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Review Article

A Review on Studies and Research on Corrosion and Its Prevention

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ABSTRACT

Corrosion is one of the major reasons for wear and tear of equipments. It is also responsible for reducing the life of equipments. Many accidents occur because of failure of pipelines due to corrosion. There are many methods to minimize corrosion. Cathodic protection, use of inhibitors, use of anticorrosive coatings is few methods used for this purpose. The presence of moisture in the atmosphere favours the corrosion. Various investigators have carried out research on various aspects of corrosion. Humidity and temperature are two important parameters in addition to metal properties and chemicals involved in the process. Use of green inhibitors is new trend in corrosion control. The current review summarizes research carried out on corrosion and its control.

Key words: pH, temperature, pitting corrosion, galvanic corrosion, inhibitors, metals.

INTRODUCTION

Corrosion is deterioration of metal because of reaction with surroundings. Important types of corrosion are general attack corrosion, metal attack corrosion, galvanic corrosion, environmental cracking, flow assisted corrosion, intragranular, fretting corrosion and high temperature corrosion. Generally corrosion is the effect of low water pH. H^+ ion reacts with electrons at cathode. The factors like pH, oxygen content, chemical makeup of water, dissimilar metals, temperature, velocity and pressure in pipeline are important in corrosion of piping systems. Coating, galvanizing, tinning, electroplating, anodizing are few common methods for corrosion prevention. New economical and effective methods are being explored by various investigators. Corrosion problem affect economy of the chemical process. The corrosion prevention has become important area of research because of the growing need to implement effective and economical corrosion presentation method. The present review summarizes research carried out on corrosion and its prevention.

RESEARCH ON CORROSION AND ITS PREVENTION

Katundi et. al. characterized the corrosion resistance in the steel sheets (Hot dip galvanizing of steel sheets) used in automotive industry. [1] They carried out simulated corrosion tests, wet/humidity test and hot dust/dry cycle talk test in laboratory conditions. They tested dynamic behaviour of the corroded specimens dynamically to simulate under the crash test conditions. They exposed the samples to changing

climatic conditions in terms of humidity. It was also observed that the pitting corrosion damage and crack initiation sites were developed and propagated. Fang et. al. carried out an investigation to study the effect of elemental sulfur on the corrosion of mild steel. [2] They observed that sulphur reacted with water at temperatures more than 80^0C. They also observed that sulphur can cause localized corrosion when it comes in direct contact. They also observed that pitting corrosion rates were significantly higher than the general corrosion rates.

Rani and Basu discussed green inhibitors for corrosion protection of metals and alloys. [3] According to them corrosion control is important from technical, economical, environmental, and aesthetical point of view. Use of inhibitors is one way to reduce the corrosion. According to these studies sol-gel coatings doped with inhibitors have shown real promise. Green corrosion inhibitors are biodegradable and they do not contain any heavy metals. Malik et. al. reviewed research related to anticorrosive properties of surfactants. [4] They also discussed effect of surfactant concentration, temperature, the mechanism of corrosion inhibition and mode of adsorption. The corrosion inhibition of the metal is by virtue of adsorption of the surfactant molecules onto metal surface. According to them, addition of surfactants to acidic media was an efficient and quite cheap method for rust protection of metal surfaces. They discussed the critical micelle concentration (CMC) as key indicator in determining the effectiveness of surfactants as corrosion inhibitors. According to them, an excellent surfactant inhibitor was one that aggregates or adsorbs at low concentrations.

Muslim et.al. carried out research on effect of pH level on corrosion of metals. [5] They investigated the corrosion of aluminium and copper. They carried out experiments at two temperatures 25 and 50 ^{0}C and pH values of 4.8, 7and 8.2.They observed that the corrosion decreased with increasing pH. It increased with increase in temperature. Johnson et. al. carried out studies on corrosion by deionized water. [6] They discussed the corrosion of copper, cadmium, tungsten, and Mallory-1000. During investigation, they observed that titanium, 1100 aluminium, 304 stainless steel, boron steel, silver, and tantalum showed no corrosion in deionized water but cadmium, mallory-1000, tungsten, and copper exhibited corrosion at this temperature. Oladele and Okoro investigated corrosion effect of mild steel on orange juice. [7] They observed that the corrosiveness of sweet orange juice on mild steel was mainly a function of its acidity. According to this research packed orange juice with preservative was most corrosive followed by natural juice. Babutsky et.al. carried out an investigation on two kinds of structural metals initially treated by a pulsed electric current(PEC) of high density. [8] According to these studies the treatment influenced the corrosion rates of metals. The PEC treatment decelerated the corrosion process. Iyasara and Ovri carried out an investigation on corrosion inhibition of stainless steel (314l) using molasses. [9] They observed that the solution of the molasses inhibited the corrosion of the stainless steel samples to an extent depending on the concentration of the molasses and the type of medium. According to them, the physical adsorption of the inhibitor (molasses) on the surface of the stainless steel was a reason for corrosion inhibition. Nurnberge investigated corrosion of metals in contact with mineral building materials. [10] The presence of free water in the capillary, pore, or canal-like cavities, that exist in each building material leads to corrosion.

Baldissera and Ferreira used coatings based on electronic conducting polymers for corrosion control. [11] In their work, they

studied corrosion protection of mild steel by a novel epoxy resin (EP)-based coating system containing polyaniline (PAni) as an anticorrosive agent. They observed that the addition of three forms of PAni-undoped, sulfonated and fibers-to the EP resin increased its corrosion protection efficiency. They chose epoxy resin, as paints formulated with this resin are widely used in marine and industrial maintenance. They concluded that The coating containing sulphonated polyaniline, SPAN had the best performance in the protection of the metal among all the other samples containing PAni and the coating containing zinc phosphate (a commercial pigment widely used for this purpose). Mark carried out studies on the corrosion of steel, aluminium and copper in electrical equipments. [12] According to him corrosion is the tendency of the metals to revert to their original ore state from the metallic state. According to him, corrosion is essentially an electrical circuit wherein electrons fl own from the anode to the cathode. He emphasized that each metal used is subject to its own unique corrosion process.

Sharma et. al. studied the effect of mineral acids on corrosion properties of metals. [13] They carried out experimentation on the corrosive propensity of mild steel, aluminium and copper in various concentrations of mineral acids viz. Hal and H_2SO_4. They studied effect of acid strength on the metal loss by weight loss methods. The observed that in H_2SO_4 media, the corrosion rate of mild steel was higher than that of aluminium and copper. Aluminium corroded faster in HCL. Correa et. al. investigated the effect of clad metal composition on stress corrosion cracking (SCC) behavior of three types of SMAW filler metals (E308L-16, E309-16 and E316L-16). [14] They carried out the experimentation in 43% MgCl2 solution. They evaluated the susceptibility to stress corrosion cracking in terms of the time-to-fracture. According to the results obtained by them, the E309-16 clad metal presented the best SCC resistance.

Landolfo et.al. prepared a state of the art report on modeling of metal structure corrosion damage. [15] According to them the durability of the metal is strong function of the atmospheric conditions. They modeled the corrosion as a function of time in power form. According to them, the initial corrosion rate usually decreases over a long-term period. A large scattering of predicted corrosion depth was observed by them. Malik presented the results of an investigation related to the effect of heavy metal ions. [16] They took into account the aspects such as the nature of aqueous medium, metal ion concentration, temperature, pH and flow condition They observed that there was decrease in the corrosion rates of carbon steel in distillate water containing higher concentration of Cu and Ni under both static and dynamic conditions. They also observed that there was an increase in corrosion rates with increasing metal ion concentrations.

Rahmanto et.al. carried out investigation on corrosion rate of copper and iron in seawater. [17] They carried out investigation in three corrosion systems, in the (i) closed bath, (ii) opened or air exposed bath, and (iii) aerated bath. They determined determine the effect of oxygen contained in the air to the metals' corrosivity. They observed that air oxygen give strong effect on the corrosion of copper and iron metal .It was seen that oxygen or carbon contained in the aerating air speed up the corrosion rates of copper as well as iron. According to the report presented by Koch et. al., corrosion affects our society on daily basis. [18] They considered direct cost of corrosion as incurred by owners and operators of structures, manufacturers of products, and suppliers of services and indirect cost as cost

due to lost productivity because of outages, delays, failures, and litigation; taxes and overhead on the cost of corrosion portion of goods and services; and indirect costs of nonowner/operator activities. They found that direct cost is approximately equal to indirect cost. In estimates based 2001 data the total corrosion cost in USA was $552 billion.

CONCLUSION

Many investigators have carried out investigation on various aspects of corrosion. Corrosion control is important from technical, economical, environmental, and aesthetical point of view. Pitting corrosion rates were significantly higher than the general corrosion rates. It was found that that in H_2SO_4 media, the corrosion rate of mild steel was higher than that of aluminium and copper. It was also seen that oxygen or carbon contained in the aerating air speed up the corrosion rates of copper as well as iron. Many convention corrosion prevention methods like use of coatings, galvanizing can be effective for the corrosion prevention. There is scope for decreasing the loss due to corrosion by modifying current techniques or replacing them by new methods like use of green inhibitors.

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