

Investigating Benzotriazole Corrosion Inhibitors in the Action of Organic Mechanism

Ankit Kumar¹, Sandeep Kumar², Navedul Haque³, Shashi Bhushan Kumar⁴

^{1,2,4}Post Graduate Student, University Department of Chemistry, B.R.A. Bihar University, Muzaffarpur, Bihar, India.

³H.O.D. University Department of Chemistry, B.R.A. Bihar University, Muzaffarpur, Bihar, India.

Abstract:- This present research paper deals with the Investigation on Benzotriazole Corrosion Inhibitors in the action of organic Mechanism. This paper introduces the properties and mechanism of Benzotriazole Corrosion inhibitors. The Synergistic action of Benzotriazole and Imidazole better illustrates the progress of the sustained release. Combined with the Corrosion example of Copper in Sodium Chloride Solution to illustrate the Corrosion inhibition of Triazole Compounds which is our main conclusion.

Keywords: Benzotriazole Corrosion Inhibitor, Copper Corrosion Inhibitor, Synergistic effect.

I. INTRODUCTION

Kundall, M.G. (2), Burberry, M.G. and Green field, G.L. (3) are the pioneer workers of the present area. In fact, the present work is the extension of work done by Kumar Ankit & Kumar Sandeep (1), Wall, K.H. & Davis, I (4) and Hallows, A.P.C. (5). In this paper we have investigated Benzotriazole Corrosion Inhibitors in the Action of Organic Mechanism.

II. ORGANIC MECHANISM AND CONCLUSIONS :

A. Benzotriazole Properties and Functions

Benzotriazole, an organic compound, White to light pink needle crystals. It is also a good corrosion inhibitor material. Soluble in alcohol, benzene, toluene, chloroform, dimethylformamide, and most organic solvents, slightly soluble in water, soluble in hot water, soluble in alkaline aqueous solution.

1,2,3-benzotriazole is divided into oil-soluble BTA chemical and water-soluble BTA chemical. The latter is dissolved in water or a solvent. The solvent includes ethanol, benzene, toluene, chloroform, and N-N-dimethylformamide.

In addition, the benzotriazole corrosion inhibitor is used for surface purification of silver, copper, and zinc in electroplating. It has an anti-tarnishing effect.

Moreover, it is a good ultraviolet light absorber and is used as a development antifoggant for black and white film and photographic paper.

Thus, Benzotriazole is also a corrosion inhibitor for copper and its alloys widely used in industry, but it is more toxic. However, the imidazole derivatives of benzotriazole are relatively less toxic and effectively inhibit the copper alloy under acidic conditions.

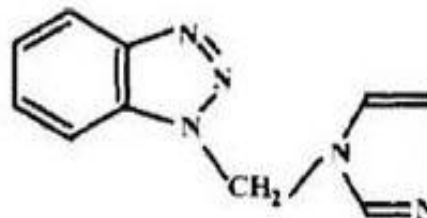


Fig. 1 Structural formula of 1-[(1'-imazole)-methyl] benzotriazole

B. Corrosion Inhibitor Profile and Mechanism

Corrosion inhibitors prevent or slow the corrosion of materials at specific concentrations and media. The amount of corrosion inhibitor is generally 0.1% to 1%, which provide significant corrosion inhibitor protection. The medium covers acidic, neutral and gaseous. It includes boiler cooling water, descaling and rust removing acid solution and gas phase corrosion inhibitor. The following is explained by the classification of control parts.

(i) Anode Type Corrosion Inhibitor

The anode type corrosion inhibitor is generally an oxygen-free strong oxidant, including chromium, molybdenum, tungsten, vanadium and other oxyacid salts and nitrite. The mechanism of action is to form an oxidized coating film with a metal cation in the anode region of the metal surface and to protect it, that is, passivation.

Thus, this action inhibits the dissolution of the metal. However, the inhibition depends on the concentration of the corrosion inhibitor. If the concentration is not high enough, the protective film is not fully covered, which cause pitting.

(ii) Extreme Corrosion Inhibitor

Cathodic corrosion inhibitors are types that inhibit the cathodic reaction on metal surfaces. The types include zinc carbonate, calcium carbonate, zinc phosphate, calcium phosphate, and the like. The mechanism of action of the cathode type corrosion inhibitor is to react with the metal in the cathode region to form a sufficiently thick deposited film, hindering the release of electrons and participating in the reaction.

In practical applications, calcium ions, carbonate ions, and hydroxide ions are naturally present in water. Therefore, it is only necessary to add soluble zinc and phosphate to inhibit corrosion.

(iii) Mixed Corrosion Inhibitor

A mixed corrosion inhibitor is a special organic corrosion inhibitor. The molecular architecture contains two opposite polar groups. The region where the monomolecular film is formed on the metal surface is either an anode region or a cathode region. The inhibition is to inhibit the diffusion of dissolved oxygen in the water to the metal surface, which hinders the progress of the corrosion reaction. Such corrosion inhibitors include benzotriazole, cetyl amine, and the like.

C. Benzotriazole Corrosion Inhibitor Effect

(i) Synergistic Effect of Imidazole and 1 2 3-Benzotriazole

On the copper metal surface, monovalent copper ions and benzotriazole form an insoluble composite film by adsorption and reaction. It also acts to hinder the corrosion of copper metal.

Moreover, the BTA chemical has a very significant effect on the copper oxide film to promote passivation. The polarization of the anode-anode process after the combination of benzotriazole and imidazole significantly enhanced. The corrosion potential is negatively shifted and compounding increase the inhibition of Cu in the NaCl medium.

Thus, from a molecular perspective, benzotriazole and imidazole act on the oxide film on the surface of Cu and monovalent copper ions. Thereby suppressing corrosion of copper, when imidazole and benzotriazole are used in combination, the imidazole partially accept electrons from the Cu(d) orbital. Thereby increasing the stability of the complex film.

(ii) Sustained Release of Benzotriazole on Metal Surfaces

In acidic and neutral environments, the effectiveness of corrosion inhibition is multifaceted. As the chemical potential increases, the electrophilic effect decreases and increases. It also increases as the minimum non-occupied orbital energy of the molecule increases.

In particular, in a neutral environment, a nitrogen atom forming a double bond in a molecular structure and an oxygen atom connecting a carbon atom become active sites. Moreover, the regions of these atoms become regions with a large electron density. It mainly reflects the electronegativity of the whole molecule.

In addition, under acidic conditions, the reactive sites are concentrated in the middle of the nitrogen atom. This is followed by an oxygen atom and plays the same role as the neutral condition.

Therefore, through the above comparison, we conclude that the triazole compound containing a sulfur atom is superior to the triazole compound containing an oxygen atom in the inhibition performance.

III. CONCLUSION

Benzotriazole corrosion inhibitor(BTA) is widely used in metal rust and copper corrosion inhibitors. It is used as an anti-rust and gas phase corrosion inhibitor. This product also used together with a variety of scale inhibitors, bactericidal algacides for corrosion inhibition and rust prevention of copper and silver equipment.

In electroplating applications, it is used as a surface for the purification of silver and copper, prevent oxidative discoloration. For copper corrosion inhibition applications, benzotriazole forms covalent bonds and coordination bonds with surface copper ions. The reaction produces a polymeric protective film. Stopping the progress of the corrosion redox reaction.



International Journal of Recent Development in Engineering and Technology

Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 14, Issue 10, October 2025 Crossref DOI 10.54380/IJRDET1025_03)

The same corrosion inhibition effect also occurs in other metal materials. Such as zinc, lead, cast iron, and nickel.

Thus, Benzotriazole is also used in combination with a variety of other corrosion inhibitors to improve sustained release. In the corrosion inhibition application of the closed circulating cooling water system, the effect is very good.

In addition, the addition of 1,2,3-benzotriazole to the antifreeze mixture of ethylene glycol and water for automobiles is also exert a good sustained release effect, which provides a more promising prospect for extending the life of the device.

Thus, Benzotriazole is a commonly used and readily available corrosion inhibitor and chemical raw material.

Hence, the result.

Acknowledgement :-

The authors are thankful to Prof. (Dr.) Navedul Haque, Head, University Department of Chemistry, B.R.A.B.U. Muzaffarpur, Bihar, India, Prof. (Dr.) Arun Kumar Former Head, University Department of Chemistry, B.R.A.B.U. Muzaffarpur, Bihar, India, Prof. (Dr.) Syed Mumtazuddin, Former Vice Chancellor, V.K.S.U. Arrah, Bihar, India, Prof. (Dr.) Ram Kumar, University Department of Chemistry, B.R.A.B.U. Muzaffarpur, Bihar, India, Dr. Bhawana, University Department of Chemistry, B.R.A.B.U. Muzaffarpur, Bihar, India, Dr. Sunil Kumar Singh, Retd. Associate Professor in Zoology, L.N.T. College Muzaffarpur, B.R.A.B.U. Muzaffarpur, Bihar,

India, Dr. Abhay Nanda Srivastava, University Department of Chemistry, B.R.A.B.U. Muzaffarpur, Bihar, India, Dr. Priya Ranjan Kumar, University Department of Chemistry, B.R.A.B.U. Muzaffarpur, Bihar, India, Mr. Jaynath Kumar, University Department of Chemistry, B.R.A.B.U. Muzaffarpur, Bihar, India, Dr. Anil Kumar Singh, Assistant Professor of Mathematics S.N.S. College Hajipur, B.R.A.B.U. Muzaffarpur, Bihar, India and Mrs. Suman Kumari, M.A.(Psychology) M.L.I.S. for extending all facilities in the completion of the present research work. The authors are also thankful to Dr. Umesh Kumar Srivastava, (D.Sc. Awardee in Maths and Global Image of Research Award), the Reviewer, the Senior Editorial Board Member and Co-ordinator of IJETAE for publication of this present Research Paper in the International Journal.

REFERENCES

- [1] Kumar Ankit & Kumar (2025) : International Journal of Recent Sandeep Development in Engineering & Technology, Vol. 14 (05), pp. 24 – 26.
- [2] M.G. Kendall (1966) : International Copper Research Association, New York, pp. 28.
- [3] M.G. Burberry and G.L. Green field (1968) : International Copper Research Association New York, pp. 34.
- [4] K.H. Wall and I. Davies (1965) : Journal of Applied Chemistry 15(8) pp. 389 – 392.
- [5] A.P.C. Hallows (1962) : Brighter outlook of Copper, Vol. 15 pp. 4 – 6.