GREEN INHIBITORS: A POSSIBLE SOLUTION TO CONTROL CORROSION

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Abstract- In this review article we are going to discuss about corrosion control of metals which is of technical, environmental, and aesthetical importance. Use of inhibitors is one of the best techniques to protect any kind of metal and alloys from the effect of corrosion. We are more inclined towards searching for biodegradable component which are harmless for the environment. There are more advantages of using a biodegradable inhibitors such as they are environment friendly, inexpensive, readily available, ecologically acceptable and renewable as well. Recent studies have shown that the sol-gel coatings doped with inhibitors are effectively controlling corrosion.

Keywords- Inhibitors, Extraction, Plant Extracts, Corrosion Process

I. INTRODUCTION

Corrosion is all about the deterioration of metal by various attacks and reactions with its environment. Protection from corrosion completely is a difficult process. The study of mild steel and iron is matter of theoretical and practical concern and has received so much interest around the world. Acidic solutions are used in industry to clean metal before coating and acid pickling. Corrosion results diffusion of metal into the coating matrix and formation of oxides.

II. CORROSION INHIBITORS

A lot of times and efforts have been put to find suitable organic origin inhibitors. All the derivatives of nitrogen-base material, sulphur-containing compounds, aldehydes, thio aldehydes,
acetylenic compounds etc. are used as inhibitors. Inhibitors decrease effect on the metal and reduce the corrosion rates by:

1. Adsorption of ions onto metal surface.
2. Increasing or decreasing the anodic and cathodic reaction.
3. Decreasing the diffusion rate for reactants to the surface of metal.
4. Decreasing the electrical resistant’s of the metal surface.
5. Inhibitors that are easy to use have in situ advantage.

### III. ORGANIC INHIBITORS

They generally have heteroatom’s. O, N, S has higher basicity and electron density act as corrosion inhibitors. They are active centers for the process of adsorption on the metal surface. The efficiency follows the following sequence O<N<S<P. Availability of no bonded and p-electrons in these molecules facilitates electron transfer from the inhibitors to metal. When an H atom is attached to the C in the ring is replaced by a substituent group which improves inhibition. It increases with the carbon no. in the chain to about 10 carbons, but with higher members. However the presence of a hydrophilic group in the molecule increases the solubility. The inhibition could be due to:

1. Adsorption of the molecule or it’s ions on anodic and cathodic sites.
2. Increase in cathodic and anodic over voltage.
3. The formation of a barrier film which is protective.

Some factors that contribute to the action are length, size of molecule, bonding, strength of bonding to the substrate, cross linking ability, solubility in the environment.
IV. ROLE OF INHIBITORS

Their role is to form a barrier of one or several molecular layers against acid attack. Inorganic substances such as phosphates, chromates, dychromates, silicates, borates, tungstates, molybdates and arsenates have been found as a protection against metal corrosion. They are also useful in the formulation of primers and anti-corrosive coating, but the major disadvantage is the amount of toxicity in their use. Inhibitors are often added in industrial process to secure metal from acid solution. The hazardous effect of most synthetic inhibitors and the need to develop cheap, nontoxic and ecofriendly process have forced the researchers to focus on the use of natural products. The use of inhibitors is one of the best option of protecting metals against corrosion. However, most of them are toxic to the environment.

V. GREEN INHIBITORS

This protective action is often associated with chemical and/or physical adsorption involving a variation in the charge of surface and transfer of charge from one to another among the alternative corrosion inhibitors, organic substances containing polar function with nitrogen, sulphur, oxygen in the conjugated system have been reported to exhibit good properties. The main constituents of plants extracts have been reported to be a wide variety of organic compounds, including polyphenols, terpenes, carboxylic acids and alkaloids. Some of these compounds have the ability to inhibit microbial development as they can act as very effective reactive oxygen scavengers.
Distribution of the research work performed in the last two decades on natural products as corrosion inhibitors for aluminium and its alloys presented in this review.

VI. MECHANISM ACTION OF GREEN INHIBITORS:

Many authors have suggested that organic substances, which form onium ions in acidic solutions are adsorbed on the cathodic side of the metal surface. The anodic dissolution mechanism of mild steel is:

\[
\begin{align*}
\text{Fe} + \text{Cl}^- & \leftrightarrow (\text{FeCl}) \\
(\text{FeCl})^- & \leftrightarrow (\text{FeCl}^-)^+ + e^- \\
(\text{FeCl}^-)^+ & \leftrightarrow (\text{FeCl}^+) + e^- \\
(\text{FeCl})^- & \leftrightarrow \text{Fe}^{2+} + \text{Cl}^- 
\end{align*}
\]

The cathodic hydrogen mechanism is:

\[
\begin{align*}
\text{Fe} + \text{H}^+ & \leftrightarrow (\text{FeH}) \\
(\text{FeH})^+ + e^- & \leftrightarrow (\text{FeH})^+ \\
(\text{FeH})^+ + \text{H}^+ + e^- & \leftrightarrow \text{Fe} + \text{H}_2
\end{align*}
\]

Generally, the corrosion inhibition mechanism in an acid medium is adsorption of the inhibitor on the metal. The charge of the metal, the chemical structure of the organic inhibitor and all the type of aggressive electrolyte.
Various mechanisms, of actions have been postulated for the corrosion inhibition property of the natural products.

VII. ARGEMONE MEXICANA

It is a contaminant of mustard seeds contain all alkaloid which has a long chain of aromatic rings,

GARLIC:

It contains allyl propyl disulphide. Probably, this S-containing unsaturated compounds affects the potential cathodic process of steel.

CARROT:

It contains pyrrolidine in aqueous media, resulting in stronger bond formation at N Carrot does not ionize in acidic media and thus does not protect in acids.

FENNEL SEEDS:
Essential oil from fennel (Foeniculum vulgare) (FM) was tested as corrosion inhibitor of carbon steel in 1 M HCl using electrochemical impedance spectroscopy (EIS), Tafel polarisation methods, and weight loss measurements. The analysis allowed the identification of 21 components which accounted for 96.6% of the total weight. The main constituents were limonene (20.8%) and pinene (17.8%) followed by myrcene (15%) and fenchone (12.5%). It is logical to assume that such adsorption is mainly responsible for the good protective properties by a synergistic effect of various molecules.

**GARCINIA MANGASTONA:**

Electrochemical parameters such as Ec_{corr}, and indicate the mixed mode of inhibition, but predominantly cathodic. IR analysis and impedance studies indicate that the adsorption on the metal surface is due to the heteroatoms present in the organic constituents of the extract of G. mangostana.

**IPOMEA INVOLCRATA:**

The plant has been shown to contain mainly d-lysergic acid amide (LSA) and small amounts of other alkaloids, namely, chanoclavine, elymoclavine, and ergometrine, and d-isolysergic acid amide. Thus, the formation of a strong physisorbed layer between the metal surface and the phyto constituents of the plant extract could be the cause of the inhibitive effect.

**SOYA BEAN:**

It is rich in proteins, which are often good inhibitors in acidic media. Most natural extracts constitute of oxygen- and nitrogen-containing compounds. The complexes thus formed cause blockage of micro anodes and/or microanodes, which are generated on the metal surfaces when in contact with electrolytes, and, hence, retard subsequent dissolution of the metal.

**TERMINALIA CATAPPA:**

The inhibition potential of ethanol extract of T. catappa is attributed to the presence of saponin, tannin, phlobatin, anthraquinone, cardiac glycosides, flavanoid, terpene, and alkaloid in the extract.

**GOSSYPIUM HIRSUTUM:**

The inhibition efficiency increased with increasing concentration of the extracts. The leave extract (GLE) was found to be more effective than the seed extract (GSE). The GLE gave 97% inhibition efficiency while the GSE gave 94% at the highest concentration . The inhibitor acts by being adsorbed on mild steel surface according to classical adsorption models of Langmuir and Temkin adsorption isotherms.

**CARMINE AND FAST GREEN DYES:**

The use of dyes such as azo compounds methyl yellow, methyl red, and methyl orange as inhibitors for mild steel has been reported. The fast green molecules possess electroactive nitrogen, oxygen atoms, and aromatic rings, favouring the adsorption while the carmine molecules possess. The inhibitors were adsorbed on the mild steel surface according to the Temkin adsorption isotherm.
PLANT EXTRACTS AND CORROSION INHIBITORS:
The evaluation of some plant extracts and the correlation between the extract profile and the corrosion inhibitive effect should be focused on the total phenolic content.

EXTRACTIONS METHODS USED TO OBTAIN PLANT EXTRACTS:
The decision on selecting the extraction method to profile the target content of plant species is related to the chemical nature of the substance, sample particle size, and also by the presence of interfering substances.

DRUGS AS CORROSION INHIBITORS FOR ALUMINIUM AND ITS ALLOYS:
Especially in relation to the corrosion inhibition of steel. However, studies describing drugs as corrosion inhibitors for aluminium and its alloys are rather rare, although such research might become attractive in the near future.

ANTIBACTERIAL DRUGS:
The terms antimicrobial, antibiotic, and anti-infective encompass a wide variety of pharmaceutical agents that include antibacterial, antifungal, antiviral, and ant parasitic drugs.

PENICILLIANS:
Penicillins act by inhibiting the formation of cross-links in the bacterial cell wall, which weakens it to such an extent that the osmotic pressure in the interior of the bacteria becomes increasingly uncompensated, causing cell death.

CEPHALOSPORINS:
With a similar spectrum of activity against bacteria as penicillin, they are oven the second line of treatment, when penicillins cannot be used or when their oven low solubility in aqueous media is not a limitation.
SESMUN:
They contains lignans such as sesamol, sesamin and sesamolin. The percentage composition of fatty acid is 44%, stearic acid 4.2%, palmitic acid 9% and arachidic acid 0.7%. The presence of sesamol, sesamin and sesamoline in *indicum* oil worked as inhibitor in 0.5N HCl solution.

VIII. CONCLUSION

There is a growing trend to use plant extracts and pharmaceutical compounds as corrosion inhibitors. Inhibitors play a vital role in providing protection against corrosion. The selection of the inhibitor is important for environmental protection. Inhibitors play a vital role in providing protection against corrosion. The selection of the inhibitor is important for environmental protection. So many inhibitors specially Green Inhibitors as well as Drugs that’s used in Pharmaceutical fields that can be used as Corrosion Inhibitors. Not all inhibitors are eco-friendly. There is a growing trend to use plant extracts and pharmaceutical compounds as corrosion inhibitors. Most of these compounds are environmentally-friendly. Piperacillin sodium proved to be an eco-friendly inhibitor for mild steel in 1 M HCl solution with an efficiency of 93% at $7 \times 10^{-4}$ to $9 \times 10^{-4}$ M concentration.

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REFERENCES

[1] M. Bouklah, B. Hammouti, T. Benhadda, and M. Benkadour, “Thiophene derivatives as effective inhibitors for the corrosion of steel in 0.5 M H$_2$SO$_4$,” Journal of Applied Electrochemistry, vol. 35, no. 11, pp. 1095–1101, 2005.
[2] A. S. Fouda, A. A. Al-Sarawy, and E. E. El-Katori, “Pyrazolone derivatives as corrosion inhibitors for C-steel HCl solution,” Desalination, vol. 201, pp. 1–13, 2006.
[3] A. Fiala, A. Chibani, A. Darchen, A. Boulkamh, and K. Djebbar, “Investigations of the inhibition of copper corrosion in nitric acid solutions by ketene dithioacetal derivatives,” Applied Surface Science, vol. 253, no. 24, pp. 9347–9356, 2007.
[4] U. R. Evans, The Corrosion and Oxidation of Metals, Hodder Arnold, 1976.
[5] O. K. Abiola, N. C. Oforka, E. E. Ebenso, and N. M. Nwinuka, “Eco-friendly corrosion inhibitors: The inhibitive action of Delonix Regia extract for the corrosion of aluminium in acidic media,” Anti-Corrosion Methods and Materials, vol. 54, no. 4, pp. 219–224, 2007.
[6] M. Kliskic, J. Radoservic, S. Gudic, and V. Katalinic, “Aqueous extract of Rosmarinus officinalis L. as inhibitor of Al-Mg alloy corrosion in chloride solution,” Journal of Applied Electrochemistry, vol. 30, no. 7, pp. 823–830, 2000.
[7] A. Y. El-Etre, “Natural honey as corrosion inhibitor for metals and alloys. I. Copper in neutral aqueous solution,” Corrosion Science, vol. 40, no. 11, pp. 1845–1850, 1998.
[8] A. Y. El-Etre, “Inhibition of aluminum corrosion using Opuntia extract,” Corrosion Science, vol. 45, no. 11, pp. 2485–2495, 2003.
[9] A. Y. El-Etre, “Khillah extract as inhibitor for acid corrosion of SX 316 steel,” Applied Surface Science, vol. 252, no. 24, pp. 8521–8525, 2006.
[10] E. E. Ebenso, U. J. Ibok, U. J. Ekpe et al., “Corrosion inhibition studies of some plant extracts on aluminium in acidic medium,” Transactions of the SAEST, vol. 39, no. 4, pp. 117–123, 2004.