Journal of Molecular Liquids 336 (2021) 116166

Contents lists available at ScienceDirect

Journal of Molecular Liquids

journal homepage: www.elsevier.com/locate/molliq

Decyltriphenylphosphonium bromide containing hydrophobic alkyl-chain as a potential corrosion inhibitor for mild steel in sulfuric acid: Theoretical and experimental studies

Madhusudan Goyal [a,*], Hemlata Vashisht [b], Salhah Hamed Alrefaee [c], Reena Jain [d], Sudershan Kumar [d,*], Savaş Kaya [e], Lei Guo [f], Chandrabhan Verma [g,*]

[a] Department of Chemistry, University of Delhi, Delhi-110007, India& Department of Higher Education Haryana, India
[b] Department of Chemistry, Kirori Mal College, University of Delhi, Delhi 110007, India
[c] Department of Chemistry, College of Science, Taibah University, Yanbu 30799, Saudi Arabia
[d] Department of Chemistry, Hindu College, University of Delhi, Delhi 110007, India
[e] Sivas Cumhuriyet University, Health Services Vocational School, Department of Pharmacy, 58140 Sivas Turkey
[f] School of Material and Chemical Engineering, Tongren University, Tongren 554300, China
[g] Interdisciplinary Research Center for Advanced Materials, King Fahd University of Petroleum and Minerals, Dhahran, 31261, Saudi Arabia

ARTICLE INFO

Article history:
Received 1 December 2020
Revised 9 April 2021
Accepted 12 April 2021
Available online 16 April 2021

Keywords:
Linear alkyl group
Electrochemical tests
Polarization
Corrosion inhibition
Ionic Liquids

ABSTRACT

A triphenylphosphonium based ionic liquid containing a long hydrophobic alkyl-chain (designated as DTPPB) was evaluated as a potential corrosion inhibitor for mild steel (MS) in 0.5 M H_2SO_4 solution. Inhibition efficiency and adsorption behavior of DTPPB was determined by performing the experimental analyses were carried out at the different concentration and temperature. Corrosion inhibition effectiveness of DTPPB was determined experimentally using electrochemical and surface analyses (SEM-EDX and AFM). Polarization studies showed that DTPPB acted as a mixed-type inhibitor. Inhibition effectiveness of DTPPB increases with increasing its concentration. The potentiostatic polarization study revealed that passivation was perceived at lower DTPPB concentrations. The Nyquist plot of impedance is expressed mainly as a depressed capacitive loop with different concentrations. Self-organization of the chains and tail groups to form a coherent hydrophobic film that serves as a barrier for the transport of water, oxygen, and corrosive ions to the metal surface. In addition to the electrochemical studies, surface morphology analyses provided strong evidence for the existence of inhibitor film over the MS surface and their results were supported by the computational data.

1. Introduction

In a modern business, technology and industrial failures due to corrosion cannot be tolerated, especially those where personal injuries, fatalities, unscheduled shutdowns, and environmental contamination are concerned. So, corrosion control at the stage of designing and at the operational phase are the needs of the times [1–5]. Recently, among various practical methods such as cathodic and anodic protection, alloying as well as coating, etc. the utilization of inhibitors has shown the most effective method to ensure metal against acid corrosion. The corrosion prevention via inhibitors methods has gained more advantage awing to suitable process, simplicity, and economic viability [6–9]. The structural feature of the molecule containing the atoms such as phosphorus, sulfur, oxygen, nitrogen, and multiple bonds or aromatic rings has been widely accepted corrosion inhibitor as they facilitate the adsorption on the metal surface in various media. Thus, the corrosion inhibitive efficiency of an organic molecule on the metals is considerably influenced by factors such as the geometry of the molecule, side chain, group, and atoms present in the structure. Advantages and shortcomings of using ionic liquids as corrosion inhibitors for different corroding systems are described by Verma et al. [10]. Recently, the pursuit of a suitable corrosion inhibitor has attracted research on the inhibitor compounds [11–13].

It has been reported that phosphonium showed surface-active properties through the hydrophobic and hydrophilic groups

* Corresponding authors at: Center of Research Excellence in Corrosion, Research Institute, King Fahd University of Petroleum & Minerals, Dhahran 31261, Saudi Arabia.

E-mail addresses: msgoyaldu@gmail.com (M. Goyal), srfaay@taibahu.edu.sa (S. Hamed Alrefaee), reenajain@hinducollege.ac.in (R. Jain), sudershankumar@hindu.du.ac.in (S. Kumar), savaskaya@cumhuriyet.edu.tr (S. Kaya), chandraverma.rs.apc@itbhu.ac.in (C. Verma).

https://doi.org/10.1016/j.molliq.2021.116166
0167-7322/