CORROSIVITY OF DIFFERENT MEDIA ON BRASS

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Abstract- A study of rate of corrosion on brass plates was conducted at room temperature under uniform conditions in different aqueous media of acids and salts such as: sulphuric acid, hydrochloric acid, acetic acid and salt solutions (ammonium chloride and potassium iodide acidified by adding 2-3 drops of glacial acetic acid). A brass sheet was used for this purpose and cut into small pieces with same dimensions. These pieces were immersed over a known period of time in the solutions prepared for conducting the corrosion studies and weight loss was recorded periodically to measure the corrosive effect. Through the studies it is concluded that the rate of corrosion in the solutions is of the following order hydrochloric acid > ammonium chloride > sulphuric acid > acetic acid > acidified potassium iodide.

Keywords- Brass sheet, Corrosion rate, Weight loss method, Different media, corrosive environment.

I. INTRODUCTION

Corrosion is a natural process and can be defined as a slow oxidation of metal / alloy by the environment leading to its deterioration. Rate of Corrosion is influenced by 1) nature of the metal and ii) the environment surrounding it. Another important determining factor in the rate of corrosion is the surface of the material. Presences of air, salts, free ions, moisture and gases all these lead to intense corrosion. Formation of galvanic cells is the major cause of corrosion in metals and can be explained well with the help of electrochemical theory. Brass finds wide variety of applications both domestically and in industries. It is used in devices made for heat exchange and condensers due to its good thermal and electrical properties. It is also used in grillwork, jewelry, decoration pieces, badges, door handles, marine hardware, pen, electrical terminals, plugs and lamp fittings, locks, name plates, hardware, clock components, gear meters etc. All these applications make brass a commercial alloy. Brass is an alloy of copper and zinc and chances of formation of galvanic cells in brass is very high as the electrode potential of copper (0.34 V) and zinc (-0.76 V) are greatly distant apart. Zinc starts dissolving as it becomes anode and copper becomes cathode in the corroding medium. Brass is a useful alloy and finds various applications, therefore its corrosion behavior in different acids and salts has received much research attention in the past [1 - 14].

II. MATERIALS AND METHODS

2.1 Sample Preparation:

Small rectangular pieces (3cm × 4cm) of Brass sheet was made and used as samples. The brass plates were subjected to pretreatment before their immersion in the corrosive media.

The pretreatment involved cleaning of the plates to remove the dust and grease. This was achieved by cleaning it with acetone followed by double distilled water and then air dried [15].

2.2 Test solution

1% solutions of \( \text{H}_2\text{SO}_4 \), \( \text{HCl} \), \( \text{CH}_3\text{COOH} \), \( \text{NH}_4\text{Cl} \), and acidified KI (2-3 drops of glacial acetic acid were mixed with KI solution) were prepared using double distilled water.

The reagents used for the study were of analytical grade.
2.3 Weight loss measurements
Rate of corrosion was studied using the weight loss method. The brass plates of rectangular size (12 sq.cm) were made from brass sheet and immersed in small beakers containing 50ml of corrosive solutions. The pre weighed plates of brass were immersed and exposed to the corrosive environment for a definite period of time at room temperature. The plates after definite hours were taken out from the solution. They were washed with double distilled water followed by acetone, dried and weighed again to calculate the loss in weight due to corrosion.

2.4 Weight Loss Method
It is a simple, accurate and reliable method to determine the corrosion. It has been used by many authors [16 - 20] in studying the corrosive behavior of various metals. In this method the metal / alloy of known area is exposed to the environment for a specified time. The difference in the weight before and after the immersion is calculated. The rate of corrosion is calculated as follows:

\[
\text{Corrosion rate (mmpy)} = \frac{\text{Weight loss (W) \times Constant (K)}}{\text{Exposed area (A) \times Density of the specimen (D) \times Exposure time (T)}}
\]

Where,
K = 8.76 \times 10^{-4} \text{ (constant)},
W = \text{weight loss in g},
A = \text{area in sq.cm and}
D = 8.520 \text{ gm/cm}^{3} \text{ (density)},
T = \text{exposure time in hours}.

Table 1: Weight loss method in various solutions

| Immersion time in hours | Loss of weigh in grams |
|-------------------------|------------------------|
|                         | H₂SO₄      | HCl        | CH₃COOH    | NH₄Cl      | KI         |
| 24                      | 0.0014     | 0.0048     | 0.0042     | 0.0004     | 0.0032     |
| 48                      | 0.0074     | 0.0221     | 0.0093     | 0.0183     | 0.0046     |
| 96                      | 0.0176     | 0.0878     | 0.0169     | 0.0387     | 0.0065     |
| 120                     | 0.0227     | 0.1302     | 0.0201     | 0.0481     | 0.0070     |
| 144                     | 0.0278     | 0.1672     | 0.0241     | 0.0558     | 0.0072     |
| 168                     | 0.0324     | 0.1818     | 0.0282     | 0.0658     | 0.0076     |
| 192                     | 0.0402     | 0.2035     | 0.0385     | 0.0818     | 0.0079     |
| 216                     | 0.0501     | 0.2305     | 0.0482     | 0.0958     | 0.0081     |
| 240                     | 0.0551     | 0.2424     | 0.0511     | 0.1038     | 0.0082     |
Figure 1 Graphical representation of % of weight loss in various solutions

Figure 2 Graphical Representation of rate of corrosion in various solutions
III. RESULT AND DISCUSSION

The results obtained from the study are tabulated for weight loss at a time interval of 24 hrs recorded up to 240 hrs for the materials under study in table 1 and it is clear from the data that the maximum weight loss was recorded by immersing in HCl whereas immersion in KI resulted into minimum weight loss due to corrosion. The difference in percent weight loss due to different corroding environments emerged much more pronounced and clear only after 96 Hrs of immersion (Figure 1). This suggests that a brief immersion in these corroding medium does not have significant corrosive effect. However, there were marked differences in rate of corrosion due to different corroding medium right from the beginning (Figure 2). The percentage weight loss and rate of corrosion was maximum in hydrochloric acid followed by ammonium chloride. In sulphuric acid and acetic acid the % loss in weight was almost comparable. However action of sulphuric acid was more corrosive compared to acetic acid. Least corrosion was observed in acidified potassium iodide (Figure 1 & 2). In the present study the rate of corrosion in the solutions is of the following order hydrochloric acid > ammonium chloride > sulphuric acid > acetic acid > acidified potassium iodide. The rate of corrosion of the alloy brass is mainly due to chloride ions present in hydrochloric and ammonium chloride. The chloride ions attack zinc to dissolve from the alloy forming zinc chloride which is also referred to as dezincification. Sulphate and acetate ions also showed high rate of corrosive action but their corrosive action was slow compared to the chloride ions. Thus the corrosion rate is higher in the electrolytes containing chloride ions.

IV. CONCLUSION

The study suggests that the objects made of brass should be prevented from exposure to the chloride ions in the atmosphere to minimize the corrosion and to improve the life span.

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REFERENCES

[1] Karpagavalli, A and Balasubramaniam, A, “Development of novel brasses to resist dezincification”, Corrosion science, vol. 49, pp. 963-979, 2007.
[2] Satendra, K., Sankara Narayanan, T.S.N., Suresh Kumar and M., Manimaran, A., “Dezincification of Brass in Sulfide Polluted Sodium Chloride Medium: Evaluation of the Effectiveness of 2-Mercaptobenzothiazole”, Int. J. Electrochem. Sci, vol. 1, pp. 456-469, 2006.
[3] Abd-El-Nabey, B.A., Abdel-Gaber, A.M., Khamis, E., Morgaan, A.I.A. and Ali, N.M., “Inhibition of Corrosion of Brass in 0.1 M H2SO4 by Thioxopyrimidinone Derivatives”, Int. J. Electrochem. Sci, vol. 8, pp. 11301 – 11326, 2013.
[4] Tambi, A., Stefano, R. and Lucien, B., “Corrosion Inhibition Action of Sulfamethoxazolefor Brass in Acidic Media”, Int. J. Electrochem. Sci, vol. 11, pp. 6819 – 6829, 2016.
[5] Geler and D.S. Azambuja, “The electrochemical behavior of brass in 0.1 M HCl solution”, Journal of the Brazilian Chemical Society, vol. 8, no.2, 1997.
[6] Ashok Kumar, R. Shukla and A Venkatachalam, “STUDIES OF CORROSION AND ELECTROCHEMICAL BEHAVIOR OF SOME METALS AND BRASS ALLOY UNDER DIFFERENT MEDIA”, RasayanJ.Chem, Vol. 6, No.1. pp. 12-14, 2013.
[7] Walaa A. Hassein, Amal S. I. Ahmed, Wafa A. Ghanem and Ghalia A, “Gaber, Studies of Corrosion and Electrochemical Behavior of Cu-Zn Alloys in H2SO4 and HNO3 Acid Solutions”, Journal of Metallurgical Engineering, vol. 5, 2016.
[8] Memon Samina, Abdul Karim and A. Venkatachalam, “Corrosion Study of Iron and Copper Metals and Brass Alloy in Different Medium”, E-Journal of Chemistry, vol. 8, pp. 44-48, 2011.
[9] V. R. Rathi, S. D. Nirmal and S. J. Kokate., “Corrosion study of mild steel, tor steel and CRS steel by weight loss method”, J. Chem. Pharm. Res., vol. 2 (2), pp. 97-100, 2010.
[10] K. K. Taha, M. E. Mohamed, S. A. Khalil and S. A. “Talab, Inhibition of Brass Corrosion in Acid Medium Using Thiazoles”, International Letters of Chemistry, Physics and Astronomy, vol. 9(2), pp. 87-102, 2013.
[11] Selvaraj, S., Ponnariappan, M., Natesan, and N. Palaniswamy, “Dezincification of Brass and Its Control: An Overview”, Corrosion Review, vol. 21, no. 1, 41-74, 2003.
[12] Milan Radovanović, Marija Petrović Mihajlović and Milan Antonijević, “2-AMINO-5-ETHYL-1,3,4-THIADIAZOLE AS INHIBITOR OF BRASS CORROSION IN 3% NaCL”, Metall. Mater. Eng, Vol. 22 (1), pp. 51-60, 2016.
[13] Samar .Y. Al-Nami, “Effect of 4-phenyl4-phenylthiazole derivatives on preventing dezincification of α-brass in acid chloride solution”, J. Mater. Environ. Sci. vol. 4(1), pp. 39-48, 2013.
[14] H. S. Gadow, M. M. Motaweb and H. M. Elabassy, “Investigation of myrrh extract as a new corrosion inhibitor for α-brass in 3.5% NaCl solution polluted by 16 ppm sulfide”, The Royal Society of Chemistry, vol. 7, pp. 29883–29898, 2017.
[15] Guddi Choudhary, Arpita Sharma and Alka Sharma., “CORROSIVE BEHAVIOR OF AL, Cu and MS IN DIFFERENT ACIDIC MEDIA”, International Journal of Innovative Research in Science, Engineering and Technology, vol. 2(10), 2013.
[16] Anima Upadhyay and M. Chandrakala, “Corrosion Studies on Tinned Iron Plates From Infant Food Cans”, Material Science Research India, Vol. 13(2), pp. 106-109, 2016.
[17] V. R. Rathi, S. D. Nirmal and S. J. Kokate., “Corrosion study of mild steel, tor steel and CRS steel by weight loss method”, J. Chem. Pharm. Res., vol. 2(2), pp. 97-100, 2010.
[18] H. Zarrok, H. Oudda, A. Zarrouk, R. Salghi, B. Hammouti and M. Bouachrine., “Weight Loss Measurement and Theoretical Study of New Pyridazine Compound as Corrosion Inhibitor for C38 Steel in Hydrochloric Acid Solution”, Der Pharma Chemica., vol. 3(6), pp. 576-590, 2011.
[19] Kingsley O. Oparaodu, and Gideon C. Okpokwasili, “Comparison of Percentage Weight Loss and Corrosion Rate Trends in Different Metal Coupons from two Soil Environments”, International Journal of Environmental Bioremediation & Biodegradation, Vol. 2, No. 5, pp. 243-249, 2014.
[20] Mamatha.G.P., Pruthviraj. R. D and Ashok.S.D, “Weight Loss Corrosion Studies of Aluminium-7075 Metal Matrix Composites Reinforced with SiC Particulates in HCl Solution”, International Journal of Research in Chemistry and Environment, Vol. 1 Issue 1, pp. 85-88, 2011.