ORIGINAL RESEARCH PAPER

Chemistry

# A COMPARATIVE STUDY OF GLYCINE, GLUTAMIC ACID AND ASPARTIC ACID AS CORROSION INHIBITORS FOR BRASS IN ALKALINE MEDIUM

**KEY WORDS:** Brass, artifact, glycine, glutamic acid, aspartic acid corrosion inhibitor.

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**ABSTRACT**

This study aimed to investigate the effectiveness of glycine, glutamic acid and aspartic acid as corrosion inhibitor for brass. The inhibiting properties of all three amino acids as brass corrosion inhibitors in a strong basic solution of 1.0 N Sodium Hydroxide was studied by weight loss techniques and SEM technique. Weight loss measurements revealed that these compounds have a protective effect against brass corrosion and their inhibition efficiencies depend on the structure of these amino acids. The toxicity of organic and inorganic corrosion inhibitors to the environment has prompted the search for safer corrosion inhibitors such as green corrosion inhibitors as other more environmental friendly corrosion inhibitors most of which are biodegradable and do not contain heavy metals or other toxic compounds. Amino acids have the ability to control the corrosion of brass and bronze .The corrosion rate decreases with increasing amino acid concentration . The order of inhibition efficiency of the three amino acids is glycine < glutamic acid < aspartic acids.

## INTRODUCTION:

Conservation treatment of corroded copper- based archaeological artifacts has remained a major concern for conservators and conservation scientists for more than 50 year. Several studies have been conducted to investigate new conservation material to stabilize these significant cultural materials. Corrosion inhibitors are materials which, when added in a small concentration to a corrosive environment, reduce or suppress the corrosion of a metal exposed to that environment. Amino acids were usually found to be the most effective inhibitor and they remains the most widely used corrosion inhibitor for copper-based artifacts in the conservation field.

Glycine, Glutamic acid and Aspartic acids are an amino acids that have been investigated as a corrosion inhibitor for copper and its alloy. Amino acids inhibited the anodic dissolution of copper in alkaline medium. Ismail used electrochemical methods to study the efficiency of amino acids as non-toxic corrosion inhibitor for copper in neutral and alkaline media. They found that amino acids inhibited the cathodic reaction to a high extent by adsorption of amino acid molecules and forming a layer that retarded the transfer of oxygen molecules to cathodic site on the copper surface. Barouni et al. examined the corrosion inhibition effectiveness of three amino acids ( glycine, glutamic acid and aspartic acid ) on brass corrosion in alkaline media. Weight loss and electrochemical polarization measurement showed that aspartic acid was the most effective corrosion inhibitor. Presence of heteroatom in amino acids, which was a stronger electron donating group. Amino acids exists in acidic solution as a zwitter ion ( a solution species with both a positive or cationic and a negative or anionic ionic charges on the molecule). The cationic part of this ion adsorbs on the cathodic site of brass and decreases the cathodic reaction, while the anionic part adsorbs on the anodic sites and decreases the anodic dissolution of brass.

This study investigated the surface morphological changes of corroded brass reference coupons when treated with glycine, glutamic acid and aspartic acid.

## EXPERIMENTAL:

Rectangular specimens of brass of approximate composition 60% Cu, 40% Zn of dimension 2.5 cm x 2.0 cm x 0.05 cm containing a small hole of about 2 mm diameter near the upper edge were taken. Specimens were cut from the centre of brass 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 50 ml 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 inhibitior efficiency was calculated as-

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

$\Delta M_u$ = Mass loss of metal in uninhibited solution.
$\Delta M_i$ = Mass loss of metal in inhibited solution.

The Degree of surface coverage ($\theta$) of metal specimen by inhibitor was calculated

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

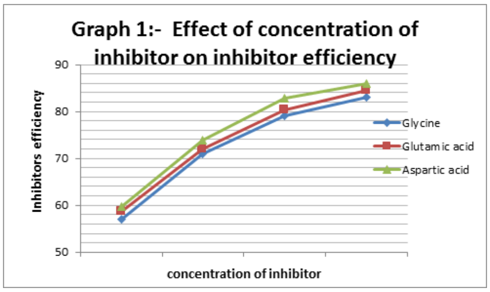
The corrosion rate in mmpy (milli mils penetration per year ) can be obtained by following equation

$$\text{Corrosion rate (mmpy)} = \frac{87.6 \times \Delta M}{ATd}$$

Where
ΔM = Mass loss in mg
A = Exposed area of metal surface in cm2
T = Time exposed in hours
d = Metal density in gm-3

**Table :-1 Mass Loss ( m) And Inhibition Efficiency (η) For Brass In Naoh Solution ( 1 N ) With Given Inhibitor Addition. ( Time Exposure = 24 Hr )**

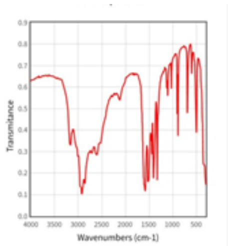
| Amino acid addition | Glycine | | | Glutamic acid | | | Aspartic acid | | |
|---|---|---|---|---|---|---|---|---|---|
| | ΔM (mg) | η% | θ | ΔM (mg) | η% | θ | ΔM (mg) | η% | θ |
| Blank | 10.0 | 57.00 | 0.57 | 9.7 | 57.73 | 0.57 | 9.3 | 58.06 | 0.58 |
| 0.5 | 4.3 | 71.00 | 0.71 | 4.1 | 71.13 | 0.71 | 3.9 | | |
| 1.0 | 2.9 | 79.00 | 0.79 | 2.8 | 80.41 | 0.80 | 2.6 | 72.04 | 0.72 |
| 2.0 | 2.1 | 83.00 | 0.83 | 1.9 | 84.53 | 0.84 | 1.6 | | |
| 5.0 | 1.7 | | | 1.5 | | | 1.3 | 82.79 | 0.82 |
| | | | | | | | | 86.02 | 0.86 |



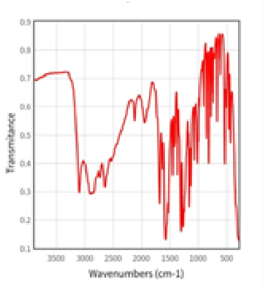

## ANALYSIS OF IR SPECTRA

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 an IR absorption spectrum.

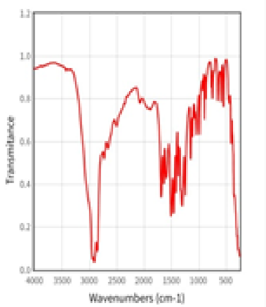
A characterstics feature of IR spectra of glycine in the presence of a relatively large number of sharp band and particularly diagnostic are these near 3300 $cm^{-1}$ N---- H Symmetrical stretching, 1650 $cm^{-1}$ C== O Stretching, 1540 $cm^{-1}$ N--- H deforming. For glutamic acid 3450 $cm^{-1}$ N--- H Symmetrical stretching, 1690 $cm^{-1}$ C== O Stretching, 1523 $cm^{-1}$ N--- H deforming. For Aspartic acid 3505 $cm^{-1}$ N--- H Symmetrical stretching, 1753 $cm^{-1}$ C== O Stretching, 1697 $cm^{-1}$ N--- H deforming.




**(A) GLYCINE**




**(B) GLUTAMIC ACID**




**(C) ASPARTIC ACID**

## SEM ANALYSIS:

The sheet obtained from weight loss measurement are used in SEM studies, Fig (A), (B), and (C) presents the brass surface morphology after 24 hours of immersion in the corrosive solution in presence of glycine, glutamic acid and aspartic acid. It can be seen that the brass surface covered with a layer of corrosion products. Images shows that more corrosion inhibition efficiency of aspartic acid than glutamic acid and glycine.

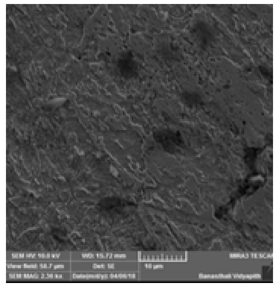
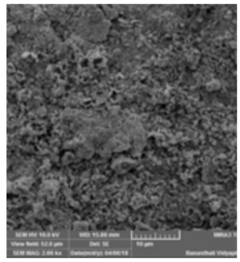
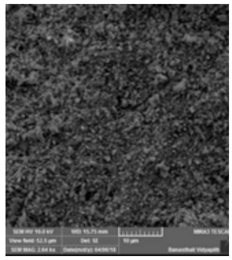


**Fig (a):-brass Surface Image In The Presence Of Glycine**



**(b):-brass Surface Image In Fig The Presence Of Glutamic Acid**



**(C):-Brass surface image inthe presence of Aspartic acid**

## CONCLUSION:

It has been shown that amino acids are efficient corrosion inhibitors in different alkaline medium. The efficiency of amino acids as corrosion inhibitor depends not only on the characterstics of the environments in which it act, the nature of the metal, electrochemical potential at the interface but also on the structure of inhibitor (Amino acid ) it self. Effectiveness of inhibitor ( Amino acid ) is aspartic acid > glutamic acid > glycine.

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