Relation Ship Between Hardness And Roughness For dezincification of Brass

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Abstract

The corrosion rate of brass in sodium chloride solution has been studied by means of weight-loss method. Typically the weight loss of the brass in sodium chloride solution in the occurrence of various concentrations of (1\%, 2\% and 3\%) NaCl solution was determined right after 24 hrs immersion. The weight loss experiment was taken out at temperature 25 °C. The corrosion regarding the metal was increased with an increase in the concentration of salt. The effect of corrosion on roughness of brass was investigated. Mechanical properties such as hardness by using Vickers method and compressive test were carried out making use of instron 8872 instrument. The results attained showed that the mechanical properties of brass improved for with and with no immersion method exhibited of which increase the corrosion rate of brass, lead to decrease of the strain and stress, and decrease hardness of metal.

Keywords : Brass, Corrosion Rate, Weight-Loss, Roughness, Hardness, Compressive Test

I. Introduction

Metal of brass is commonly used for electrical fittings and pipe, screws, ornamental brass metal work, musical tools, and several others, due to its ductility, bright gold-like appearance, acoustic properties, etc. Throughout spite of its essential application, brass is suffering from deterioration in aqueous environments that contains corrosive ions like sulfate and chloride. Dezincification on the subject of brass stands for wide-ranging processes based on the nature of brass metal and its losses of valuable physical and mechanical features leading to collapsed structure [XXIV].

In spite of the many studies reported, the reaction mechanism at various potentials is yet to be able to be explained [XX][XIII][VIII][VI][XI][II][XVI][XIV]. De alloying, or dezincification, in brass metal may be easily observed with naked eye because the alloy builds up a reddish color that will contrasts with its unique yellowish color.
Normally, there are two kinds of dealloying. Uniform or layer dealloying usually occurs in high zinc alloys in which the outer layer is dealloyed and will will becomes dark while the inside is usually not affected; plug dealloying is typified by the existence of the dealloyed dark plugs in the not affected matrix of low zinc alloys [IV]. The mechanical properties of brass depend mostly on degree of deformation and the content of zinc , and also on the parameters of heat temperature treatment, typically the temperature of recrystallization [V][XXIII][XVIII][VII][XII][XVII][XXII]. The corrosion is regarding the main problem in most of equipment, leads to the interruption work and take of the unit service to be disassembled and cleaned and it can be very costly [IX][X].

Various grades metal of brass, with different quantities of zinc, have different properties in surface softness, corrosion-resistance rate, easey and quality of machining, ductility levels , response to plating, chemical and temperature limits. The present study suggests the effect of dezincification, as corrosion rate (mmpy) by immersion method in mechanical properties of brass.

II. Experimental Procedure

Metal used in this experimental work is brass metal alloy. The composition metal of brass has been evaluated based on chemical investigation in (Ministry planning / Central Organization for Standardization and Quality Control/Baghdad/Iraq); Chemical composition of the investigated brass alloy has been presented in Table 1

| Cu  | Zn  | Pb | P  | Sn  | Mn  | Fe  | Ni  |
|-----|-----|----|----|-----|-----|-----|-----|
| 72.7439 | 27.2 | 0.006 | 0.008 | 0.006 | 0.006 | 0.001 | 0.005 |

| S  | As  | Ag  | Co  | Bi  | Cd  | Sb  |
|----|-----|-----|-----|-----|-----|-----|
| 0.0001 | 0.003 | 0.007 | 0.007 | 0.003 | 0.001 | 0.003 |

The brass specimens were polished with emery papers, automatically with SiC papers, cleaned with doubly purified water and degreased in acetone, and dried. The specimen were weighed. Weight loss method measurements were done with cubic specimen of brass, each of dimension exactly (8.5 x 6.4x 6.3) mm. The metal has been immersed in the beaker having numerous concentration of (1%, 2%, and 3%) NaCl solution for full day at room temperature (25 °C). The specimens of metal after immersion within salt solution with rinsed with acetone and double distilled water for removing adherent corrosion products. Weight loss was taken as the difference in weight from the
specimens before and after immersion determined making use of LP 120 digital balance with sensitivity of ±1 mg. The difference including initial weight before immersion and last weight, after elimination of corrosion products as a result of standard method [I], was used to compute corrosion rate by:

\[ \text{Corrosion Rate (mmpy)} = 87.6 \times \frac{W}{D \times A \times T} \]

Where, mmpy = millimeter per year

\[ W = \text{Mass loss (mg)} \]

\[ D = \text{Density (gm/cm}^3) \]

\[ A = \text{Area of specimen (cm}^2) \]

\[ T = \text{Time in hours.} \]

The hardness was calculated by using Vickers's method. Metallographies scanning was achieved by using an optical microscope. The metallography tests were realized on cross sections of metal brass before and after immersion. The cross sections area have etched in the mixture, having 3g ferric chloride (FeCl₃), hydrochloric acid (HCl) and ethanol (C₂H₅ OH) [IX]. Uniaxial compression investigations have been taken out by means of an instron 8872 instrument at room temperature under a strain rate of 0.5 s⁻¹. The deformation of the specimen was calculated by a calibrated extensometer. The roughness of specimen was measured by roughness tool TR110, produced by TIME HOLLND Company, China.

III. Results and Discussion

In this study the influence of the corrosion rate of brass metal in different concentration of sodium chloride solution, weight loss method were achieved in (1%, 2%, and 3%) NaCl solution for 24 hours at room temperature. The variation of the corrosion rate (mmpy) versus with concentration of NaCl solution is plotted in Figs. 1. The corrosion rate of brass increased with increase concentration of NaCl solution. In order to conduct realistic corrosion tests, variation in sea water conditions necessity be taken into account [XV].
Optical microscopy was used to study the brass surface before and after immersion for 24 hours in different concentration of NaCl solution. Brass alloy has two phase microstructure as shown in figure 2 a α phase is light and β phase is dark. The micrographs of brass with corrosion as shown in figure 2 (b,c and d) show number of fairly small and shallow pits. A relatively more pits are created in case of 3% NaCl solution as shown in figure 2 d shows the influence of which is visible on the grain.

Figure 2 Optical micrographs of brass with and without immersion at different concentration of NaCl % solution a) without immersion b) 1% NaCl c) 2% NaCl and d) 3% NaCl.

Figure 3 plot the influence hardness on brass after exposure to the various concentration of salt of brass. The hardness decreases with increase concentration of salt solution. The results indicate that the brass without corrosion has the higher hardness. The samples after immersion method, the hardness value decreases with an increase corrosion rate (mmpy).
Table 1 shows results of immersion test in salt solution, Roughness (Ra) as received sample of brass is gradually increasing with increasing of concentration of salt solution.

**Table 1. Roughness (Ra) of Metal at different concentration of NaCl % solution**

| Condition                                      | Ra (μm) |
|------------------------------------------------|---------|
| Metal as received                              | 0.88    |
| Metal with corrosion at concentration of 1 %   | 1.2     |
| NaCl solution                                  |         |
| Metal with corrosion at concentration of 2 %   | 2.01    |
| NaCl solution                                  |         |
| Metal with corrosion at concentration of 3 %   | 2.46    |
| NaCl solution                                  |         |

Figures (4 to 7) illustrates the compressive test for specimen with and without corrosion in (1%, 2%, and 3%) NaCl solution at a constant strain rate of about 5 x 10^{-1} s^{-1}. The cross-sectional area is decreasing, and the load-bearing ability of the specimen continues to decreasing. For this to happen, the material should be weaker.
Figure 4 Compressive load-deformation plots of the brass samples without corrosion.

Figure 5 Compressive load-deformation plots of the brass samples with corrosion at concentration of 1% NaCl solution.

Figure 6 Compressive load-deformation plots of the brass samples with corrosion at concentration of 2% NaCl solution.
The mechanical features of brass alloy with and without corrosion in 1%, 2%, and 3% NaCl solution for full day under room temperature (25 °C) are compared. The stress and strain decreases with increase corrosion rate of brass which lead to decrease of strength brass. The results indicate that the brass without dezincification has the higher stress. The addition of zinc to copper brings about an increase in strength because the zinc enters into solid solution in the copper [III]. Figure (8) illustrates the conclusion parameters that can be obtained from these curves above; the relationship between concentration of sodium chloride solution with (stress, strain, and deformation). Brasses with less than 40% Zn the mechanical properties, even elongation, increase with increasing zinc content [XXI].

**Figure.7** Compressive load-deformation of brass testers with corrosion under concentration of 3% NaCl solution

**Figure.8** Comparison of mechanical properties of brass alloy with and without corrosion in 1%, 2%, and 3% NaCl solution for 24 hours at room temperature
IV. Conclusion

The effect of the corrosion rate (mmpy) on the mechanical properties of brass in sodium chloride solution was investigated by weight-loss method. The present study leads to the following conclusions: Chloride concentration is very influential factor in dezincification. Higher chloride concentration make higher corrosion rate. Brass alloy without corrosion attained higher strength compared to that of the specimen with corrosion of brass specimen. During compression loading, higher stress of brass without corrosion was recorded than the specimen with corrosion of brass. In dezincification of brass cases, the stress decrease was recorded with increase corrosion rate (mmpy). With the increase concentration of salt solution, the roughness increase, because of, chloride aggressive became higher. Higher hardness and higher zinc and have very limited effects on dezincification corrosion.

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