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Corrosion Inhibition of 70-30 Brass Corrosion by Benzotriazole in Nitric Acid Solution

Dr. Abhay Singh
Associate Professor, Department of Chemistry, K.L.P. College, Rewari, India

Abstract: ***Benzotriazole has been investigated to control the corrosion of 70/30 brass in 3.0 N nitric acid solution using weight loss measurement and Scanning Electron Microscope (SEM) analysis. The measurements showed increase in inhibition efficiency with increase in the concentration of the Inhibitor but decreases with the increase in temperature. Scanning Electron Micrographs reveal the changes in the metal surface morphology in the presence of benzotriazole. Micrographs indicated that the metal surface was in a better condition in the presence of the inhibitor than the specimen exposed in the absence of the inhibitor.***

Keywords: Benzotriazole, 70/30 Brass, SEM, Corrosion, Inhibitor.

I. INTRODUCTION

Brasses are the most widely used group of copper alloys. They are extensively used in domestic appliances, industrial and chemical plant process equipments involving exposure to a wide variety of organic and inorganic chemicals. A variety of artificial jewellery, statues, grills and many decorative items are made with brass. Fresh water supply lines and plumbing fittings are made up of brass for which superior resistance to corrosion by various types of waters and soil is important.

Brasses are in general, corrosion resistant and superior electrical and thermal conductors. They can resist many saline solutions, alkaline solutions and organic chemicals. However, brass is more susceptible to attack by oxidizing acids, oxidizing heavy metal salts, sulphur, ammonia and some compounds of ammonia. Losses due to corrosion of brasses are extremely high in industries and there is an urgent need to develop corrosion inhibitors for industrial operations where brass objects are used.

Various organic compounds such as azoles [1-4], thiourea and its derivatives [5], phenols [6], aldehydes and ketones [7,8], amines [9], heterocyclic compounds [10,11] have been investigated as corrosion inhibitors for brasses and copper in wide range of solutions. In the present investigation, benzotriazole has been studied to control the corrosion of 70/30 brass in 3.0 N nitric acid solution at 20, 30, and 40°C temperature using weight loss method and Scanning Election Micrographs of 70/30 brass in the presence and absence of the inhibitor.

II. EXPERIMENTAL

A. Materials Preparation

All the chemicals used were of AR grade and the solutions were prepared by using double distilled water. Rectangular specimens of size 2x4 cm² were cut from 70/30 brass alloy sheet having the following composition for weight loss experiments.

Element	Cu	Zn	Pb	Sn	Other Elements
% (w/w)	69.92	29.9	0.05	0.04	0.09

B. Weight Loss Method

All the specimens were polished successively with different grades of emery papers and were then thoroughly cleaned with double distilled water and acetone. Weight loss measurements were performed using 0, 100, 200 and 300 ppm concentrations of benzotriazole in 3.0 N nitric acid solution at 20, 30 and 40°C temperatures for 3 hours exposure time. The specimens in uninhibited and inhibited solutions were weighed using electronic balance before and after exposure to calculate the loss in weight due to corrosion. Corrosion rate and percentage inhibition efficiency were calculated using the following relations.

$$\text{Corrosion Rate(mpy)} = \frac{534\,W}{DAT}$$

where,

W= Weight loss in mg
D= Density of specimen in gcm^{-3}
A= Area of specimen in square inch
T= Exposure time in hours

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and $E = (\frac{A-B}{A}) \times 100$

where, E= Percentage inhibition efficiency
A= Weight loss in uninhibited system
B= Weight loss in inhibited system

C. Surface Morphology Study

To study the morphology of corroded surface of the specimens, Scanning Election Microscope (Model JSM-840, JEOL Make) was used. The specimens were exposed to 3.0 N nitric acid solution for 3 hours in the absence and presence of 200 ppm of the inhibitor. All the micrographs of corroded specimens were taken at a magnification of 2000.

III. RESULTS AND DISCUSSION

Corrosion rate and percentage intubation efficiency data calculated using weight loss method by exposing 70/30 brass samples in 3.0N nitric acid solution for 3 hours in the absence and presence of 100, 200 and 300 ppm concentrations of benzotriazole at 20, 30 and 40°C temperatures have been recorded in Table 1.

Table 1
Percentage Inhibition efficiency of Benzotriazole for the corrosion of 70/30 Brass in 3.0N Nitric acid solution by weight loss method (Exposure Time = 3 hours)

Concentration of Inhibitor (ppm)	Temperature (^{0}C)	Weight Loss (mg)	Corrosion Rate(mpy)	Inhibition Efficiency (%)
Nil	20	462.67	7741.0	----
	30	650.97	10891.5	----
	40	1354.25	22658.1	----
100	20	69.38	1160.79	85.00
200	20	40.54	678.27	91.23
300	20	36.72	614.36	92.06
100	30	130.85	2189.25	79.89
200	30	85.24	1426.15	86.90
300	30	78.68	1316.39	87.91
100	40	375.69	6285.66	72.25
200	40	265.27	4438.23	80.41
300	40	252.94	4231.93	81.32

It is observed from the results recorded in the Table 1 that benzotriazole acts as an efficient inhibitor for 70/30 brass in 3.0 N nitric acid solution. The percentage inhibition efficiency increases with an increase in concentration of the inhibitor. However, the increase in inhibition efficiency is quite remarkable when the concentration increases from 100 to 200 ppm and after that when the concentration is increased to 300 ppm then the increase in inhibition efficiency is quite low. The inhibition efficiency decreases with an increase in temperature from 20 to 40°C. The maximum inhibition efficiency of 92.06% was obtained at 300 ppm concentration of inhibitor at 20°C temperature.

Fig. 1 and 2 show the scanning electron micrographs (SEM) of 70/30 brass samples exposed to 3.0N nitric acid solution for 3 hour in the absence and presence of 200 ppm concentration of benzotriazole. In the absence of the inhibitor the surface of the brass appears very rough and highly corroded while in the presence of the inhibitor, the surface appears to be smooth and covered with a protective film. This protective film is formed due to adsorption of benzotriazole molecule on the surface of brass and hence provided corrosion resistance to 70/30 brass in 3.0N nitric acid solution.

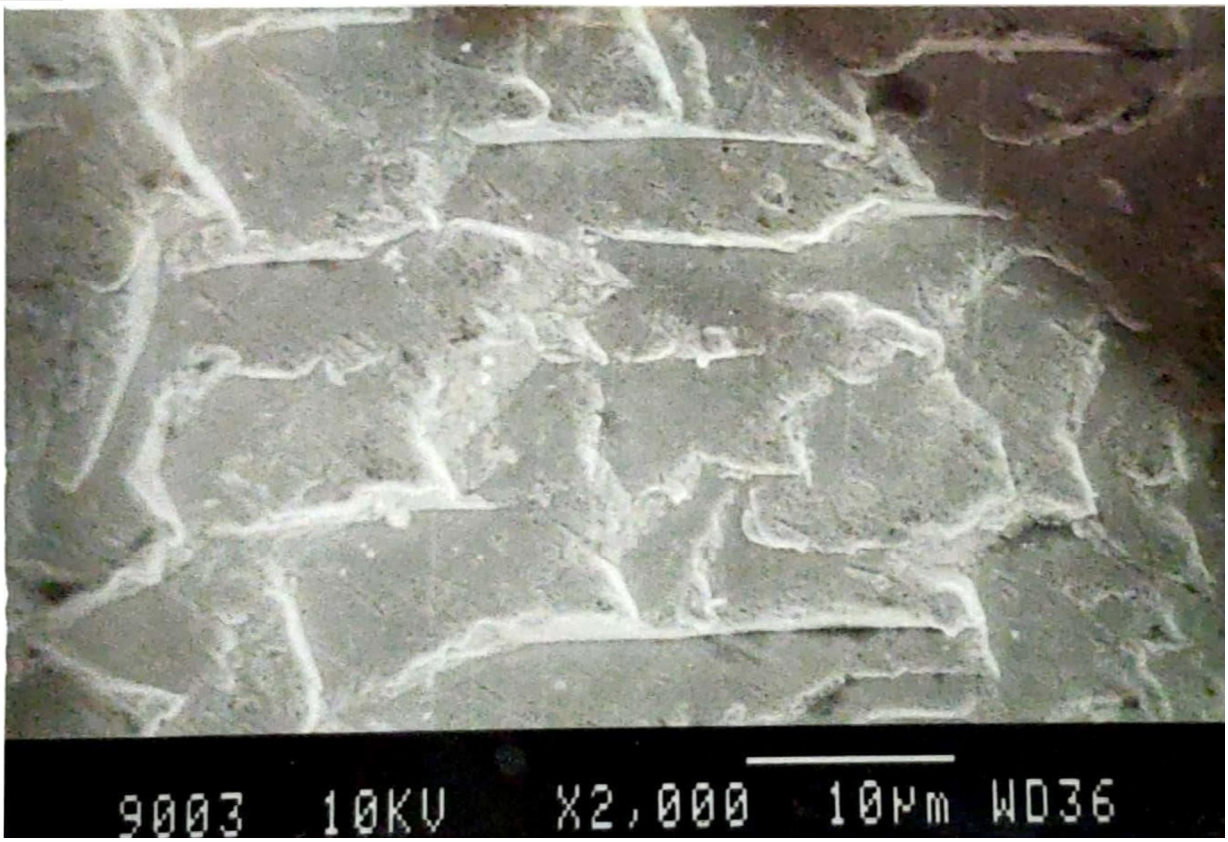


Fig. 1 SEM micrograph of 70/30 brass surface exposed to 3.0N nitric acid solution for 3 hours (x 2000).

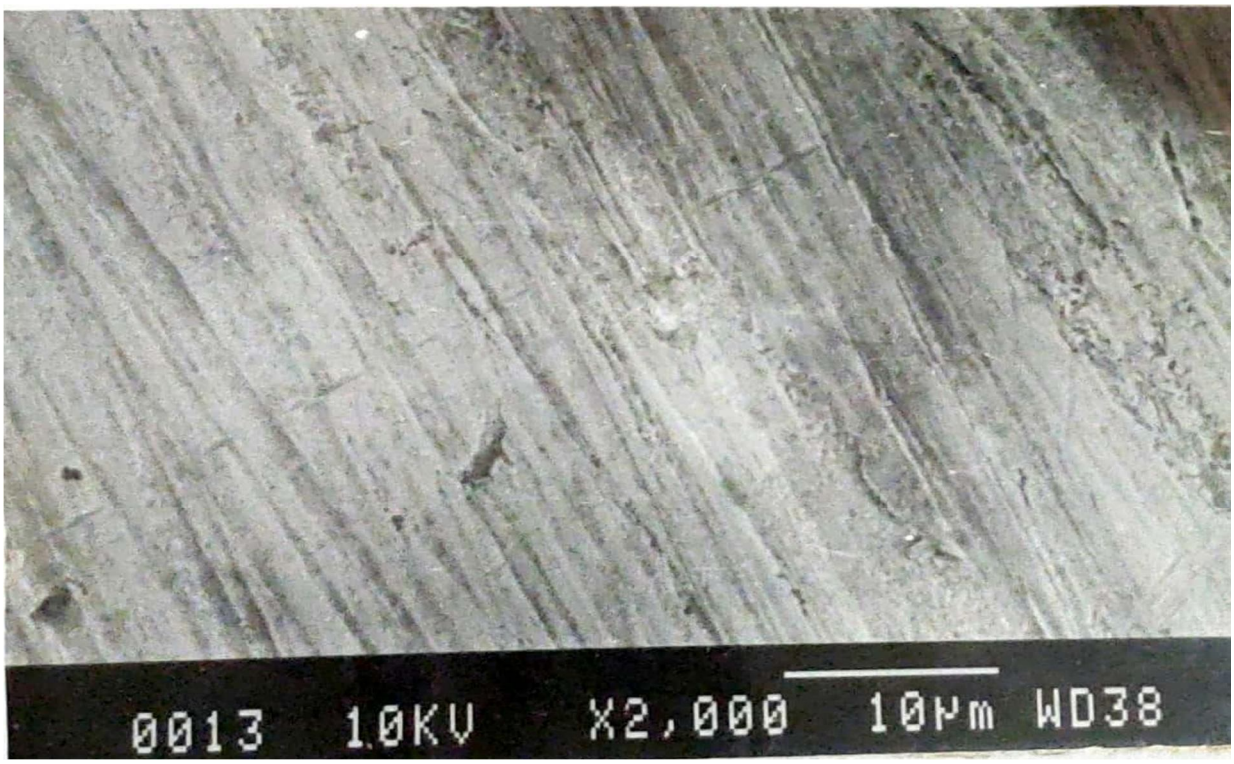


Fig. 2 SEM micrograph of 70/30 brass surface exposed to 3.0N nitric acid solution in presence of 200 ppm of Benzotriazole for 3 hours (x 2000).

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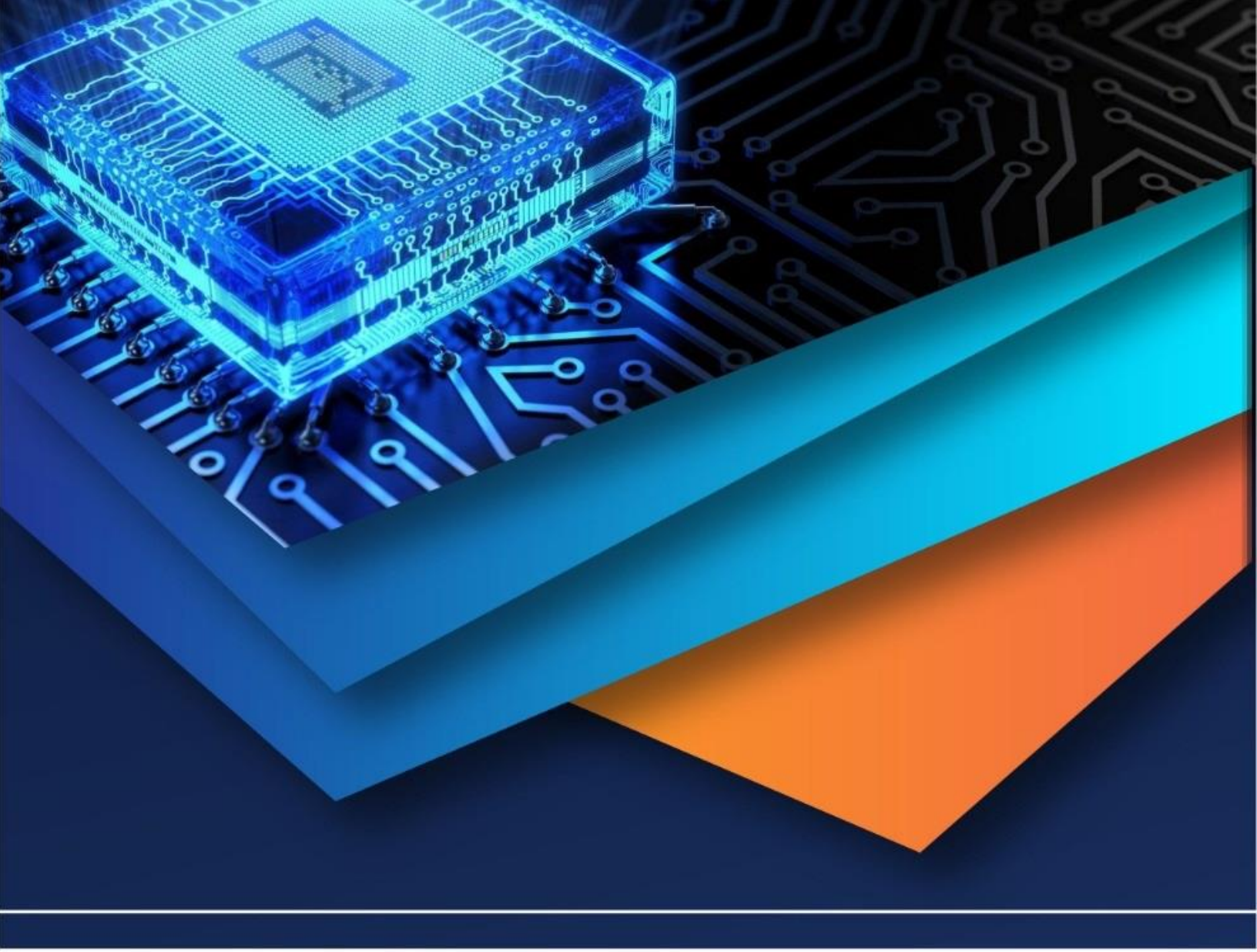
IV. CONCLUSION

Benzobiazole is an effective corrosion inhibitor for the protection of 70/30 brass in 3N nitric and solution. The inhibition efficiency increases with increase in concentration of the inhibitor and the inhibition efficiency decreases. with increase of temperature. A maximum inhibition efficiency of 92.06% is provided by the inhibitor at 20°C and 300 ppm concentration. SEM images showed that benzotriazole is adsorbed on the surface of 70/30 brass for providing protection from corrosion.

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