

Agricultural waste of tobacco stem extract as a novel and efficient inhibitor for the corrosion of steel in HCl solution

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Abstract: To promote the efficient utilization of waste tobacco stems in agricultural systems and develop a highly effective, eco-system-friendly corrosion inhibitor for cold-rolled steel (CRS), this work focuses on the extraction and evaluation of tobacco stem extract (TSE) as a novel inhibitor. TSE was prepared using a simple and cost-effective reflux extraction method and tested for its corrosion inhibition performance on CRS in hydrochloric acid (HCl) media through both experimental studies and theoretical calculations. The results show that TSE contains multiple functional groups such as Fe-O, Fe-OH, C=O, and others, which contribute to its superior hydrophobicity and adhesive properties when adsorbed onto the steel surface. When 200 mg/L TSE was added, the inhibition efficiency was 91.1% at 40 °C. Its adsorption on the surface follows the Langmuir isotherm, and it acts as a mixed-type inhibitor. TOF-SIMS analysis reveals the presence of hydrocarbon peaks on the inhibited steel surface, with a significant number of N atoms and Fe-related bonds observed in both positive and negative ion spectra, confirming the effective adsorption of TSE molecules. The superior inhibition effect of TSE is attributed to its various components, with quercetin and nicotine identified as the primary active agents. In addition, Quantum chemical calculations and molecular dynamics simulations convincingly demonstrate that TSE exhibits significant anti-corrosion properties. This work provides new insight and opportunity for the development of Tobacco stem extract eco-friendly corrosion inhibitor for CRS.

Keywords: corrosion inhibitor; tobacco stem extract; steel; adsorption;

Reference

[1] H. Wang, S. Deng, G. Du, X. Li, Synergistic mixture of Eupatorium adenophora spreng leaves extract and KI as a novel green inhibitor for steel corrosion in 5.0 M H₃PO₄, *Journal of Materials Research and Technology* 23 (2023) 5082-5104.

[2] T. Zheng, J. Liu, M. Wang, Q. Liu, J. Wang, Y. Chong, G. Jia, Synergistic corrosion inhibition effects of quaternary ammonium salt cationic surfactants and thiourea on Q235 steel in sulfuric acid: Experimental and theoretical research, *Corros. Sci.* 199 (2022).110199.

[3] B. Tan, A. Fu, L. Guo, Y. Ran, J. Xiong, R. Marzouki, W. Li, Insight into anti-corrosion mechanism of Dalbergia odorifera leaves extract as a biodegradable inhibitor

for X70 steel in sulfuric acid medium, Industrial Crops and Products 194 (2023).116106.

[4] W. Guo, M. Talha, Y. Lin, Y. Ma, X. Kong, Effect of phosphonate functional group on corrosion inhibition of imidazoline derivatives in acidic environment, J Colloid Interface Sci 597 (2021) 242-259.

[5] A. Dehghani, B. Ramezanzadeh, Rosemary extract inhibitive behavior against mild steel corrosion in tempered 1 M HCl media, Industrial Crops and Products 193 (2023).116183.

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