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Determination of corrosion rates by electrochemical DC and AC methods

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Abstract

A brief review is given of DC and AC techniques which can be used to determine corrosion rates. The advantages and disadvantages of the extrapolation method of Tafel lines, polarization resistance measurements and impedance measurements are discussed. In particular it is shown that the intercept of the capacitive impedance loop with the real axis of the complex impedance diagram does not correspond to the charge transfer resistance of complicated corrosion systems exhibiting several time constants in the capacitive and inductive loop(s). Therefore, the correlation between this intercept value and the corrosion rate is not generally valid.

Experimental data are presented for two types of iron (Marz and Johnson-Matthey) and 4340 steel in de-aerated and aerated 0.5 M H_2SO_4 and 1 M HCl in the absence and presence of the following inhibitors: triphenylbenzylphosphonium-chloride ($TPBP^+$), propargylic alcohol (PA), 2-butyne-1,4-diol (BD) and hexynol (H). Corrosion rates have

propargylic alcohol (PA), 2-butyne-1,4-diol (BD) and hexynol (H). Corrosion rates have been determined by applying DC and AC measurements and solution analysis by atomic absorption. The results, in the absence of inhibitors and in the presence of $TPBP^+$, show that the corrosion rate is unequivocally correlated to electrochemical DC data and to the extrpolated value of the inductive loop of AC measurements to zero frequency. However, in systems containing the other inhibitors the corrosion rate cannot be correlated to the polarization resistance because of an irreversible desorption of the inhibitor in the close vicinity of the corrosion potential, which gives an unpolarizable behaviour of the system in the anodic range.

The relatively low inhibition efficiencies in the presence of PA and BD can be explained by a superimposed fast electrochemical reduction of the additives. Moreover, it is shown that the inhibition efficiency depends on the hydrodynamic conditions.

The results of these investigations show that electrochemical DC and AC techniques can successfully be applied for determination of metal corrosion rates in systems that have simple corrosion kinetics. In more complicated systems knowledge of the details of the mechanism is necessary for interpretation of the experimental data.

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