Copper and its alloys are widely used in many applications of industry due to their superior thermal conductivity and machinability characteristics. Brass is the best known and mostly used alloy of copper and it is widely utilized in cooling water systems, shipboard, power generation plants, petrochemical heat exchangers etc. [1–5]. Brass materials are relatively noble. Nevertheless 65-35 brass exhibits α to β transition which is more prone to corrosion. It reacts easily in ordinary environments in the presence of oxygen and high concentration of chloride, sulphate, sulphite and nitrate ions. The corrosion behavior of brass has been extensively studied in a wide range of experimental conditions, with specific interest in dezincification [5–9], passivation, pitting corrosion [9–15], dealloying and stress corrosion. The corrosion behavior of brass has been searched from an aspect of dezincification mechanism, dealloying and stress corrosion. Dezincification of brass is a well known and common process by means of which brass loses its valuable physical and mechanical properties [5, 9, 14].

Many studies have been reported on the applications of inhibitors to prevent brass corrosion [5, 15–20]. Electrolytic metal coatings are very effective for corrosion prevention in addition to the inhibitors. Metal coating on steel is commonly used. The corrosion behavior of steel, coated by electrolytic or potentiostatic methods with Zn, Co, Ni or Zn–Co, Zn–Ni alloys, has been investigated [21, 22]. However, studies on metal coating to brass, for corrosion protection, are very few.

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Copper, silver, gold, cadmium, and zinc are normally deposited from solutions of complex cyanides. Complex ions used for electrocoating are anions. The cathode tends to repel them, and their transport is controlled entirely by diffusion. Silver coating is carried out by using Ag (CN)\(^{-}\) complex as illustrated in Fig. 1 [23].

There are several practical advantages of coating from complex cyanides. The reduction in deposition potential is the most important one in the application of relatively noble metals to base substrates by avoiding metal corrosion.

The effect of silver coating to prevent corrosion of brass was examined in this study. The corrosion behavior of electrolytically silver coated brass in 0.1 M HCl, 0.1 M H\(_2\)SO\(_4\) and 0.1 M H\(_3\)PO\(_4\) solutions was investigated by Tafel polarization curves and cyclic voltammetry curves at 1., 24., 48., 72., 96. and 168. hours. The coating efficiency was calculated by current density of corrosion determined from Tafel polarization curves. Surface analysis of coated brass immersed into acidic solution by 168 hours was done. It is concluded that silver coating is very effective to protect the corrosion of brass for a long time.

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1. INTRODUCTION

Copper and its alloys are widely used in many applications of industry due to their superior thermal conductivity and machinability characteristics. Brass is the best known and mostly used alloy of copper and it is widely utilized in cooling water systems, shipboard, power generation plants, petrochemical heat exchangers etc. [1–5]. Brass materials are relatively noble. Nevertheless 65-35 brass exhibits α to β transition which is more prone to corrosion. It reacts easily in ordinary environments in the presence of oxygen and high concentration of chloride, sulphate, sulphite and nitrate ions. The corrosion behavior of brass has been extensively studied in a wide range of experimental conditions, with specific interest in dezincification [5–9], passivation, pitting corrosion [9–15], dealloying and stress corrosion. The corrosion behavior of brass has been searched from an aspect of dezincification mechanism, dealloying and stress corrosion. Dezincification of brass is a well known and common process by means of which brass loses its valuable physical and mechanical properties [5, 9, 14].

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2. EXPERIMENTAL

2.1. Electrochemical Measurements

The electrochemical behavior of brass was studied in 0.1 M HCl, 0.1 M H\(_2\)SO\(_4\) and 0.1 M H\(_3\)PO\(_4\) solutions. Electrochemical tests were carried out in three-electrode system. The brass electrode used as the working electrode was prepared from brass with a composition of 2% Pb, 58% Cu and 40% Zn; it was cut as a strip and sealed with epoxy resin. The electrodes were mechanically polished with fine grain emery paper of 1200 grade under water flow, washed with dis-
tilled water and acetone and dried prior to the experiments. Surface area of brass was 0.785 cm². A platinum wire acted as counter electrode and a saturated calomel electrode (SCE) as the reference electrode. All experimental potentials are as V_SCE. Potentiostat / Galvanostat (PAR 263 A) were used for electrochemical measurements. Voltammograms were scanned with a scan rate (dE/dt) of 10 mV/s. Following 1-h stabilization at open circuit potential (OCP), measurements were performed in the following order: Tafel plots ±250 mV versus OCP using a scan rate of 10 mV/s, potentiodynamic curves starting from –0.5 V versus OCP up to 0.5 V using a scan rate of 10 mV/s, cyclic voltammetric curves –1.2 V–(+1.0 V) potential using a scan rate of 5 mV/s.

2.2. Coating Bath Characteristics

The standard bath consists of 40 g/L Ag, 130 g/L KCN and 74.1 g/L K Ag(CN)₂. Silver plate was used as anode and brass was selected as cathode material. The conditions for coating are given as; time: 255 s, current density: 2 A/dm², coating temperature: 20–30°C. The amount of deposited silver after coating was determined as 0.57 g by using Faraday equation given below,

\[
m = \frac{O}{F} \times \frac{108}{96500} \times \frac{I}{t}
\]

Where, I: current, t: coating time. Silver coated electrode is washed and then carried over to the electrochemical cell for electrochemical measurements.

2.3. SEM measurements

Surface analysis of silver coated and uncoated brass was carried out using a Jeol JSM 6060 scanning electron microscope (SEM).

3. RESULTS AND DISCUSSIONS

3.1. Cyclic Voltammetric Measurements

Cyclic voltammetric curves of silver coated and uncoated brass in 0.1 M HCl, 0.1 M H₂SO₄ and 0.1 M H₃PO₄ solutions with a scan rate of 5 mV/s from –1.2 V to +1.0 V are given in Fig. 2, 3 and 4, respectively. Zinc is selectively oxidized according to reaction 2 due to the dezincification of brass in 0.1 M HCl solution with anodic polarization from –1.2 V to +1.0 V.

\[
\text{Zn} + 4\text{Cl}^- \rightarrow \text{ZnCl}_4^{2-} + 2\varepsilon.
\]

Zinc is oxidized anodically from the beginning of –0.25 V. Also, copper may be oxidized as of +0.2 V in chloride containing acidic solutions [18, 24]. The ox-