

Protection of Steel Against Corrosion in 4% HCl Solution Using Wild Oregano Extract

Zaštita čelika od korozije u 4% rastvoru HCl-a primjenom ekstrakta divljeg origana

Kristina Đerić^{1,*}, Marija Mitrović¹, Milorad Tomić^{1,2}, Nebojša Vasiljević^{1,3}

¹ University of East Sarajevo, Faculty of Technology Zvornik, 75400 Zvornik, Republic of Srpska,

² Engineering Academy of Serbia, Department of Technology and Metallurgy, 11000 Belgrade, Serbia

³ University of Novi Sad, Faculty of Technology, 21102 Novi Sad, Serbia

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*kristinadjeric8@gmail.com

Abstract

In this study, the potential use of wild oregano extract as a green corrosion inhibitor for two types of steel in 4% HCl solution was investigated. Four solutions of 4% HCl were prepared: one without inhibitor (solution 1) and three with the addition of wild oregano extract at different concentrations (0.5, 1.0, and 1.5 g/L). Steel samples 1 and 2, with dimensions of 30 mm × 30 mm × 2 mm, were immersed in the prepared solutions for 2, 4, 6, 8, 24, 72, and 168 hours. Based on the weight loss of the steel samples before and after immersion, the negative mass corrosion index (K_m^-), corrosion rate (π), and inhibition efficiency (z) were calculated. The obtained results indicate that the wild oregano extract exhibits corrosion inhibition properties and effectively slows down the corrosion of both steel types. For steel 1, the protection efficiency ranged from 83.78% to 97.56%, while for steel 2 it reached up to 79.68%. The optimal concentration of wild oregano extract in 4% HCl was determined to be 1 g/L, as at this concentration the protection efficiency for steel 1 ranged from 79.89% to 97.56%, and for steel 2 from 40.25% to 79.49% across all immersion times. The average corrosion rate for steel 2 in pure 4% HCl was 1.0836 mm/year, while for steel 1 it was 4.1359 mm/year. This indicates that steel 2 is more resistant and exhibits faster self-passivation than steel 1, which explains the somewhat lower, though still significant, inhibitory effect of wild oregano extract. The obtained results are in good agreement with those derived from electrochemical measurements of corrosion rate, including electrochemical impedance spectroscopy (EIS) and Tafel polarization plots. These findings suggest that wild oregano extract can serve as an effective and environmentally friendly corrosion inhibitor in acidic environments such as HCl solutions.

Keywords: corrosion inhibitor; eco-friendly inhibitors; steel; wild oregano extract; inhibition efficiency

Izvod

U ovom radu ispitivana je mogućnost korišćenja ekstrakta divljeg origana kao zelenog inhibitora korozije za dvije vrste čelika u 4% rastvoru HCl-a. Korišćena su četiri rastvora 4%HCl, jedan bez inhibitora (rastvor 1) i tri uz dodatak ekstrakta divljeg origana kao inhibitora korozije, različitih koncentracija (0.5, 1.0 i 1.5 g/L). Uzorci čelika 1 i 2 dimenzija (30mm x 30mm x 2mm) potapani su u pripremljene rastvore tokom 2, 4, 6, 8, 24, 72 i 168 sati. Na osnovu gubitka mase uzoraka čelika prije i poslije vremena provedenog u pripremljenim rastvorima računati su negativni maseni pokazatelj korozije (K_m^-), dubinski pokazatelj korozije (π) i efikasnost inhibitora (z). Na osnovu dobijenih rezultata može se zaključiti da ekstrakt divljeg origana ima inhibitorsko dejstvo i da usporava koroziju oba korišćena čelika. Kod čelika 1 stepen zaštite se kreće od 83,78 -97,56%, dok kod čelika 2 stepen zaštite je do 79,68%. Na osnovu dobijenih rezultata optimalna koncentracija

ekstrakta divljeg origana u 4% HCl je 1g/L, jer kod čelika 1 stepen zaštite za sva vremena se kreće od 79,89-97,56%, a kod čelika 2 od 40,25-79,49%. Za čelik 2 srednji dubinski pokazatelj korozije $\pi = 1,0836\text{mm/god}$ u čistoj 4% HCl, a za čelik 1 $\pi = 4,1359\text{mm/god}$. To ukazuje na činjenicu da je čelik 2 otporniji i brže se samopasivira od čelika 1, pa je zbog toga i i dejstvo ekstrakta divljeg origana manje izržen, ali je ipak značajno. Dobijeni rezultati se u velikoj mjeri slažu sa dobijenim rezultatima elektrohemijskih mjerenja brzine korozije: spektroskopije elektrohemijske impedanse (SEI) i Tafelovih polarizacionih dijagrama. Ovi rezultati sugerišu da ekstrakt divljeg origana može poslužiti kao efikasan i ekološki prihvatljiv inhibitor korozije u rastvoru HCl-a.

Ključne reči: inhibitor korozije; ekološki inhibitori; čelik; ekstrakt divljeg origana; efikasnost inhibitora