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To cite this article: R.C. Nduma *et al* 2021 *IOP Conf. Ser.: Mater. Sci. Eng.* **1107** 012220

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Assessing the potential of inhibitors and essential drugs toward corrosion preventive measure

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Abstract

Corrosion as a major problem and inhibition of corrosion can be said to be the best economic option applied when mitigating corrosion. Corrosion inhibition has already been established in various commercial enterprises, either for the protection of pipes in the petroleum industry or to reduce the disintegration rate of feed water sections or boilers or also used to cut down the sulphide induced decomposition in industries that are being utilized for the gasification of steel pipelines. Thus, this overview establishes the fundamental principle of inhibitor usage on metallic materials and the factor affecting the choice of the inhibitor.

Keywords: Potential, inhibitor, green, prevention

1. Introduction

Corrosion degradation has been a major challenge in material technology application due to activities of environment and other condition [1-5]. Pitting corrosion is a type of corrosion that occurs in metals that passivate. The metal has gone through a process whereby it does not corrode as fast as it would have in the presence of a corrosive environment [6-8]. Passivation is the establishment of a layer of shield material which occurs as a micro coating in order to reduce the environmental effects on the metal [9-14]. Passivation is very crucial to numerous industries, science and technology involving metals and metal alloys which need a high corrosion resistance to function [15-20]. Pitting corrosion is a form of localized attack which produces holes in metals or metal alloys. On the other hand, the use of exotic metals is one of the ways of reducing crevice corrosion among other control methods. Stainless steel is predisposed to intergranular corrosion because of the chromium present in its micro structure [21-25]. If austenitic stainless steel is exposed for a specific amount of time to high temperature that is between 450-850 °C, the chromium carbides are precipitated and left to a bare minimum making the steel very sensitive to the corrosion process [26-30]. Intergranular corrosion usually weakens the bonding force between the mechanical strength of metals and crystal grains of the metals and the metals will be flagged as damaged [30-33]. It is a well-known cause of failure in aircrafts. Progression of corrosion must time are often different and simultaneous in nature. The result of the simultaneous action of erosion and corrosion is known as erosion corrosion. A fast-flowing fluid is involved in this process [34, 35]. Here, the effect of the fast-flowing fluid causes the protective layer of the metal to wear off making the metal less resistant to corrosion hence causes failure because the active part of the metal makes contact with the corrosive environment. Thus, this overview establishes the fundamental principle of inhibitor usage on metallic materials and the factor affecting the choice of the inhibitor.

2. Inhibition of the surface of the metal



An inhibitor can be explained as any physical entity supplied in little quantity to a corrosive environment so as to minimize the magnitude of deterioration on a metal. An inhibitor is seen as a retarding catalyst. Furthermore, an inhibitor can be described as any chemical entity or group of content that is added in small amount, reduces the amount of metal wastage, minimizes the extent of hydrogen embrittlement, protects the metal and metal alloy from pitting, and reduces excessive reaction between the corrosive environment and the metal [34]. They reduce material deterioration by acting as an obstruction either by retarding the anodic or cathodic processes or retarding both or by creating an adsorbed layer on the surface of the metal. Inhibition of corrosion can be said to be the best economic option applied when mitigating corrosion. Corrosion inhibition has already been established in various commercial enterprises, either for the protection of pipes in the petroleum industry or to reduce the disintegration rate of feed water sections or boilers or also used to cut down the sulphide induced decomposition in industries that are being utilized for the gasification of steel pipelines. There are different classifications of inhibitors which are; adsorption type inhibitors. These types of inhibitors represent the highest type of inhibitors used. Generally, adsorption type inhibitors are a set of organic compounds that get adsorbed on the surface of a metal and provide a form of blanketing effect all over the total surface of the metal. Examples of adsorption type inhibitors are organic amines such as hydrogen evolution poison which are substances that delay the hydrogen-evolution reaction. They include arsenic and antimony ions. These poisons are very potent in acidic mixture but are powerless in those environments where some reduction reactions are the controlling reactions example oxygen reduction. Scavengers on the other hand can be seen as substances which eliminate corrosive agents from the solution. Examples of scavengers are hydrazine and sodium sulphate. They get rid of dissolved oxygen from aqueous solutions. This kind of inhibition works well in environments where reduction reactions are the controlling reactions. Some metals and metal alloys exhibit active-passive transitions. Examples of oxidizers are iron and stainless steel. Oxidizers are used to inhibit these metals and metal alloys that show the form of transition mentioned above and some of these oxidizers are chromate, ferric salts and nitric salts and oxidizers. Another important inhibitor is the vapor-phase inhibitors to inhibit atmospheric corrosion of metals without being placed in direct contact with the metals. They are also known as volatile inhibitors. These chemical substances have low but very significant vapor pressure.

Factors affecting the choice of inhibitors

The following factors are considered when selecting different inhibitors for different applications;

- It should not be a source of pollution or toxicity to the environment;
- It is expected to possess long range effectiveness;
- It should possess the ability to suppress the different forms of corrosion;
- The inhibitor should be readily available;
- The cost of purchasing the inhibitor;
- The inhibitor utilized should be environment friendly;
- The inhibitor should remain efficient at different operating conditions;
- It must give good corrosion resistance with the little concentration added;
- It must be able to protect the surface of the material which is exposed from attack

- No deposits of the inhibitor should remain on the surface of the metal especially at locations in where heat transfer takes place.

3. A review on the application of drugs as inhibitors

According to [1], established the fact that drugs can act as an inhibitive compound and they are efficient substitutes for high toxic organic inhibitors since both of them operate on the principle of adsorption. They stated that drugs are relatively cheap, non-toxic and the negative effects of drugs on the environment are negligible. Fayomi, Anawe & Daniyan investigated the effect of drugs employed as inhibitors of corrosion on aluminium alloys in a coastal-acidified medium. The research saw the different experiments involving the characteristics of aluminium in HCl being investigated as various drugs were used as inhibitors. Meclazine which is an antihistaminic drug showed excellent inhibition of Aluminium in HCl at 303K (30°C). Clotimazole and Fluconazole which are antifungal drugs show that both drugs serves as excellent inhibitors to the medium. Finally, voltaren drug resulted in a shift in the E_{corr} to the route which is more noble by the molecules of the inhibitor [1].

Fajobi, Fayomi, Akande & Odunlami (2019) studied the inhibitive operation of ibuprofen on the metal mild steel in 0.5moles of sulfuric acid. The research work carried out examined the adsorption outcome when ibuprofen is used on mild steel using polarization method. The concentration of the drug ranged from 0-20ml with a 5ml difference for 5 samples. The adsorption studies carried out, unveiled that while there is addition in the concentration of ibuprofen drug, the level of efficiency of the samples which were inhibited increase. The results also shows the ibuprofen produced a level of protein on the mild steel in the environment which caused rapid attack. The investigation showed that the Freundlich adsorption isotherm complied appropriately which shows mild steel adsorbed the inhibitor with a correlation regression coefficient of 0.97. The nearness of the value of correlation regression coefficient to unity shows that ibuprofen acts reliably as an inhibitor[2]. Fouda, Ibrahim & Atef (2017) looked into the adsorption properties and the inhibitive properties of sildenafil which is commonly known as viagra for zinc in a hydrochloric solution. The investigations which were carried out on Zinc (Zn) in one mole of hydrochloric acid solution with Sildenafil (Viagra) as the inhibitor at 298K (25°C). The electrochemical results displayed efficiency in the use of the drug as a corrosion inhibitor in HCl environment. The outcome also highlighted that the (I.E) reached 91% at 300ppm. The inhibition efficiency increases with increase in the concentration of the drug while the inhibition efficiency reduces with increase in the temperature. The Langmuir adsorption isotherm was in line with the results gotten. Plots from the analysis shows Sildenafil behaves like a mixed type inhibitor [37].

Guruprasad, Sachin, Swetha & Prasanna (2019) conducted an extensive research on the adsorption and the inhibitive properties of seroquel drug for the corrosion of zinc in 0.1M HCl solution. The action of the inhibitor which is seroquel drug on the depletion of zinc in 0.1moles of hydrochloric acid was examined using gravimetric analysis, electrochemical potentiodynamic polarization method and impedance spectroscopic techniques. The I.E of the corrosion process displayed an affirmative effect when the concentration of the drug was increased. Similarly, a positive result was given when the temperature of the solution was increased. The results obtained all round were in accordance with one another. Study showed that the outcome of using seroquel drug as an inhibitor is as a result of the adsorption property of the drug molecule on the surface of zinc. The adsorption isotherm which agreed

perfectly with the results gotten was the Temkins adsorption isotherm. The potentiodynamic polarization studies showed us that the inhibitor behaves like a mixed type inhibitor. The metal which had corroded was characterized using a scanning electron microscope (SEM) [5].

3.1. A review on the utilization of erythromycin as an inhibitor

Agnesbrigitte, Thangavelu & Rajedran conducted different experiments to find out the corrosion resistance of orthodontic wires in artificial saliva in the presence and absence of erythromycin tablet (500mg). The orthodontic wires are basically Ni-Ti and Ni-Cr alloys which were plunged in spittle with or without Erythromycin tablets 500mg which was evaluated through electrochemical studies of polarization and AC impedance Spectra. From the AC impedance spectra and the polarization studies, it is revealed that the presence of the 500mg tablet of Erythromycin in artificial saliva, the corrosion of Ni-Cr decreases. This is revealed by the increase in I_{corr} (corrosion current), the decrease in charge transfer resistance (R_t), decrease in linear polarization resistance (LPR) and the increase in double layer capacitance (C_{dl}). The studies reveal that corrosion resistance of Ni-CR alloy decreases in the order; Artificial Saliva > Artificial Saliva + Erythromycin. Hence, people clipped with orthodontic wire made of Ni-CR alloy should avoid taking erythromycin orally. For Ni-Ti alloy, corrosion resistance decreases in the order Artificial Saliva + Erythromycin > Artificial Saliva. Hence people clipped with orthodontic wires made of Ni-Ti alloy should avoid taking erythromycin tablet orally [4].

Eddy, Odoemelam, Ogoko & Ita (2010) made remarkable study on the inhibition of the corrosion of zinc in 0.01-0.04M of H_2SO_4 by erythromycin. The inhibition of the corrosion process using erythromycin was studied using weight loss and hydrogen evolution method. The results which were obtained from the experiments showed that the drug erythromycin is an excellent adsorption inhibitor for the corrosion of zinc in H_2SO_4 solutions. The results gotten from experiments shows that the inhibition efficiency of erythromycin increases with increasing concentration while the inhibition efficiency reduces with increase in the temperature. From the adsorption and thermodynamic studies which were carried out, it was revealed that adsorption of erythromycin on the surface of zinc is spontaneous, exothermic and characterized by increasing degree of orderliness. The best adsorption isotherm to describe the inhibition effect of erythromycin on zinc in H_2SO_4 is the Langmuir adsorption isotherm. From the results, we can say the type of adsorption which occurs here, is physical adsorption of the erythromycin on the surface of the zinc metal [5].

Brigitte, 2018 studied the corrosion resistance of SS18/8 alloy, SS316L alloy, Gold 18 carat and Gold 22 carat in artificial saliva in the absence of erythromycin tablet 500mg. The corrosion resistance of the alloys in artificial saliva in the presence and absence of erythromycin were evaluated by electrochemical study which is polarization study. The results show that the Gold 18 and Gold 22 carat reduce in the order; AS + Erythromycin > AS which means that the people clipped with an orthodontic wire made of SS316L alloy of either Gold 18 or Gold 22 carat can take Erythromycin tablets orally. The polarization results show that the SS18/8 alloy decreases such that; AS > AS + Erythromycin which means that people clipped with an orthodontic wire of SS18/8 should avoid taking erythromycin tablet [6].

3.2. A review on the use of ampicillin and cloxacillin as an inhibitor

Adejoro, Ojo & Obafemi (2014) performed a research on the corrosion inhibition potentials of Ampicillin for mild steel in hydrochloric acid solution. Ampicillin which is an antibiotic drug was investigated as an inhibitor for mild steel in HCl using gravimetric method. The

study showed various results at different concentrations for ampicillin. The results generally showed a trend which involved the increase in the inhibition efficiency when the concentration of the inhibitor was increased. Furthermore, the inhibition efficiency of ampicillin reduced with increase in temperature. The adsorption was revealed to be a physical for of adsorption which was also exothermic and was spontaneous as confirmed by values of the free energy and activation energy of adsorption. The results gotten also fitted perfectly to the Langmuir adsorption isotherm. The LUMO and HOMO plot shows that ampicillin is an effective corrosion inhibitor [35].

Fadila, Sihem, Sameh & Kardas studied the inhibition effect of expired amoxicillin on mild steel in 1M of HCl. The inhibition effect and adsorption effect of expired amoxicillin on mild steel in 1M HCl was studied by potentiodynamic polarization, electrochemical impedance spectroscopy, weight loss, zero charge potential method and characterized by atomic force microscopy and scanning electron microscope. The inhibition efficiency which was obtained by weight loss is 94.47% at 1800ppm after immersion for 8 hours. Amoxicillin is said to perform like a mixed inhibitor from the results gotten and the surface is negatively charged. It obeys the Langmuir adsorption isotherm with a self-generated process. Physiosorption can also be identified here [36].

Conclusion

The continuous failure of metallic materials in several applications has been due to corrosion activities. It is established from this study that corrosion propagation is an electrochemical responses. It is also affirmed that the effect of materials damage in services in relations to the environment when inhibitor are use on. Thus several reviews process on adsorptive organic inhibitor was determine. Factor affecting the selection of inhibitive plans was also well-known.

Acknowledgement

The authors will like to acknowledge the support of Covenant University for the publication fund

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