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RESEARCH ARTICLE

Analysis of Inhibitive Performance of *N'*-[(*E*)-Phenylmethylidene]Pyridine-3-Carbohydrazide on Corrosion of IS 2062 E250 Mild Steel in 0.5-M Trichloroacetic Acid

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Received: 5 September 2025 | **Revised:** 22 December 2025 | **Accepted:** 13 January 2026

Keywords: DFT calculation | mild steel | *N'*-[(*E*)-phenylmethylidene]pyridine-3-carbohydrazide | trichloroacetic acid | weight-loss method

ABSTRACT

The Schiff base *N'*-[(*E*)-phenylmethylidene]pyridine-3-carbohydrazide (PPC) was investigated as a corrosion inhibitor for IS 2062 E250 mild steel in 0.5-M trichloroacetic acid. The inhibition performance was evaluated using weight-loss measurements, potentiodynamic polarization, and electrochemical impedance spectroscopy at different inhibitor concentrations and temperatures, supported by quantum chemical calculations. The study provides a systematic evaluation of PPC as a corrosion inhibitor in an aggressive organic acid medium and establishes an experimental–theoretical correlation to elucidate its inhibition mechanism. Thermodynamic parameters such as activation energy, enthalpy, entropy, and Gibbs free energy of corrosion indicate that the adsorption of PPC on the steel surface involves both physical and chemical interactions. The inhibition efficiency reached up to 97% in 0.5-M trichloroacetic acid. Polarization studies show that PPC modifies both anodic and cathodic Tafel slopes, confirming mixed-type inhibition behavior. Electrochemical impedance results demonstrate strong adsorption through the formation of a protective surface film following the Temkin adsorption isotherm. Density functional theory calculations support the experimental observations by identifying key electrophilic (C20, C18, N15, and O28) and nucleophilic (C18, C20, and C2) active sites responsible for strong metal–inhibitor interactions. The combined results confirm PPC as an efficient corrosion inhibitor for acidic environments.

1 | Introduction

Metals are highly useful in all domestic and industrial processes but at the same are highly prone to the corrosion when they contact with the environment. Mild steel is being used for ornaments and decoration from ancient times. The mild steel is a versatile material used in everything from a jet engine to surgical instruments. Different types of iron and steel contain different amounts of these ingredients arranged in varying crystalline structures. Making iron alloys or steel by one method or another will change the relative amounts of the ingredients, altering its properties. Treating steel in different ways after it is made changes its physical properties by altering its internal crystalline structure. Mild steel is an alloy of iron and carbon, and their properties are improved by heat treatment to the alloys. There are three categories of the alloy steels: constructional alloy steels, alloy tool