Environmentally friendly corrosion inhibitor of the copper in 0.5 M sulphuric acid solution.

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Copper corrosion inhibition by gramine [3-(dimethylaminomethyl)indole] in the 0.5 M sulphuric acid solutions was studied in the temperature range 25-55 °C using electrochemical impedance spectroscopy techniques (EIS).

Gramine was dissolved at various concentrations (from $5 \cdot 10^{-4}$ to $7.5 \cdot 10^{-3}$) in 0.5 M sulphuric acid. The surface preparation of the specimens was carried out using silicon carbide paper up to grade 1200.

EIS measurements were performed after dipping the working electrode into the 0.5 M sulphuric acid solutions with or without inhibitor at E_{corr} with an a.c. voltage amplitude of 5mV. The frequency range was swept between 100 kHz and 10 mHz with 10 point for hertz decade.

The presence of gramine led to changes of the impedance plots in both shape and size. The plots of Nyquist exhibited that some impedance spectra consisted of one capacitive loop at the higher frequencies which was attributed to a faradaic process involving a charge transfer resistance in parallel with double-layer capacitance element [1]. The size of the capacitive arc increased by increasing the concentration of gramine. This indicated that gramine increased the charge transfer resistance and then it had an inhibiting effect on copper corrosion in 0.5 M sulphuric acid solutions. Inhibition efficiencies results showed that the gramine inhibited the copper corrosion in the temperature range 25-55 °C reaching the maximum value of 86% at 55 °C.

Impedance spectra also showed a depression of Nyquist-plot semicircles that can be related to the surface heterogeneity due the microscopic roughness of the electrode surface and inhibitor adsorption [2]. Moreover at the lower frequencies in both the uninhibited solutions and inhibited ones by lower inhibitor concentrations, the Warburg impedance appeared. In the copper corrosion in oxygenated sulphuric acid solutions at E_{corr} the anodic reaction is copper dissolution and cathodic reaction is oxygen reduction being the hydrogen discharge current density negligible as compared to oxygen reduction current density. Then the Warburg impedance could be attributed to oxygen transport from the bulk solution to the copper surface [3].

The adsorption behaviour of gramine followed Temkin's isotherm. The values of the standard free energy of adsorption of the gramine at 25 °C, 35 °C, 45 °C and 55°C were calculed.

A structural model of the interface copper/0.5 M H_2SO_4 was proposed.

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