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The Behavior of Bronze in Sea Water

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ABSTRACT

In this study we were interested in the behavior of bronze, intended for the marine sector. So, we immersed bronze coupons in seawater in the absence and then in the presence of oxygen Scavenger which is considered a corrosion inhibitor. We were particularly interested in the evolution of the corrosion rate as a function of time and the concentration of the inhibitor. The techniques used in this work are gravimetric and electrochemical (open circuit potential, potentiodynamic polarization, linear polarization resistance and electrochemical impedance spectroscopy), in addition to surface characterization by scanning electron microscopy and X-ray fluorescence. By adding an inhibitor (oxygen Scavenger) at different concentrations to seawater, reductions were observed in corrosion rates. A minimum value is recorded at 200 ppm (0.0940 mm/year). The effectiveness of the inhibitor is proportional to its concentration, a value of 48.77% efficiency is obtained in the presence of 200 ppm of Scavenger oxygen.

Keywords: sea water, environment, bronze, inhibitor, oxygen scavenger

1 Introduction

This work focuses on the study of the electrochemical behavior of bronze in seawater. Different electrochemical techniques were used, namely the monitoring of corrosion potential as a function of time; polarization measurements; electrochemical impedance spectroscopy and gravimetry. The effect of adding a corrosion inhibitor, in this case Scavenger oxygen, on the behavior of bronze was also examined.

2 Materials and operating procedure

The electrochemical tests are carried out using an electrochemical measuring setup from the corrosion laboratory of the Research and Development Center -CRD-Boumerdes. The materials used are: electrochemical measurement chain which includes: Potentiostat / EGG model 273A type galvanostat; EGG model 273A type electrometer; SOLARTON transfer function analyzer, SI 1255 model; computer equipment, electrochemical cell. The material is mechanically cut from a bronze plate, the sample is mechanically polished using progressively graded silicon carbide abrasive discs of grade 80, 120, 150, 360, 400, 600, 800, 1000, 1200, 1500 up to grade 2000. After polishing, it undergoes different surface treatments.

3 Results and discussion

Our results show that the corrosion rate of bronze decreases as a function of immersion time in sea water. It reaches its minimum value, which is 0.014 mm/year, after the 7th day. This reduction is due to the formation of a layer of copper oxide (Cu_2O and CuO) which plays the role of a passivation film. The values of the polarization resistance (RP) vary depending on the immersion time in the aggressive environment, the maximum value was recorded after the 7th day. The impedance diagrams given by the Nyquist representation give flattened semi-circles. This is explained by the fact that the surface of the metal is heterogeneous.

4 Conclusion

By adding an inhibitor (oxygen Scavenger) at different concentrations to seawater, reductions were observed in corrosion rates. A minimum value is recorded at 200 ppm (0.0940 mm/year). The effectiveness of the inhibitor is proportional to its concentration, a value of 48.77% efficiency is obtained in the presence

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of 200 ppm of Scavenger oxygen. The study of the evolution of the inhibitory effectiveness of the oxygen reducer, reproducing real conditions, is carried out by injecting 500 ppm of the inhibitor considered as a shock treatment. The results reveal, on the one hand, a sudden reduction in the corrosion rate during the injection of the inhibitor after 8 hours of immersion. On the other hand, the stabilization of this speed during all the remaining time. Which means that after 80 hours of immersion our alloy is protected by the formation of the inhibiting film of the oxygen reducer and by the passivation layer formed at the surface of the bronze, which prevents the passage of current and blocks cathodic reactions until the 3rd change where we observed an increase in the corrosion rate values to 0.056 mm/year after 104 hours of immersion, which can be due to partial detachment of the inhibitor film adhered to the surface of the bronze.

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