Mechanism of corrosion inhibition of steel in trichloroacetic acid by an alcoholic extract of rosemary

Yun Gao [1], Xianghong Li [1], Juan Xu [*]

College of Materials and Chemical Engineering, Southwest Forestry University, Kunming 650224, P.R. China

e-mail address: 3010874680@qq.com

Abstract: Plant corrosion inhibitors have advantages over traditional inhibitors, such as being environmentally friendly, abundant in resources, and cost-effective. This study investigates the corrosion inhibition performance of rosemary (Rosmarinus officinalis L.) ethanol extract on steel in a trichloroacetic acid (TCA) solution. A novel inhibitor, ROE, was prepared using ultrasonic extraction, and its corrosion inhibition mechanism on steel in 0.10 mol/L TCA solution was explored through weight loss method, electrochemical methods, surface analysis techniques, and theoretical calculations. The results indicate that at a concentration of 100 mg/L, ROE achieves a corrosion inhibition rate of 96.30% at 20℃. The adsorption of ROE on the steel surface follows the Langmuir isotherm (20-30℃) and the Frumkin isotherm (40-50℃). Electrochemical studies show that ROE acts as a mixed-type inhibitor, with the entire inhibition process controlled by charge transfer, following a "geometric coverage mechanism" accompanied by a "frequency dispersion effect." Surface tests, including AFM, CLSM, and contact angle measurements, indicate that the addition of ROE significantly reduces the corrosion degree and roughness of the steel surface while enhancing its hydrophobicity. Theoretical calculations elucidate the adsorption behavior of ROE on the steel surface and the interactions between ROE and the metal, further confirming that ROE exhibits excellent corrosion inhibition performance by forming an adsorptive film on the steel surface. The research results provide new insights for the high-value utilization of rosemary.

Keywords: Alcoholic extract of rosemary, trichloroacetic acid, corrosion inhibition, mechanism of action

Reference

[1] Qiang Y, Guo L, Li H, et al. Fabrication of environmentally friendly Losartan potassium film for corrosion inhibition of mild steel in HCl medium[J]. Chemical Engineering Journal, 2021, 406: 126863.

[2] Wang X, Liu J, Zhang Z, et al. Mechanism for corrosion inhibition of pure iron in 1 M HCl by Rauiella Fujisana: Experimental, GCMS, DFT, VASP and solidliquid modeling studies[J]. Industrial Crops and Products, 2024, 207: 117692.
[3] Zu P, Zhang Y, Zhang S, et al. Excellent corrosion inhibition and lubrication performance of MMT based ionic liquids as ester oil additives[J]. Tribology International, 2024, 194: 109473.