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EFFECT OF SULPHIDE IONS ON THE CORROSION BEHAVIOUR OF Al-BRASS IN SEAWATER

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ABSTRACT
The corrosion behaviour of the Al-brass was investigated in absence and presence of different concentration of sulphide ions in natural seawater with potentiodynamic polarization technique. The potentiodynamic polarization measurements indicate that the presence of sulphide ions decreases the alloy corrosion resistance.
Keywords: Al-brass, corrosion, sulphide ions, potentiodynamic polarization technique

1. INTRODUCTION
Aluminium brass and copper-nickel alloys have been used for condenser tubes where seawater is used for cooling. Because of relatively low cost and high corrosion resistance Al-brass is used for tubes in seawater cooled steam condensers. In sulphide polluted seawater this corrosion resistance decrease. The impact of sulphides on the corrosion of copper alloys has obtained considerable attention. Mainly sulphide was introduced into seawater by rotting vegetation and by industrial waste discharge. Sulphides are formed *in situ* by biological activities and decaying [1] too. In the present work, the corrosion characteristics of Al-brass were investigated in different conditions. The corrosion data were obtained by use of anodic potentiodynamic polarization studies and Tafel plots of Al-brass specimens under different concentrations of Na_2S in natural seawater.

2. EXPERIMENT
Potentiodynamic polarization studies were carried out with test electrodes that were cut and prepared from the original steam condensers tube. Specimens were then mounted in cold setting resin. The open surface ($1cm^2$) was prepared by abrading until the finest grade of 600 was reached. Polished specimens were then degreased with acetone and washed with distilled water just before setting up cell. The initial potential in anodic polarization was at -250 mV (SHE), and the scan rate was 1 mV/s. Anodic polarization studies were carried out with a three-electrode system using a computer-controlled Potentiostate/Galvanostate Model 342, with Softcorr Measurement Software, Model 342, (to control the potentiodynamic process)-EG and G/Princeton Applied Research Corp. Platinum electrode was used as counter electrode, a saturated calomel electrode (SCE) was used as reference electrode, and condenser tube material (CuZn20Al2 .00 alloy) was used as a working electrode. The specimens were immersed in aerated: 1) 750 ml of natural seawater with addition of the 32 ppm Na_2S, 2) 750 ml of natural seawater with addition of the 102 ppm Na_2S. All tests were carried out at temperature of 20°C.

3. RESULTS AND ANALYSIS
Corrosion data, obtained with potentiodynamic polarization studies for the specimen of a CuZn20Al2.00 alloy in solution of natural seawater with different concentration of Na_2S, are presented in Table 1.

Table 1. Corrosion data obtained for a CuZn20Al2.00 alloy electrode in different solutions

Solutions	E_{corr}, mV vs. SCE	Corrosion rate, x 10^{-2} mm year $^{-1}$
Aerated natural seawater with addition of 32 ppm Na_2S	- 299	5.23
Aerated natural seawater with addition of 102 ppm Na_2S	- 258	2.76

It is obvious that the values of the potential E_{corr} and corrosion rate for the sample immersed in aerated natural seawater with addition of 32 ppm Na_2S were higher than for sample immersed in aerated natural seawater with addition of 102 ppm Na_2S which can be seen in Table 1. By increasing the concentration of Na_2S at the 102 ppm Na_2S the potential E_{corr} value was more positive because of the formation of a porous film of cuprous sulphide [5]. Decrease in corrosion rate in solution with 102 ppm Na_2S can be explained by formation of pseudo-passive film on the Al-brass surface [6]. This sulphide film does not confer much protection against further corrosion attack [7]. From this follows that decrease in corrosion rate with presence of the Na_2S was only apparently. In both curves can be seen pitting appearance on which base the corrosion rate was measured. Formation of the not homogenous passive film, which is cathodic (it is a semiconductor) really prevent uniform dissolution of the Cu on electrodes surfaces. However, formed pits can propagate in depth with higher rate because the anodic surface of pit is small that means that the higher value of current density is relevant for the metal dissolution on anode while in same time the large cathode is an pseudo-passive sulphide film. Those anode/cathode ratios always stimulate pitting corrosion damage on metal surface.

Anodic potentiodynamic polarization curves for Al-brass in each condition are given in Figures 1 and 2. Corrosion rates were carried out using the Tafel plots obtained in same conditions as tested alloy.

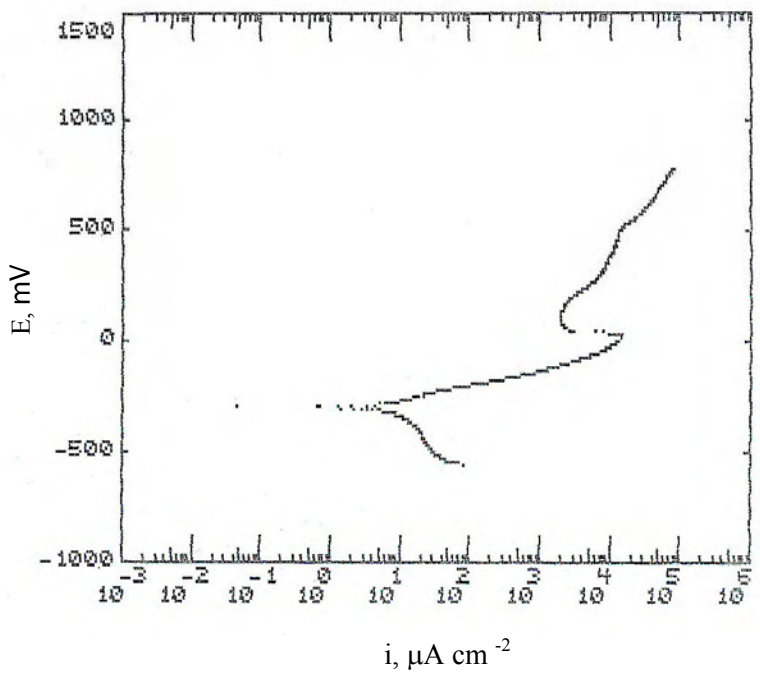

Figure 1. Anodic polarization curve obtained for Al-brass in aerated natural seawater with addition of 32 ppm Na_2S

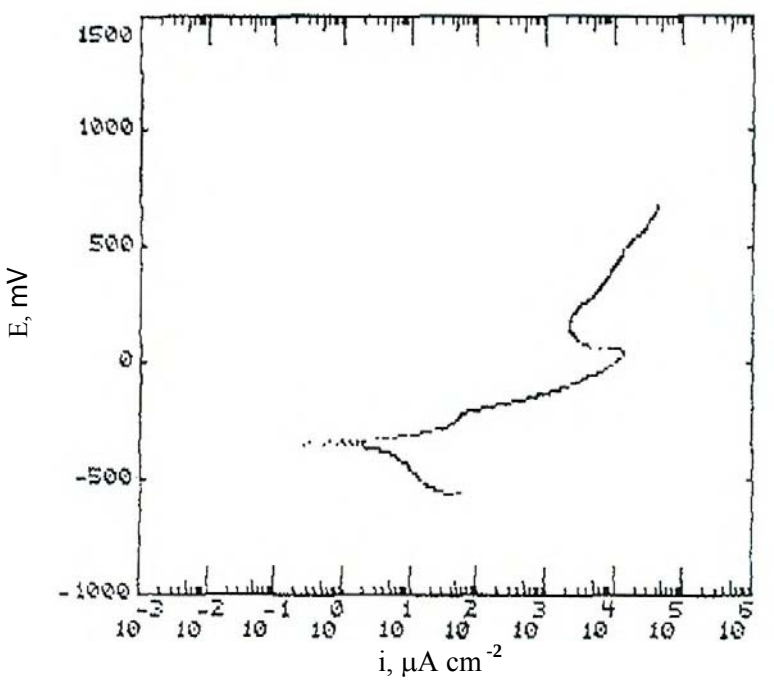

Figure 2. Anodic polarization curve of Al-brass in aerated natural seawater with addition of 102 ppm Na_2S

It is clear that the anodic corrosion current decreases slightly as sulphide concentration increases, which is shown on Figure 2. This is in agreement with the results reported in [4].
Figure 3 showed cross-section of the condenser tube CuZn20Al2.00 alloy obtained after measurement of an anodic potentiodynamic polarization curve in stagnant aerated natural seawater. In this condition on Al-brass the pitting corrosion was occurred. The black pits occurred on Al-brass surface indicates that the natural cooling seawater was polluted with sulphides.

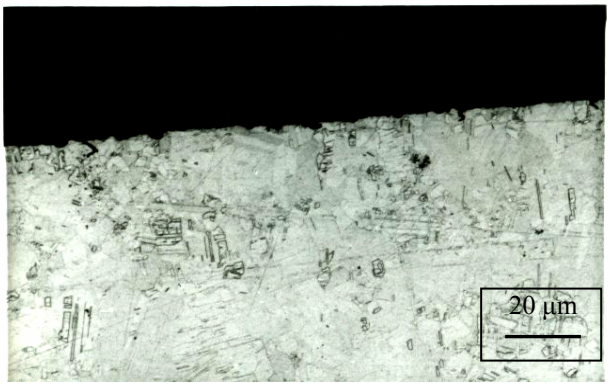

Figure 3. Pitting corrosion and microstructure of the cross-sectional electrode (CuZn20Al2.00 alloy) after measurement of the anodic potentiodynamic polarization curve in natural seawater; magnification: 200x

4. CONCLUSION

The obtained electrochemical parameters presented in Table 2, show that corrosion rate of CuZn20Al2.00 alloy decrease in aerated natural seawater solution with added 102 ppm Na_2S. For both cases (Figures 1 and 2) the anodic potentiodynamic polarization curves showed a small passive region. This region is termed as "pseudo-passivity". Decrease in corrosion rate in solution with 102 ppm Na_2S can be explained as a result of pseudo-passive film formation on the Al-brass surface. This

sulphide film does not confer much protection against further corrosion attack. Pitting appeared in both curves on which base the corrosion rate was measured. Pitting corrosion was appearing on surface of working electrode (Al-brass) after measurement of the anodic potentiodynamic polarization curve in aerated stagnant natural seawater, and that means sulphide pollution of this water.

5. REFERENCES

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