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Study on Recent Mechanism of Benzotriazole as Corrosion Inhibitor for Organic Compounds

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Abstract:- **This paper presents the study on Recent mechanism of Benzotriazole as corrosion inhibitor for organic compounds including its alloys and acting as Cathodic inhibitor. Here, in this paper, we discuss about organic compounds and its alloys including efficacy and dependency on its concentration coverage area of the organic compounds and its alloys. Here, it is proved in this paper that Inhibitors are adsorbed on the surface of the organic compounds with respect to Langmuir adsorption.**

Keywords:- **Benzotriazole, Langmuir Adsorption, and Cathodic Inhibitor, Buffer Solutions, Sodium Salt, Sodium Hydroxide.**

I. Introduction

Hallowes A.P.C. (2) and Kandall, M.G. (3) are the pioneer workers of the present area. In fact, the present work is the extension of work done by A.F. and D.K. (1), Schaeffer, J.R. (4), Meighen, A.D. (5), M.G. and G.L. (6) and Wall, K.H., Davies I (7). In this paper, we have studied a new characterization of Benzotriazole Mechanism as Corrosion Inhibitor for organic compounds.

II. Chemical Formulations & Conclusions

Benzotriazole forms a strongly bonded chemisorbed two-dimensional barrier film less than 50 angstroms thick. This insoluble film, which may be a monomolecular layer, protects copper and its alloys in aqueous media, various atmospheres, lubricants, and hydraulic fluids. Benzotriazole also forms insoluble precipitates with copper ions in solution (that is, it chelates these ion), thereby preventing the corrosion of aluminum and steel in other parts of a water system.

Use of benzotriazole, and other protective chemicals such as tolutriazole, constitutes a significant advance in the quest for corrosion inhibitors. It demonstrates that effective inhibition can function through the formation of true chemical bonds.

The inhibitor effectively combats tarnish beneath lacquer films. This mode of failure is due primarily to peroxides formed during the early stages of degradation of the lacquer film and residual solvent under the influence of ultraviolet radiation.

Greatly increased protection is afforded by the incorporation of suitable ultraviolet absorbers, antioxidants and copper complexing agents. Careful cleaning and spraying are essential. Wiping with an inhibitor-cleaner (40 grams benzotriazole in a gallon of water) is recommended as the last cleaning step before the coating is applied. Benzotriazole has also proved beneficial in paints, pigmented lacquers and inks. Example a bronze lacquer, containing 4g of bronze pigment powder and 100 g of cellulose nitrate clear lacquer (30% solids), was dived and to one portion was added 1% benzotriazole. After aging for 3 days, the untreated fraction had turned dark green, but the treated fraction had not changed. In another application, the tendency of polypylene electrical insulation to oxidize more rapidly in the presence of copper is corrected by adding an antioxidant and benzotriazole to the insulation. The role of benzotriazole in preventing copper staining has been studied by making polarization curves in 3% sodium chloride under potentiostatic control. Significant differences in cathodic behavior have been found in treated and untreated samples with smaller but reproducible differences in anodic behavior. Unsuccessful coating treatments gave polarization curves similar to those observed untreated samples. Benzotriazole suppresses the cathodic reduction of oxygen but does not appear to affect hydrogen discharge. Thus, to some extent it functions as a cathodic inhibitor, but it also serves more significantly as an anodic inhibitor.

Benzotriazole treated papers interleaved between sheets of copper or copper alloy stacked in packing cases protect the metal from staining and discoloring for long periods. Reels of copper wire can be protected by wrapping the outside with treated paper. And copper items in sealed drums will not tarnish if the interiors are lined with impregnated paper. Internal surfaces of waveguides and other microwave components can be protected by filling the bores with the shredded paper. Self-adhesive papers and vinyl tapes guard against scuffing and scratching during fabrication, storage and transit. The tapes are widely used in the printed circuit industry.

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Treatment with benzotriazole is incorporated into the production of sheet from copper and copper alloy powders. The method includes following steps:

(1) compacted standard electrolytic copper powder by passing it through a pair of rolls;
(2) sinter at 1000 F in a hydrogen atmosphere for 15 minutes to get oxidefree sheet with 25% porosity;
(3) immerse the sheet in a 5% aqueous solution of benzotriazole at 100 F, allowing the solution to cool to 60 F over a period of 8 minutes, then holding at 60 F for 2 minutes;
(4) dry the sheet in air;
(5) compact it further by cold rolling it 50% Untreated stock stained within 18 hours in a polluted atmosphere; treated sheet remained unstained for 30 days.

Benzotriazole is suggested as a parting agent which helps separate cathode deposits from starting sheets or master forms in electrolytic refining and electroforming. There is evidence that benzotriazole code posits with copper from a plating solution. Its effect on electrodeposits has been studied by assign it to copper sulfate plating solutions.

(1) Benzotriazole in acid copper sulfate solutions form an insoluble cuprous complex which code posits with copper.
(2) Additions of 0.012 g per liter give fine-grained deposits of copper and prevents epitaxial; 0.12 g per liter gives fully bright deposits with a banded structure. There are reports, however, that soluble copper will precipitate benzotriazole, thus ending its beneficial effect.

Corrosion in hot water is prevented by adding mixture of 1 to 2% triethanolammonium phosphate and 0.01 to 0.2% benzotriazole (or mercaptobenzotriazole) at pH 7.5 to 9.0. Also, solutions of 1,2,3-triazole are effective corrosion inhibitors for plumbing containing iron and copper parts. Aerated tap water containing 0.1% of a 3-to-1 mixture of sodium nitrate and sodium borate causes one hundredth as much corrosion of steel in the presence of cooper when benzotriazole (1% of the weight of the mixture) is added. The inhibitor action of benzotriazole (5 mg per liter) is greatly increased by the presence of 50 mg per liter of highly condensed polyphosphates (P205:Na20 1:1-1.5).

Corrosion in plumbing constructed of ferrous and non-ferrous metals is slowed if the aqueous solutions contain sodium nitrate, sodium borate and benzotriazole. A synergistic effect results from the combination.

The additive consists of about 75% sodium nitrate, 25% sodium borate and 1% benzotriazole and is used in a concentration of 1000 to 2000 ppm, Substitution of 1% mercapto benzotriazole, KSCN di ethyl di thiocarbamate, 2-methylthiozole, 3-aminothiotriazole and s-trithiane for benzotriazole has proven less affective. Inhibitors consisting of sodium nitrate (at least 0.02% sodium nitrite (at least 0.03%), sodium silicate (at least 0.05%) or cyanate or urea (at least0.10%), and sodium mercapto benzothiazole or benzotriazole (at least 0.0125%) in water have been examined to determine their effect on corrosion of solder (70-30 lead-tin), aluminum, cast iron, mild steel, and copper.

Benzotriazole additions to water is effective in preventing galvanic corrosion in mixed metal systems such as copper-steel, copper-zinc, and copper aluminum. In experiments on aluminum-copper and aluminum-copper-iron couples in domestic water, benzotriazole inhibits corrosion of aluminum-copper couples and 2-benzimidazolethiol aluminum-copper-iron couples. Tests on aluminum-copper couples in natural sea water showed that 2, 5-dimercaptothiadiazole reduced corrosion of the aluminum electrode.

The benefits of benzotriazole as an inhibitor of copper corrosion is observed in closed-circuit water-cooled stators. The initial does should leave a film on the copper and bring the benzotriazole concentration in the water up to about 20 to 100 ppm. This concentration is maintained by periodic benzotriazole additions. In the presence of radiation, benzotriazole is an effective inhibitor of copper corrosion by reactor cooling water.

III. Conclusions

Lasting 60 to 90 days, 0.001% benzotriazole completely protected copper. Corrosion of gray cast iron is reduced 8 to 10 times by 1% benzotriazole. In a 0.1% buffer solution containing benzotriazole and its sodium salt at a pH of 7.3 to 7.5, the corrosion rate for gray cast iron and for steel is the same as in a solution containing 1% benzotriazole at a pH of 5.9 to 6.2. In this way, the buffer solution is the most effective.

Concentrations of 0.5% eliminated corrosion of gray cast iron; 0.2% solutions protected steel; 0.6% protected steel in contact with copper and 0.001% protected copper. Thus, in other work on the protective properties of benzotriazole with respect to the corrosion of copper and steel in neutral and acid solutions, it concluded that despite a certain inhibiting action, benzotriazole is not be considered an effective anticorrosive agent for ferrous metals in neutral media.

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Hence, It proves effective, however, in preventing the corrosion of copper by itself and in contact with steel. In acid media, benzotriazole prevents the corrosion of copper, but visible compounds forms on the surface of the metal. For, acid solutions a related compound, 25-dimercaptothiadiazole, seems to be a better inhibitor than benzotriazole.

In this way, Benzotriazole is effective in reducing attack on copper by 3% sodium hydroxide and 0.5 N sodium hydroxide plus 1.0 N ammonium sulfate and in steam condensate systems of mixed construction, amines are used to control steel corrosion but they accelerate copper attack by forming complexes. When benzotriazole is added, copper corrosion is also be prevented.

Hence the result.

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REFERENCES

[1] A.F. Popple well, Geigy, & D.K. Howard (1967) : British Patent (U.K.), May 17, pp. 1, 069, 391.

[2] A.P.C. Hallowes (1962) : Brighter outlook of Copper, Vol. 15 pp. 4 – 6.

[3] M.G. Kendall (1966) : International Copper Research Association, New York, pp. 28.

[4] J.R. Schaeffer (1956) : Canadian Patent pp. 522, 940 (March, 2020)

[5] A.D. Meighen (1957) : Commercial Solvents Corporation (U.S. Patents) pp. 803, 603 (Aug. 2020)

[6] M.G. Burberry and G.L. Green field (1968) : International Copper Research Association New York, pp. 34.

[7] K.H. Wall and I. Davies (1965) : Journal of Applied Chemistry 15(8) pp. 389 – 392.