Influence of Dissolved Iron on the Cathodic Polarisation of Copper

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It is generally indicated[1,2] that ferric ions act as a depolariser in an electrolytic system and that therefore corrosion of a metal is increased in the presence of these ions. It has, however, recently been reported by Anoschchenko[3] that ferric ion reduces the corrosion rate of iron in hydrochloric acid and he has expressed the opinion that part of it acts as a depolariser and part is adsorbed on the surface. Makrides[4] who has studied the dissolution of iron in sulphuric acid has found that an iron electrode first made passive with impressed anodic current remains passive in the presence of ferric ions even after the current is discontinued and that in this sense, ferric ion is an inhibitor for iron.

In a study of coplanar copper-mild steel bielectrodes, circular in shape, the cathodic polarisation behaviour of the copper member of the copper: 80, mild steel: 1 systems in oxygenated 3 percent sodium chloride solution at $35 \pm 0.1\,^{\circ}C$ was investigated first using platinum, and then the corresponding mild steel member as the auxiliary electrode in separate experiments. It was found that the copper was more easily polarised cathodically against the mild-steel member than against platinum. This divergence in behaviour can only be attributed to the influence of some charged species derived from the mild steel electrode. In order to confirm this suspicion, experiments were carried out on the cathodic polarisation of copper using platinum as an auxiliary electrode, but with and without the mild steel specimen dipping independently in the solution. It is seen from Figure 1, that the presence of mild steel considerably increases the cathodic polarisation of copper. The possibility that there might have been depletion of oxygen caused by the corrosion of the mild steel specimen is ruled out by the fact that the solution was all the while being oxygenated and there was no difference in the oxygen content of the solution before and after immersion of the mild steel specimen. The effect of dipping of a mild steel specimen was also confirmed by measuring the potential of platinum wire in the solution and it was observed that its potential was shifted by nearly 500 mV in the negative direction in an hour or two after the immersion of mild steel. It would appear that the charged species contributed by mild steel forms a blanket over the cathodically polarised copper and hinders the depolarisation of the electrode by the oxygen available in plenty. However under the conditions of the experiment, there was no dissolved iron either in the ferrous or in the ferric state in the solution filtered after the experiment. It is possible that the charged species contributed by mild steel are positively charged colloidal corrosion product, since precipitated ferric hydroxide, when added to the system does not produce any effect. This was confirmed by the observation that when the mild steel electrode was surrounded by a cellophane diaphragm, the cathodic polarisation of the copper member was very similar to that obtained with platinum as an auxiliary electrode.

This study brings out the difference in the effects observed under conditions of polarisation studies employing an inert electrode and those under conditions of polarisation met with in practice when the corrosion products also may interfere with the process.

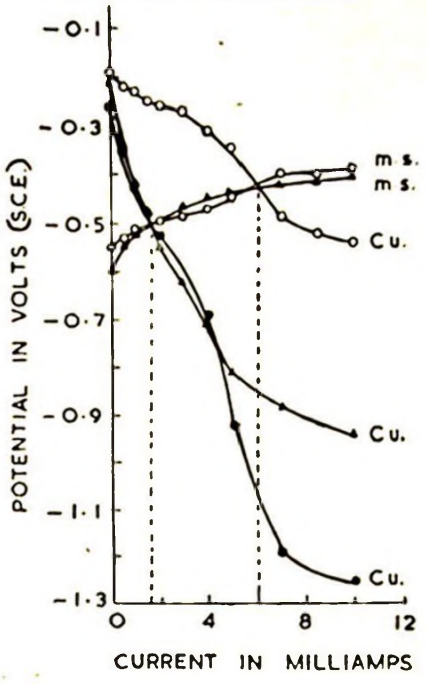
The authors are grateful to Prof. K.S.G. Doss, Director, Central Electrochemical Research Institute for his kind encouragement.

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FIG-1

CATHODIC POLARISATION OF COPPER AND ANODIC POLARISATION OF M.S. OF THE BI-ELECTRODE M.S. : Cu (1:80) IN 3% NaCl SOLUTION AT 35 ± 0·1°c



Using platinum auxiliary electrode

Simultaneous polarisation of copper and steel

Cathodic polarisation of copper using a Pt auxiliary electrode (iron specimen was kept immersed in the solution)