DOI 10.1515/corrrev-2012-0022 — Corros Rev 2013; 31(2): 61–72

Original article

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Petroleum quaternary ammonium surfactants mixture synthesized from light naphtha as corrosion inhibitors for carbon steel in 1 M HCl

Abstract: A quaternary ammonium cationic surfactants mixture was synthesized from light naphtha, petroleum fraction. The mixture was analyzed by Fourier transform infrared spectroscopy and UV/Visible spectroscopy and was evaluated as a corrosion inhibitor for carbon steel in 1 M HCl, by gravimetry, potentiodynamic polarization and electrochemical impedance spectroscopy. The results showed that inhibiting efficiency increased with inhibitor concentration and temperature, and was independent of pH (in the range of 0–4) and immersion time; its optimal value was up to 84% for 560 mg/l at 25°C. Experimental data showed that the cationic surfactants mixture acts as a mixed (anodic and cathodic) inhibitor and conformed to the Langmuir adsorption isotherm. Scanning electron microscopy images revealed the inhibiting capacity of the mixture against carbon steel acid corrosion.

Keywords: adsorption; carbon steel; cationic surfactants mixture; corrosion inhibition; surfactants synthesis.

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1 Introduction

Because of the huge economic losses as a result of acid corrosion of steel employed in numerous industrial applications, preventive strategies to minimize this deleterious facet are unequivocally necessary. Of the various means for inhibiting corrosion occurrence, the use of organic surfactants remains the most practically efficient (Malik, Hashim, Nabi, AL-Thabaiti, & Khan, 2011). That a special interest has been devoted to the study of corrosion inhibition at diverse metal/electrolyte interfaces (Abd El Rehim, Hassan, & Amin, 2002; Foad El-Sherbini, Abdel Wahaab, & Deyab, 2005; Knag, Sjöblom, Öye, & Gulbrandsen, 2004; Li & Mu, 2005; Osman, El-Ghazawy, & Al-Sabagh, 2003; Villamil, Corio, Agostinho, & Rubim, 1999) by using organic surface-active agents is due to the many inherent advantages of the latter ones. Indeed, surfactants are attractive mostly for their hydrophobic-hydrophilic structure, their relatively high molecular weights, their easy production, their moderate cost and their low toxicity against the environment compared to mineral inhibitors. Surfactant molecules physically prevent the corrosion of metals by adsorption onto their surfaces; corrosion speed is thereby significantly reduced (Migahed, Abd-El-Raouf, Al-Sabagh, & Abd-El-Bary, 2005; Mu & Li, 2005; Qiu, Xie, & Shen, 2004, 2005). Their activity as corrosion inhibitors generally increased with their concentrations and was optimal near critical micellar concentrations (CMCs) (Fuchs-Godec, 2006; Moura, Neto, Dantas, Júnior, & Gurgel, 2009; Zhang, Gao, Xu, & Zou, 2011). It is customary to combine a surfactant with an additive for enhancing the inhibiting efficiency, when both the surfactant and the additive are not efficient individually (Rajendran, Reenkala, Anthony, & Ramaraj, 2002).

Quaternary ammonium-based cationic surfactants are well known as excellent inhibitors for iron dissolution and for steel corrosion in acidic media (Osmanet al., 2003; Popova, Christov, & Vasilev, 2011; Qiu, Wu, Wang, & Jiang, 2008; Soror & El-Ziady, 2002). They can be used alone or in conjunction with inorganic anions ions such as halide ions (Deyab, 2007) or organic compounds such as 2-mercaptobenzoxazole (Tavakoli, Shahrabi, & Hosseini, 2008). There are reports (Deyab, 2007; Fuchs-Godec, 2009; Li & Tang, 2005; Mu, Li, & Liu, 2005; Tang