Investigation of the inhibitive effect of quaternary ammonium surfactant mixture synthesized from Kerosene petroleum fraction on corrosion of carbon steel pipelines in HCl 1M

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Abstract

Quaternary ammonium cationic surfactant was synthesized from Kerosene, via chloromethylation/quaternization sequences. The thus-obtained petroleum surfactant was evaluated as corrosion inhibitor for carbon steel in 1 M HCl, by gravimetry, potentiodynamic polarization and electrochemical impedance spectroscopy. The corrosion inhibiting efficiency was assessed as functions of surfactant concentration. The results showed that the inhibiting efficiency increased with surfactant concentration; its optimal value of 79 % was for a surfactant concentration of 400 mg/L at 25 °C. Potentiodynamic polarization measurements showed that the mixture acts as mixed type inhibitor. The corrosion inhibiting mechanism is thought to proceed via an adsorption of the surfactant molecules on the steel surface, generating a film and hindering the active sites. Our experimental adsorption data were found to obey Langmuir adsorption isotherm. SEM images of the treated specimens, revealing the likely formation of a protective film, demonstrated the inhibiting capacity of the petroleum quaternary ammonium surfactant against the carbon steel corrosion.

Keywords Corrosion acid, Carbon steel, Petroleum quaternary ammonium, Cationic surfactant.

Academic Discipline and Sub-Disciplines

Electrochemistry, Chemical Engineering & Chemical Technology.

SUBJECT CLASSIFICATION

Chemistry, electrochemistry, scanning electron microscopy.

TYPE (METHOD/APPROACH)

FT-IR , UV-visible, Gravimetry, potentiodynamic polarization, electrochemical impedance spectroscopy methods.

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 the corrosion occurrence, the use of organic surfactants remains the most practically efficient [1]. That a special interest has been devoted to the study of the corrosion inhibition at diverse metal/electrolyte interfaces [2-8] by using organic surface-active agents owes to the many inherent advantages of the latter ones. Indeed, the surfactants are attractive mostly for their hydrophobic-hydrophilic structure, their relatively high molecular weights, their easy production, their moderate cost and their low toxicity compared to mineral inhibitors. Surfactant molecules physically prevent the corrosion of metals by adsorption onto their surfaces; the corrosion speed is thereby significantly reduced [9]. Their activity as corrosion inhibitors generally increased with their concentrations and was optimal near critical micellar concentrations (CMC) [10-12]. It is customary to combine the surfactant with an additive for enhancing the inhibiting efficiency, when both the surfactant and the additive are not efficient individually [13].

Quaternary ammonium-based cationic surfactants are well known as excellent inhibitors for iron dissolution and for the steel corrosion in acidic media [14-16], they can be used alone or in conjunction with inorganic anions ions such as halide ions [17] or organic compounds such as Palmitylsulfo-betaineas [18], There are reports that put forward the synergetic effect of combined surfactants of different nature in corrosion inhibition of copper, brass, carbon steel and stainless steel in different corrosive media [17-21].