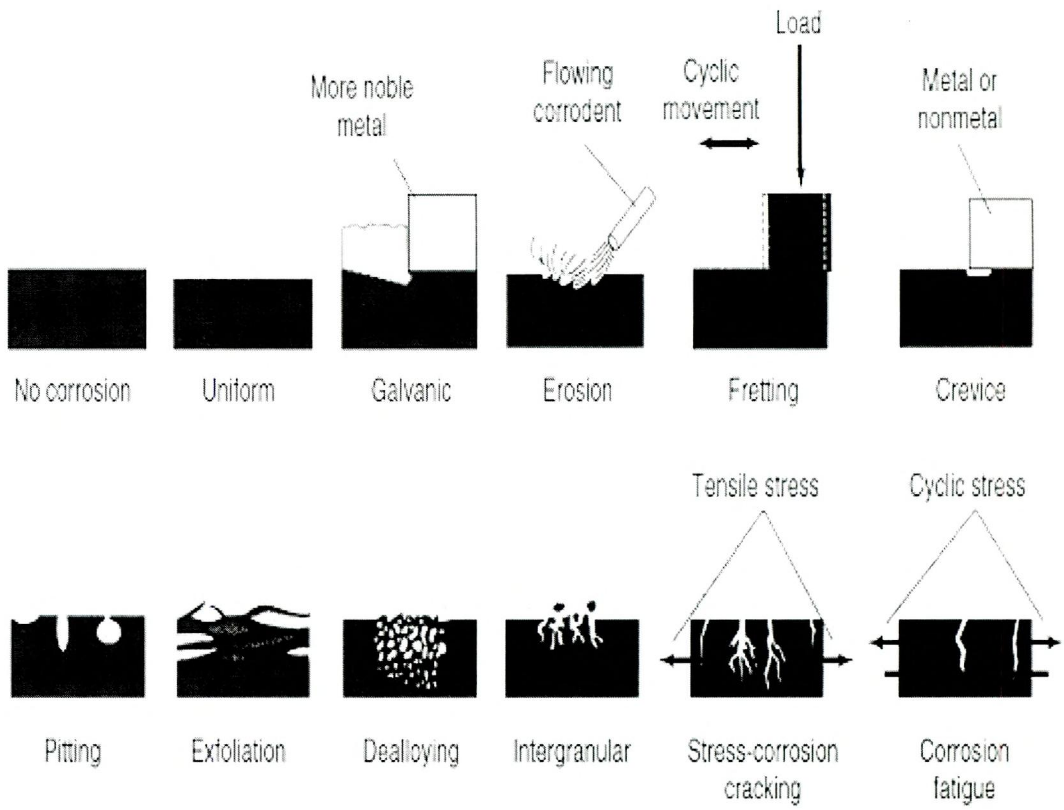


Figure-2 Schematics of the common forms of corrosion

1.3 CORROSION IN OUR DAILY LIVES

The effects of corrosion in our daily lives are both direct, in that corrosion affects the useful service lives of our possessions, and indirect, in that producers and suppliers of goods and services incur corrosion costs, which they pass on to consumers. Corrosion protection is built into all major household appliances such as water heaters, furnaces, ranges, washers, and dryers.

Perhaps most dangerous of all is corrosion that occurs in major industrial plants, such as electrical power plants or chemical processing plants. Plant shutdowns can and do occur as a result of corrosion. This is just one of its many direct and indirect consequences. Some consequences are economic, and cause the following:

- Replacement of corroded equipment
- Overdesign to allow for corrosion
- Preventive maintenance, for example, painting
- Shutdown of equipment due to corrosion failure
- Contamination of a product
- Loss of efficiency—such as when overdesign and corrosion products decrease the heat-transfer rate in heat exchangers
- Inability to use otherwise desirable materials
- Damage of equipment adjacent to that in which corrosion failure occurs

Still other consequences are social. These can involve the following issues:

- Safety, for example, sudden failure can cause fire, explosion, release of toxic product, and construction collapse
- Health, for example, pollution due to escaping product from corroded equipment or due to a corrosion product itself
- Depletion of natural resources, including metals and the fuels used to manufacture them
- Appearance as when corroded material is unpleasing to the eye

1.4 FACTORS AFFECTING CORROSION

Factors affecting corrosion can be broadly classified into two groups according to the nature of metal and the nature of the environment

FACTORS

Nature of the metal

1. Position of electrochemical series
2. Purity of the metal
3. Over voltage
4. Relative cathodic area to anodic area
5. Nature of surface film

Nature of the environment

1. Temperature
2. Humidity
3. Presence of corrosive gases
4. Presence of suspended particle
5. Effect of pH

1.5 CORROSION IN INDUSTRIES

Occurrence of corrosion and its practical control is an area of study covering a wide range of scientific knowledge. Corrosion Science provides a medium for the communication of ideas, developments and research in all aspects of this field and includes both metallic and non-metallic corrosion. Corrosion is a huge issue for materials, mechanical, civil and petrochemical engineers.

In recent years, numerous failures of industries due to corrosion are reported. Most of the failures can be avoided by the addition of suitable corrosion inhibitors (Figure -3).

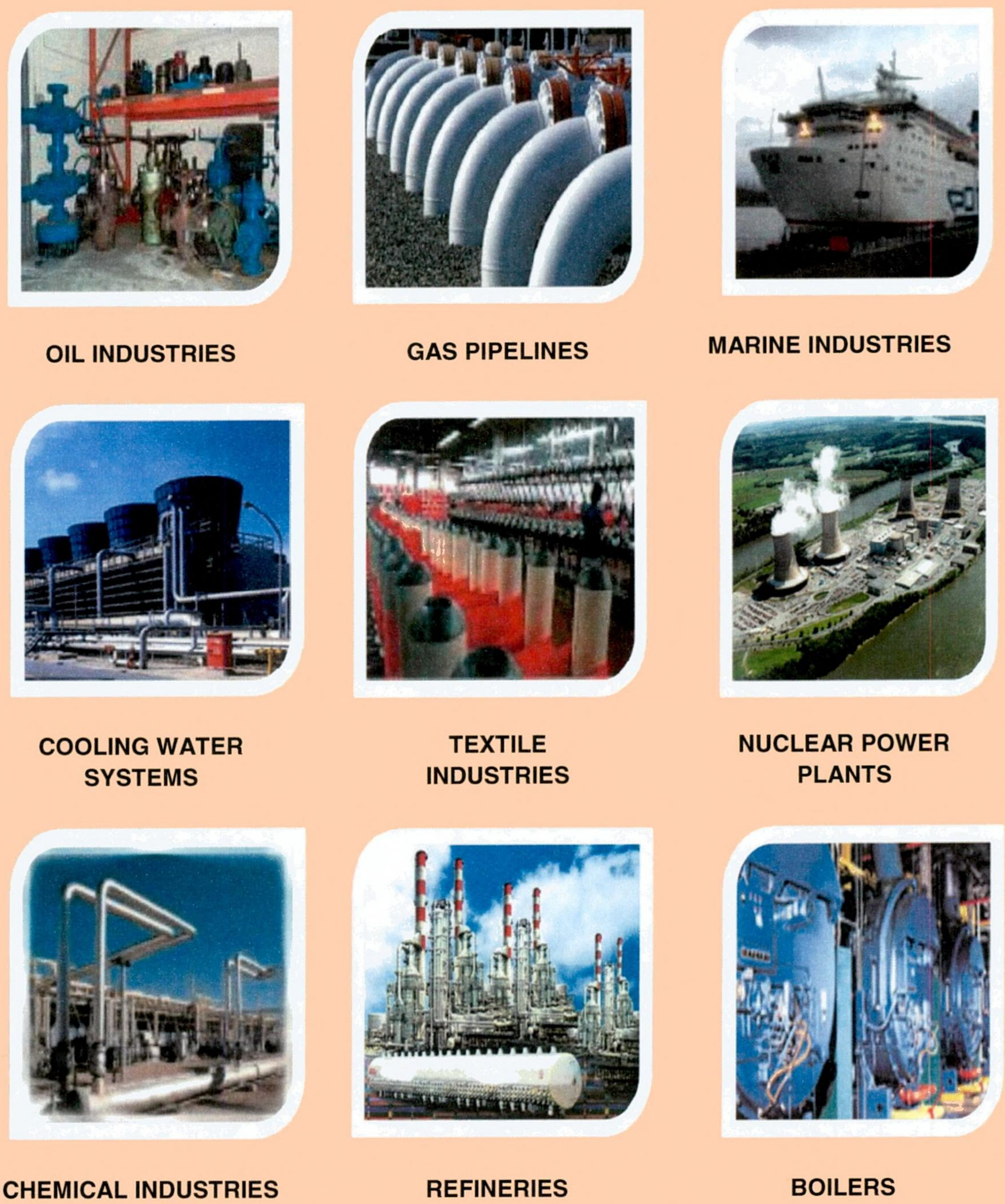
1.5.1 Boiling Water Reactors

Systems such as boiling water reactors involving aqueous solutions are affected by transpassive corrosion. In these reactors the coolant water at the reactor core is strongly oxidising. Transpassive corrosion involves the dissolution of chromium from the surface of stainless steel and nickel-base alloys. It is suspected that transpassive corrosion affects the initiation of irradiation assisted stress corrosion cracking. This technologically important corrosion process leads to the failure of such applications such as gas turbines, heat exchangers and many others that operate at high temperatures.

1.5.2 Marine Environment

Corrosion can cause rapid failure in marine system. Galvanic corrosion is the most frequent cause of unexpected corrosion failures in seawater. It has caused failures of ship fittings and deckhouse structures, fasteners, hull plating, propellers, shafts, valves, condensers and piping. The corrosion problems in these systems cause $8 billion of economical losses.

FIGURE-3 CORROSION IN DIFFERENT INDUSTRIES



1.5.3 Nuclear Power Plants

In nuclear power plants the deterioration occurs through corrosion - erosion and cracks. Nuclear power plant designed for decades of operation. One of the challenges in their maintenance related to the phenomena of stress corrosion cracking and corrosion erosion.

1.5.4 Automobiles

The costs of corrosion are not always apparent. Even though anti-rust coatings on automobiles have made signs of rustless evident, rust may be affecting the less visible parts of the vehicle. Aircraft that undergo regular anti-corrosion maintenance not only are safer, but maintain their resale value more than the untreated aircraft. Marine craft are also vulnerable to corrosion, particularly those in salt water environment.

1.5.5 Corrosion in oilfield production system

Within the petroleum producing industry corrosion is responsible for millions of U.S. dollars of cost associated with the loss of equipment through breakdowns caused by the loss of metals both from inside as well as outside. Corrosion affects all stages in the exploitation of crude oil ranging from drilling of wells through the separation process export pipelines, storage tanks, refineries and even the internal combustion engine.

1.5.6 Corrosion in natural gas pipelines

The major industries using corrosion inhibitors are oil, gas exploration and production, petroleum refining, chemical manufacturing and product additive industries. In natural gas pipelines the most prudent corrosive materials are oxygen, carbon dioxide and hydrogen sulphide. When adsorbed into water they can be aggressive attackers on the inner lining of the gas pipelines. Several kinds of inhibitors can be used to inhibit the corrosion of natural gas pipelines. Eg: organic, inorganic or natural product inhibitors.

1.5.7 Corrosion in cooling water systems

Organic inhibitors for cooling water treatment are specially designed to handle various maintenance parameters such as controlling corrosion in cooling and heating systems and controlling calcium scale formation.

1.5.8 Boiler corrosion

There are several problems within a boiler system some of which require chemical treatment and other mechanical means to overcome them. The major problems are Scale, Boiler water carryover and Sludge deposition.

1.5.9 Corrosion in Chemical Industry

In the chemical industry corrosion is often responsible for significant shutdown and maintenance costs. Shutdowns are costly in terms of productivity losses, restart energy and material costs. Additionally internal corrosion failures result in contamination of products and process streams and external corrosion leaks create undesirable safety, personal and environmental hazards. These short comings could be reduced by the usage of organic inhibitors. Researchers are developing corrosion data for commercial alloys, thermo chemical models, and understanding which will be delivered to plant designers and operators via an information system to allow industry to comprehensively and reliably predict corrosion of an extensive list of commercial alloys exposed to complex and corrosive gases at temperatures ranging from 200°C to 1,200°C. Benefits from improving corrosion management will be extensive in the chemical industry, many other industries and the economy. "Awareness and competence in corrosion control have to be supported and improved in Indian industry. Industrial Asset Management needs implementation of corrosion audits, corrosion assessment, and corrosion management" said Chandrajit Banerjee, Director General, and Confederation of Indian Industry (CII).

1.6 COST OF CORROSION

The economic consequences of corrosion affect technology. A great deal of the development of new technology is held back by corrosion problems because materials are required to withstand, in many cases simultaneously, higher temperatures, higher pressures, and more highly corrosive environments. Corrosion problems that are less difficult to solve affect solar energy systems, which require alloys to withstand hot circulating heat transfer fluids for long periods of time, and geothermal systems, which require materials to withstand highly concentrated solutions of corrosive salts at high temperatures and pressures. Another example, the drilling for oil in the sea and on land, involves overcoming such corrosion problems namely sulfide stress corrosion, microbiological corrosion, and the vast array of difficulties involved in working in the highly corrosive marine environment. **In many of these instances, corrosion is a limiting factor preventing the development of economically or even technologically workable systems. Annual loss in rupees crore occurred in various industries in India is depicted in Figure -4**

The overall loss due to corrosion alone amount to at least 2 to 4 % GNP, 25% of this could be avoided by using appropriate corrosion control technique.

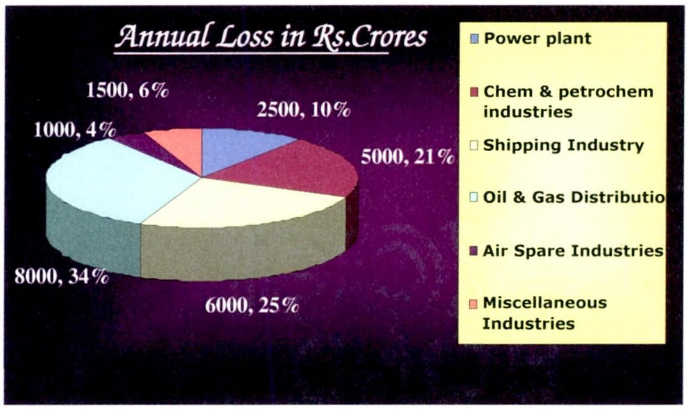


Figure -4 Illustration of Economic impact of corrosion in various Industries

1.7 STRATEGIC IMPACT AND COST OF CORROSION DAMAGE

"The cost of corrosion works out to much higher than any of the calamities the nation has faced over the years." – NACE International India.

It is essential to have an in-depth understanding of corrosion phenomena, from both a scientific and a technological view point to develop strategies that minimise the costs associated with the corrosion of materials. The high cost of corrosion results due to lack of awareness of the economic impact of corrosion, and the poor selection of protection measures. Various remedial and corrosion control measure are available and these, when coupled with a planned corrosion control programme, help reduce the cost of corrosion. Corrosion survey and corrosion audit of plant assets is the need of the day to know the impact of corrosion and its manifestation to club it before it becomes unmanageable. Corrosion and its cost have been developed since ancient times, but only recently serious attempts have been made to estimate the total cost caused by it to the community. Our economy would be drastically changed, if there were no corrosion. But corrosion touches all inside and outside the home, on the road, on the sea, in the plant and in the vehicles.

The common finding of corrosion studies undertaken by several countries is that the annual corrosion costs ranged from approximately 1 to 5 per cent of the GDP of each nation. India's corrosion loss has been estimated as Rs. 2 lakh crore annually corrosion management committee chairman Confederation of Indian Industry (CII) and Director Indira Gandhi Centre for Atomic Research, Baldev Raj, communicated that India loses a staggering figure of over Rs.2 lakh crore per year due to corrosion infrastructure, industrial equipment and other vital installations.

The overall loss due to corrosion alone amounts to at least 2 to 4 percent of GNP and at least 25 percent of this could be avoided by using appropriate corrosion-control technology.

1.8 LOSSES DUE TO CORROSION

Corrosion is the destructive attack of a material by reaction with its environment. The serious consequences of the corrosion process have become a problem of worldwide significance. The colossal losses due to corrosion are huge. There are many losses due to corrosion some of which are given pictorially in Figure -5 below.

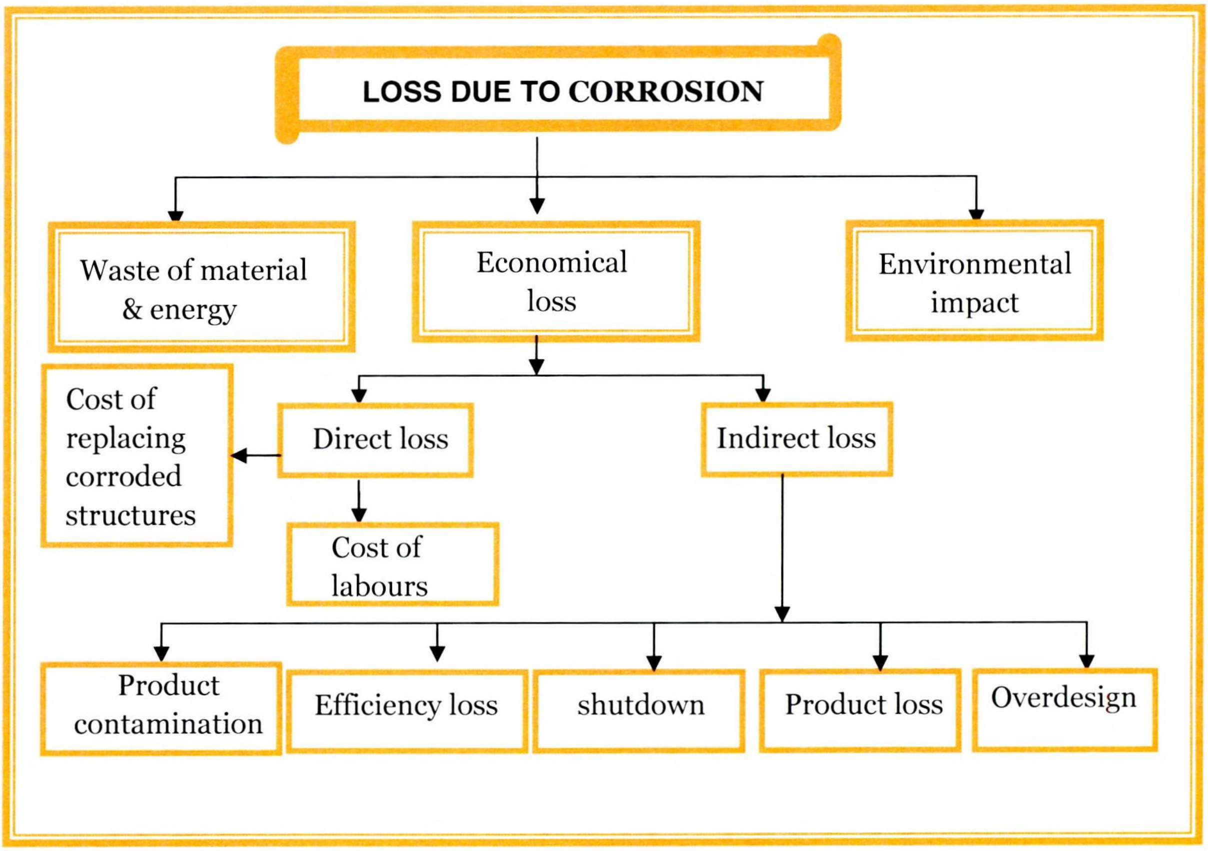


Figure-5 Losses due to corrosion

1.8.1 Environmental and Health Impact

Huge life, material losses and large scale environmental pollution are some of the results due to corrosion. Recent years have seen an increasing use of metal prosthetic devices in the body, such as pins, plates, hip joints, pace makers and other implants. New alloys and better techniques of implantation have been developed, but corrosion continues to create problems. Examples include failures through broken connections in pace makers, inflammation caused by corroded products in the tissue around implants and fracture of weight bearing prosthetic devices due to corrosion.

1.9 NEED FOR CORROSION CONTROL

Virtually all metals suffer corrosion so its effect permeates nearly every aspect of human endeavour and this fact alone should make the study of corrosion more important. It is necessary to apply more attention to metallic corrosion than was done earlier due to

- Increasing use of metals in all fields of technology
- Reduction of metal thickness leading to loss of mechanical strength and structural failure or breakdown.
- Increasing pollution of air and water resulting in more corrosive environment.

- Use of new high strength alloys which are usually more susceptible to certain types of corrosive attack.
- Safety standard of operating equipment, which may fail due to corrosion

1.10 CORROSION CONTROL METHODS

Corrosion of metals in different environments is one of the serious problems facing industry and its control has been approached from various angles. Since the types of corrosion are so numerous and the conditions under which corrosion occurs are so different, diverse methods are used to control corrosion. Some of the corrosion control methods are shown in figure 6. **One of the very important methods of minimizing corrosion today is the use of corrosion inhibitors**.

Corrosion inhibitors are extensively used in various applications and many plant operations are dependent on their successful application. One way to protect the metal against corrosion is to add certain organic molecules, which adsorb on the surface and form a protective layer. The unique advantage of the possibility of adding inhibitors is that this can be done without disruption of the industrial process. Organic corrosion inhibitors are useful when their addition in small amounts prevents corrosion.

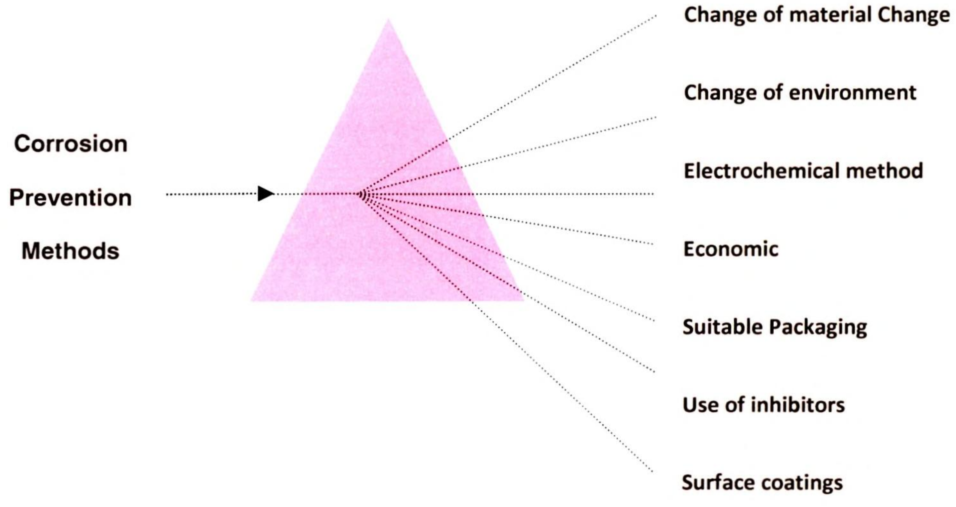


Figure-6 Corrosion control methods

1.11 INHIBITORS

Corrosion, in electrolytic phases, is an electrochemical process and any phase constituent leading to retardation of this process is called an inhibitor. A corrosion inhibitor is a substance which when added in small quantities to the aqueous corrosive environment, effectively decreases the corrosion of a metal. A universal inhibitor does not exist. There could be a good effective inhibitor for a certain environment although it might be harmful or ineffective for another environment.

The most effective inhibitor is the one which has the most stable adsorption type. Inhibitors slow corrosion processes by either:

- Increasing the anodic or cathodic polarization behaviour;
- Reducing the movement or diffusion of ions to the metallic surface;
- Increasing the electrical resistance of the metallic surface.

The scientific and technical corrosion literature has descriptions and lists of numerous chemical compounds that exhibit inhibitive properties. Of these, only very few are actually used in practice. This is partly due to the fact that the desirable properties of an inhibitor usually extend beyond those simply related to metal protection. Inhibitors have been classified differently by various authors. Some authors, for example, prefer to group inhibitors by their chemical functionality. However, by far the most popular organization scheme consists in regrouping corrosion inhibitors in a functionality scheme as follows:

- Passivating Inhibitors
- Cathodic inhibitors
- Precipitation inhibitors
- Organic inhibitors
- Volatile corrosion inhibitors

1.11.1 World consumption of corrosion inhibitors

World consumption of corrosion inhibitors is expected to grow to over 930 thousand metric tons during 2005 – 2010. The relatively low growth rates projected for corrosion inhibitors, all below GDP growth in each region, reflect the high level of maturity of most of the basic industries in the developed markets. They also reflect the replacement of steel by plastics, ceramics and corrosion resistant alloys in the industries. Industries have also used corrosion inhibitors more efficiently by employing better monitoring and control techniques to minimize discharges in the effluent streams and their impact on the environment.

Corrosion is so prevalent and takes so many forms that its occurrence and associated expenses cannot be eliminated completely. Corrosion affects our society on a daily basis, causing degradation and damage to household appliances, automobiles, air planes, highway bridges, energy production and distribution systems and much more. The cost of controlling this naturally occurring phenomenon- and costs associated with the damage it causes is substantial.

1.11.2 Selection of Inhibitor

The selection of appropriate inhibitor depends mainly on the type of acid, concentration, temperature, the extent of dissolved organic or inorganic substances in solution and chiefly the type of metallic material exposed to acid corrosion. The use of organic inhibitors in acid solution is very common, particularly in view of the high corrosion rate. Nitrogen containing organic compounds has been widely used as effective and efficient metallic corrosion inhibitors. The inhibitive action of these organic compounds has been explained in terms of number of mobile electron pairs, π-orbital character of free electrons and electron density around nitrogen atoms. The efficiency of an organic compound as an inhibitor is largely dependent on its adsorption on the metal surface which consists of replacement of water by the organic inhibitor at the interface and can be represented as

$$Org_{(sol)} + nH_2O \leftrightarrows Org_{(ads)} + nH_2O_{(sol)}$$

The adsorption of these materials is influenced by the presence of functional groups such as = NH, -N = N-, -CHO, R-OH, R = R etc in the inhibitor molecule.

1.11.3 Nature of Adsorption of Inhibitors

In formulating organic inhibitor system, it is necessary to know the inhibition mechanism and the application field of the molecules concerned. It is generally accepted that organic molecules inhibit corrosion by adsorption at the metal / solution interface and that the degree of adsorption are dependent upon

- The chemical structure of the molecule
- The chemical composition of the Solution
- The nature of the metal surface and
- The electrochemical potential at the metal / solution interface **(Riggs, 1962)**.

1.11.4 Effectiveness of inhibitors

The effectiveness of inhibitors depends upon

- The size of the organic molecules
- Aromaticity or conjugate bonding
- Chain length
- Strength of bonding to the metal substrates
- Type and number of bonding atoms or groups in the molecule
- The ability to become cross-linked
- The ability to complex with the metal atoms as a solid within the metal lattice.
- Adequate solubility in the environment.

1.11.5 Polymers as Corrosion Inhibitor

Polymers (or plastics as they are also called) are known to have good insulating properties. Polymers are one of the most used materials in the modern world. Their uses and application range from containers to clothing. They are used to coat metal wires to prevent electric shocks. However it is now recognized that there are some polymers which have conducting properties.

Polymers are used as corrosion inhibitors, because, through their functional groups they form complexes with metal ions and on the metal surface. These complexes occupy a large surface area, thereby blanketing the surface and protecting the metals from corrosive agents present in solution. The relationship between structure dependent adsorption and corrosion inhibition is well known. The corrosion inhibition of a metal involves strong adsorption of Inhibitors to the metal surface by nitrogen, sulphur or oxygen and subsequent interference with either cathodic or anodic reactions occurring at the adsorption sites.

The use of polymers as corrosion inhibitors has drawn considerable attention due to

- Their inherent stability and cost effectiveness
- Their ability to form complexes with metal ions and on the metal surface
- Multiple adsorption sites
- Large molecular size that ensures greater coverage of metallic surface and Adsorptive tendencies.

1.11.6 Selection of the inhibitor – (PVA – selected Amino acid composites)

Organic materials act as corrosion inhibitors according to their functional group, which are adsorbed on the metal surface. In view of it, water-soluble polymers or macromolecules, having functional groups (–OH, –COOH, $-NH_2$, etc.), are mentioned as corrosion inhibitors in different corrosive media. Adsorption of polyaniline derivatives on iron in 1N HCl is greatly responsible for inhibitive action of these polymers **(Sathiyanarayanan *et al.,* 1994).**

El-Sayed (1996) and Khairou (2003) reported the effect of some water-soluble polymers on corrosion of iron and cadmium. They found that the hydroxy group of polyvinyl alcohol and polyethylene glycol could be bridge between the polymer and the surface of electrode and resulted in an inhibiting effect in the HCl solution. In recent days, polymers (**Joshi *et al.,* 1989)** and conducting polymers (**Sathiyanarayanan *et al.,* 1992)** have attracted a great deal of attention because of their wide range of industrial applications and economics. Due to the presence of extensive delocalization of π-electrons, these polymers could serve as better corrosion inhibitors at very low concentrations.

PVA is a kind of poly hydroxyl polymer which is not degradable in most physiological situations (**Lee *et al.*, 2001**). PVA based hydrogels are broadly applied in tissue engineering, because of its excellent mechanical strength and good film formation property. Polyvinyl alcohol (PVA) is a water-soluble poly hydroxyl polymer, used in practical applications because of its easy preparation, excellent chemical resistance and physical properties and it is completely biodegradable and cheap.

Amino acids are nontoxic, relatively cheap and easy to produce with purities greater than 99%. At present there are more than 200 different amino acids known to occur in nature **(Bohinski *et al.*, 1973).** Most of the natural amino acids are the alpha amino acids which contain carboxyl and amino groups bonded to the same carbon atom. It was shown that the inhibition action of some organic compounds is based on adsorption phenomenon. This implies that corrosion inhibition is due to the presence of amino groups in the molecular structure. Amino acids were reported as good non-toxic corrosion inhibitors for many metals in various aggressive media (**Barouni *et al.*, 2008)**

Due to the presence of multiple adsorption sites in the molecular structure of polymer for bonding with the metal surface, polymers should be good corrosion inhibitors. Applications of corrosion inhibitors for iron and steel in acidic solution by polymers such as polyacrylic acid **(Amin *et al.*, 2009a)** poly(N,N'diallyl- N-carboethoxymethyl-N'-formyl-1,6-hexanediamine) **(Ali *et al.*, 2001)**, poly(o-phenylenediamine) **(Abd El Rehim *et al.*, 2010),** poly(*o*-methoxy-aniline) **(Sathiyanarayanan *et al.*, 1994)**, polyethylene glycols (**Ashassi-Sorkhabi *et al.*, 2006**), poly(amino quinine) **(Jeyaprapha *et al.*, 2005a),** poly(*N*-methacryloyloxymethyl) benzotriazole-*co*-methyl methacrylate **(Srikanth *et al.*, 2006)** poly(diphenylamine) **(Jeyaprabha *et al.*, 2005b)** are reported. The present investigation has been conducted using the water soluble Polyvinyl alcohol- selected Amino acid composites. Inhibitors Selected for the Present Research Work are

- **PVA - ALANINE(PVAALA)**
- **PVA - VALINE(PVAVAL)**
- **PVA - GLUTAMIC ACID(PVAGLU)**
- **PVA - GLUTAMINE(PVAGLN)**
- **PVA -TRYPTOPHAN(PVATRP)**
- **PVA - TYROSINE(PVATYR)**

It is known that polymers are adsorbed stronger than their monomer analogues, hence it is expected that polymers will be better corrosion inhibitors than the corresponding monomers. The improved performances of the oligo- or polymeric materials are ascribed to their multiple adsorption sites for bonding with the metal surface. The conducting polymers are well known for their electrical and electronic properties (**Skotheim *et al.*, 1998).** These polymers have also been recognized as excellent corrosion inhibitors for metals in acid environment (**Rohwerder *et al.*, 2007**). Even the presence of a small quantity of polymers may be effective in inhibiting the corrosion of metals in acidic environment (**Martyak *et al.*, 2007).** However, the highly insoluble nature of most of the conducting polymers in aqueous medium is the major limitation in corrosion inhibition application. Mainly these polymers were used as coating rather than inhibitors. Recently, several attempts have been made to use soluble conducting polymers for corrosion inhibition (**Sathiyanarayanan *et al.*, 2007)**. Polymers provide two advantages: a single polymeric chain displaces many water molecules from the metal surface, thus making the process entropically favorable and the presence of multiple bonding sites make the desorption of the polymers a slower process. This makes the investigation of their inhibiting properties significant in the context of the current priorities to produce eco-friendly inhibitors.

Hence the present research work aims at establishing the effectiveness of the synthesized water soluble polyvinyl alcohol- selected amino acids composites as potential corrosion inhibitors in 1 M HCl medium.

1.12 OBJECTIVES

- To synthesize the water soluble polymer composites – PVA with Alanine, Valine, Tyrosine, Tryptophan, Glutamine and Glutamic acid.
- To characterise the synthesised water soluble polymer composites.
- To utilise the same as corrosion inhibitor for mild steel in acid medium.
- To test the effectiveness of the inhibitors by weight loss and electrochemical measurements.
- To evolve a suitable adsorption isotherm model.
- To analyse the mode of inhibition from electrochemical measurements.
- To compare the inhibition efficiency by various techniques.
- To arrive at a possible mechanism for the inhibition process.
- To ascertain the adsorption of polymer on mild steel surface by surface analysis method.

Having discussed the need for corrosion control and objectives of the current investigation, a detailed **Review of related literature** is given in **Chapter II**