THE INHIBITORY EFFECT OF WHITE ALDER EXTRACT ON LOW-CARBON STEEL CORROSION IN SULFURIC ACID

Cristian George Vaszilcsin[1], George-Daniel Dima[1,2], Nataliia Rudenko[3], Mircea Laurențiu Dan[2]

[1]National Institute of Research and Development for Electrochemistry and Condensed Matter, Dr. A. P. Podeanu 144, 300569, Timişoara, Romania
[2]University Politehnica Timisoara, Faculty of Industrial Chemistry and Environmental Engineering, Laboratory of Electrochemistry, Corrosion and Electrochemical Engineering, 6 Pârvan, 300223 Timisoara, Romania
[3]University Politehnica Timisoara, Innovation and Technology Transfer Center, 2 V. Pârvan, 300223 Timisoara, Romania
e-mail: cristi_vasz@yahoo.com

Abstract

One potential way to reduce corrosion expenses is to utilize corrosion inhibitors. Recently, most of the research has focused on corrosion inhibitors with a minimal environmental effect, with plant extracts being particularly popular [1,2]. The study's goal is to determine the inhibitory impact of a commercial alcoholic extract of white alder (Alnus incana) on OL48 steel corrosion in an H_2SO_4media.

To assess the stability of the active components in the inhibitor structure, cyclic voltammograms were plotted on the Pt electrode on the potential range between the release of hydrogen and oxygen, at polarization rates of 500, 100, and 5 mV s^{-1}, in the absence and presence of 2.5, 7.5, and 10 mLL^{-1} extract. The effect of extract additions on the corrosion process of OL48 steel, which was used as a working electrode, was investigated using linear voltammetry, chronoamperometry, and the representation of electrode potential vs. time at a temperature of 293 K for extract concentrations of 1.25, 5, 2.5, 3.75, 5, 7.5, and 10 mL/L.

To conclude the research, molecular modeling of the extract's first two main natural compounds was performed. The structures were optimized using the DFT method on a B3LYP function, on the basis set 6-31G*, based on which the plotting of the Frontier orbitals and the molecular descriptors such as the energy of the HOMO orbital (E_{HOMO}), the energy of the LUMO orbital (E_{LUMO}), their difference in absolute value E_{GAP}, the molecule hardness, and softness, the electronegativity χ, the dipole momentμ, respectively the QSAR properties related to the surface and molecular volume. All of thesementioned is consistent with the electrochemical measurements and explains the formation of covalently coordinating bonds between non-participating electrons of polar functional groups and iron's vacant orbital, allowing for the formation of a protective layer that prevents further corrosive attacks [3].

References

[1] A. Zakeri, E. Bahmani, A. Sabour Rouh Aghdam, Plant extracts as sustainable and green corrosion inhibitors for protection of ferrous metals in corrosive media: A mini review, Corros. Commun., 5 (2022) 25-38.

[2] R. O. Medupin, K. O. Ukoba, K. O. Yoro, T.-C. Jen, Sustainable approach for corrosion control in mild steel using plant-based inhibitors: a review,Mater Today Sustain, 22 (2023), 100373.

[3]E.Alibakhshi, M.Ramezanzadeh, G.Bahlakeh, B.Ramezanzadeh, M.Mahdavian, M.Motamedi, J. Mol. Liq., 255 (2018) 185–198.