Electrochemical Corrosion Properties of Ternary Al and Quaternary Zr Added Bell Metal in 0.1M NaCl Solution

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ABSTRACT

The electrochemical corrosion property of ternary Al and quaternary Zr added Bell metal in 0.1M Sodium Chloride solution has been experimentally conducted at room temperature. Electrochemical impedance spectroscopy (EIS) method and Potentiodynamic polarization technique are used to carry out the electrochemical investigation. Microhardness test is also conducted for all three alloys and it reveals that Al addition increases the hardness of bell metal due to the formation of different intermetallic precipitates of Cu and Al. Optical Micrograph as well as Scanning Electron Micrograph have also been studied to characterize their surface condition. It is found that Zr addition refines the grain structure of the alloy and results in increase of hardness. The EIS study reveals that the corrosion resistance is seem to be augmented with the addition of ternary Al and quaternary Zr to bell metal. The potentiodynamic polarization curves disclose that both ternary Al added and quaternary Zr added alloy show better corrosion performance than the base bell metal alloy due to the formation of stable aluminium oxide film. The current density (I_{corr}) of base bell metal showed higher value than both ternary Al added and quaternary Zr added bell metal alloys. The corrosion potential (E_{corr}) and the open circuit potential (OCP) were seen to be moved to the more positive direction for the Al and Zr added alloys. Microstructure and SEM study of the alloys after corrosion revealed a formation of an oxide film on the surface of the ternary Al and quaternary Zr added alloys, the probable cause of which is the presence of Al in the respective alloys.

Keywords: *Bell metal, corrosion, EIS, SEM, Tafel*

I. Introduction

Bell metal is an alloy of copper where the secondary alloying element is tin. Tin has favorable melting point and also has strengthening ability, thereupon when it is added to copper its strength increases as well as it helps to attenuate the rate of corrosion [1]. In bell metal the compositional ratio of copper to tin is approximately 4:1 for most of the cases. Bell metal is famous for its unique resonance of sound and therefore most of the musical instruments are made of this promising alloy [2-4]. Other than fabrication of cymbals and percussion instruments, this unique metal is used in war industries as well as making cannons, weapons, forge tools etc. [5]. Due to its attractive color, this alloy material has also a large extent of use in making utensils, pottery, coins, vessels, ornaments, monuments, sculptures, statues etc. [6, 7]. Bell metal alloys are conventionally found in gear, bushing or bearing type applications due to its ability to endure high strengths and heavy loads [8]. This

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