Evaluation of imidazole derivatives as carbon steel corrosion inhibitors in synthetic oilfield formation water saturated with CO_2

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Abstract

Three imidazole derivatives were evaluated as CO_2 corrosion inhibitors of carbon steel in synthetic oilfield formation water. The selected chemicals inhibited the steel corrosion but the corrosion efficiencies were not high for industrial practice application.

Introdução

CO_2 dissolved in aqueous medium increases the corrosion rate of carbon steel due to the formation of H_2CO_3. Therefore, there is interest to test organic molecules in order to evaluate their potential as CO_2 corrosion inhibitors. Thus, 4-(1H-Imidazole-1-yl)-Benzaldehyde (IB), 4-(Imidazole-1-yl)-Phenol (IP) and 4-(1H-Imidazole-1-yl)-Aniline (IA) were tested as CO_2 corrosion inhibitors for carbon steel in synthetic oilfield formation water. The corrosion tests were carried out at room temperature (≈ 25 °C) and using potentiodynamic polarization and electrochemical impedance techniques. Ag/AgCl, saturated KCl, and Pt foil were the reference and auxiliary electrodes, respectively. The coupon was embedded in epoxy resin and a circular geometric surface area of about 0.71 cm^2 was exposed. Prior the electrochemical experiments, the working electrode was sanded with SiC sandpaper till grain size of 600, followed by rinse with water and acetone. Before each corrosion test, N_2 was purged for 30 min, followed by CO_2 bubbling until the pH became stable about 5.2. The concentration of the selected chemicals was 10^{-3} mol L^{-1} and the composition of the working solution is given in reference 1

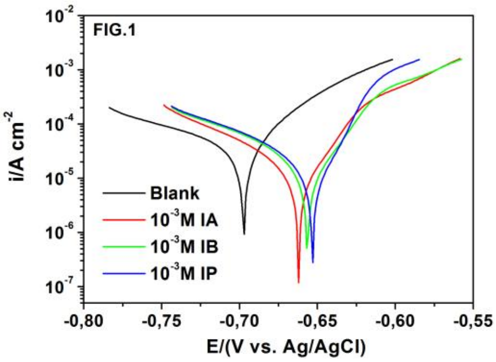
Resultados e Discussão

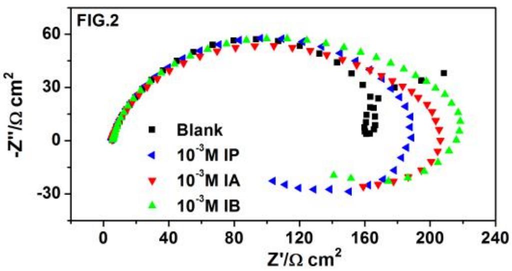
The polarization curves showed that in presence of the inhibitors, the corrosion potential (E_{corr}) shifted about 40-50 mV towards more positive direction in comparison to the E_{corr} obtained in absence of the inhibitor (blank), suggesting that these molecules can be classified as anodic inhibitors (Fig. 1). The impedance diagrams (Fig. 2) presented a capacitive loop at high frequency range. The extrapolation of the capacitive loop to the real axis at low frequencies allowed to calculate the charge transfer resistance obtained in presence (R_{ct}) and in the absence (R_{ct}^0) of the extract. Moreover, partial resolved inductive loops were observed at low frequency range which are attributed the adsorption of chemical species on steel surface. The corrosion inhibition efficiencies (ε_{im}) were calculated using equation 1. The electrochemical parameters are listed in Table 1.

$$\varepsilon_{im} = \left(1 - \frac{R_{ct}^0}{R_{ct}}\right) x\ 100 \quad \text{(equation 1)}$$

Table 1. Corrosion parameters derived from electrochemical tests.

Inhibitor	EIS method		Polarization method
	R_{tc} (Ω cm^2)	ε_{im} %	E_{corr} (V)
Blank	169,38	-	-0,697
IB	228,64	26	-0,661
IP	197,63	14	-0,654
IA	208,93	19	-0,663





Conclusões

All the studied molecules inhibited the corrosion of carbon steel in synthetic oilfield formation water saturated with CO_2. However, these molecules cannot be considering for industrial practice application, since all the corrosion efficiencies were very low.

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[1] G. A. Zhang, Y. F. Cheng, Electrochim. Acta **2011**, 56, 1676.