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Chemistry

KEY WORDS: Corrosion Inhibitor, Alkaline Solution, Bronze, Non-hazardous, Corrosion, Aspartic Acid.

INHIBITION OF BRONZE CORROSION IN ALKALINE MEDIUM USING ASPARTIC ACID (AMINO ACID)

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ABSTRACT

The inhibiting properties of aspartic acid as bronze corrosion inhibitors in a alkaline solution was studied by weight loss measurement, scanning electron microscopy (SEM) techniques. SEM analysis of the corroded bronze surface confirmed that the aspartic acid inhibit the corrosion process, due to their ability to adsorb on the metallic surface. Aspartic acid is nonhazardous towards human beings or the environment and is intended to be used as corrosion inhibitors for bronze. Their inhibition action could be attributed to the ability of the amino acids to adsorb on the bronze surface and to form an organic layer which protects the metal from corrosion. The effect of inhibitor concentration against inhibitor action was investigated. It was found that aspartic acid act as good inhibitors for the corrosion of bronze. Increasing inhibitor concentration, increases the inhibition efficiency.

INTRODUCTION:-

Corrosion is more than just an inevitable natural phenomenon, its impact is felt in three areas of concern, namely economics, safety and environmental damage. Metallic corrosion, seemingly innocuous, affects many sectors. The economic cost of corrosion is enormous, and has been estimated be in the range of 2-4% of an industrialized country's gross national product.

One of the most efficient methods for protecting metals from degradation is the use of corrosion inhibitors. Various types of organic compounds, especially nitrogen, sulphur and oxygen containing substances have been widely used as corrosion inhibitors in various aggressive media. The effectiveness of heterocyclic molecules as corrosion inhibitors is based on their ability to adsorb on the metallic surface and to form an organic layer which protects the metal from corrosion. The adsorption of inhibitors takes place through the heteroatoms (N,O and S),aromatic rings. Generally, the inhibition efficiency increases in the following order O<N<S.

In spite of their effectiveness, most of the heterocyclic compounds used as corrosion inhibitors are highly toxic and their replacement by "green" inhibitors is desirable. Among the organic compounds tested as environmental friendly corrosion inhibitors, amino acids have been reported as promising alternatives to the toxic inhibitors. They are innoxious, biodegradable, soluble in aqueous media, relatively cheap and easy to produce at high purity. These properties would justify the use of amino acids as corrosion inhibitors. The focus of this study is to investigate the inhibition properties of aspartic acid in mixed basic media to evaluate their inhibition effect in a alkaline medium.

SYNTHESIS OF ASPARTIC ACID:-

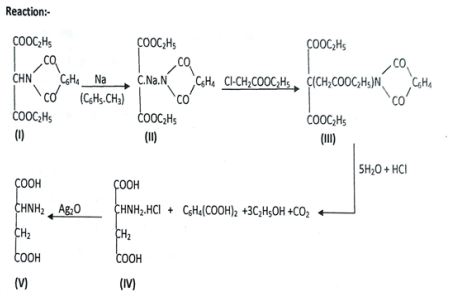
Firstly phthalimidomalonic ester (I) was prepared by the method of Osterberg. Phthalimidomalonic ester (1), react with Na in presence of toulene then obtained Sodium Phthalimidomalonic ester, where absolute alcohol is used as the solvent a 63% yield of impure product was obtained. This is due to the difficulty of completely removing the alcohol from the equilibrium mixture of sodium compound, phthalimidomalonic ester and sodium ethylate. When benzene was used as the liquid medium an 83% yield of impure product was obtained. This method is unsatisfactory because the sodium becomes coated with the insoluble sodium phthalimidomalonic ester and thus does not react completely.

Dry toluene was found to be an ideal medium for this purpose. The sodium becomes molten in the boiling fluid and quickly reacts to form 80 to 90% yield of light yellow product which, without further purification, contains the theoretical quantity of nitrogen.

With an 8:1 molal ratio of chloroacetic ester and sodium phthalimidomalonic ester the addition product, ethane-a-phthalimido-a,a,6-tricarboxylic acid triethyl ester(III), was formed as a viscous dark oil. The reaction was complete in 1.45 hours. After purification and drying 92% yield of product containing almost the theoretical amount of nitrogen was obtained.

Aspartic acid (V) was obtained by the hydrolysis of this oil. Preliminary experiments with absolute ethyl alcohol and sodium Hydroxide as the Hydrolyzing agent were carried out. The most satisfactory method of hydrolysis was found to be that with 95% ethyl alcohol and concentrated hydrochloric acid. After crystallization crystal was white and sweet tasting.

REACTION:-



EXPERIMENTAL:-

Mass loss method can be used to calculate the corrosion inhibition efficiency.

Mass loss method :- Rectangular specimens of bronze of composition Cu+Sn of dimension 2.5cm x 2.0cm x 0.05cm containing a small hole of about 2mm diameter near the upper edge were taken. Specimens were cut from the centre of bronze sheet and were thoroughly cleaned, buffed, rubbed with emery paper to obtain mirror like spotless surface. The specimens were finally degreased by using acetone . All chemicals used for the synthesis of amino acids were of analytical reagent grade and solution of sodium hydroxide were prepared in double distilled water.

Each specimen was suspended by a V-shaped glass hook made by fine capillary glass tube and immersed in a glass beaker containing 50ml of test solution at room temperature. After the exposure of sufficient time the test specimen was taken out, cleaned under running water and finally dried firstly with filter paper and secondly desicator.

The percentage corrosion inhibition efficiency was calculated as

$$IE/n\% = \frac{(\Delta M_u - \Delta M_i)}{\Delta M_u} \times 100$$

Where, ΔM_u = Mass loss of metal in uninhibited solution.
ΔM_i = Mass loss of metal in inhibited solution.

The degree of surface coverage ((24&θ) of metal was calculated as;

$$(\theta) = \frac{(\Delta M_u - \Delta M_i)}{\Delta M_u}$$

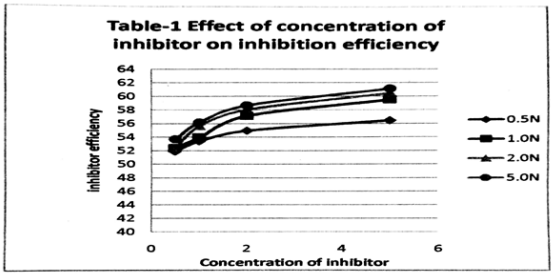
The corrosion rate in mmpy (milli mils penetration per year) can be obtained by following equation.

Corrosion Rate (mmpy) = 87.6 M/A T d

Where, ΔM = Mass loss in mg.
A = Exposed area of metal surface in cm^2.
T = Time of exposure in hours
d = metal density in gm cm-3.

Table 1. Mass loss (ΔM) and inhibition efficiency (n) for Bronze in NaOH solution with given inhibitor addition. (time exposure = 24 hr)

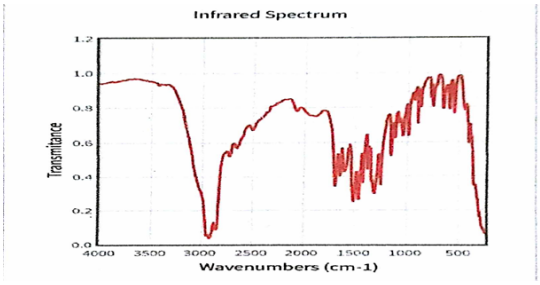
Aspartic acid addition	0.5 NaOH			1.0 NaOH			2.0 NaOH			5.0 NaOH		
	Δm (mg)	n %	θ	Δm (mg)	n %	θ	Δm (mg)	n %	e	Δm (mg)	n %	θ
Blank	13.1			12.6			12.4			12.1		
0.5	6.3	51.90	0.51	6.0	52.38	0.52	5.9	52.41	0.52	5.6	53.71	0.53
1.0	6.1	53.43	0.53	5.8	53.96	0.53	5.5	55.64	0.55	5.3	56.19	0.56
2.0	5.9	54.96	0.54	5.4	57.14	0.57	5.2	58.06	0.58	5.0	58.67	0.58
5.0	5.7	56.48	0.56	5.1	59.52	0.59	4.9	60.48	0.60	4.7	61.15	0.61



(24&ANALYSIS OF IR SPECTRA:-

A chemical substance shows marked selective absorption in the infrared region. After absorption of IR radiation, the molecules vibrate at different rates of vibration, giving rise to close packed absorption band called an IR absorption spectrum.

A characterstics feature of IR spectra of aspartic acid in the presence of a relatively large number of sharp band and particularly diagnostic are these near 3505 cm^{-1} N-H symmetrical stretching, 1753 cm-1 C=0 stretching, 1697 cm^{-1} N-H bending, 1440 cm^{-1} CH_2 deforming.



SEM ANALYSIS:-

The sheet obtained from weight loss measurement are used in SEM studies, Fig(A),(B) presents the bronze surface morphology after 24 hours of immersion in the corrosive solution in presence of aspartic acid. It can be seen that the bronze surface is covered with a layer of corrosion products. Image presents increasing concentration of amino acid, corrosive surface area decreases and inhibition efficiency increases.

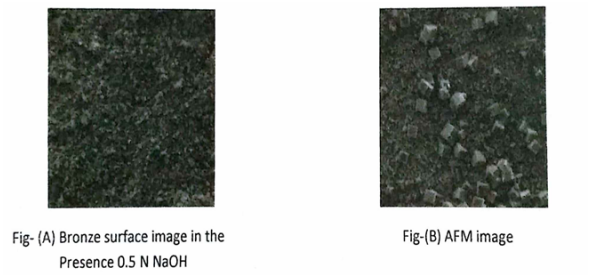


Fig- (A) Bronze surface image in the Presence 0.5 N NaOH

Fig-(B) AFM image

CONCLUSION:-

Our study reports the effect of aspartic acid on bronze corrosion in a alkaline medium using weight loss measurement, SEM - investigations. Above methods demonstrate the inhibitive properties of aspartic acid increases when its concentration increased. Aspartic acid appear to have a more pronounced inhibiting effect on the copper dissolution process as attested by the significant shift of the corrosion potential towards negative values.

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