Rust Evolution and Electrochemical Properties of Field-exposed Carbon Steel in a Tropical Marine Environment

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The corrosion behavior of carbon steel (CS) exposed in a tropical marine atmosphere for 2 years was studied by the weight loss, scanning electron microscopy (SEM), X-ray diffraction (XRD), Raman spectroscopy, and electrochemical impedance spectroscopy techniques. The results show that the corrosion layer became more loose and thick with increasing exposure time, and after 2 years exposure, the rust layer developed into the dual-layer structure. The XRD and Raman analyses confirmed that the corrosion products contained γ -FeOOH, α -FeOOH, γ -Fe₂O₃, and Fe₃O₄. The polarization curves show that the corrosion potentials (E_{corr}) and corrosion current densities (I_{corr}) changed with increasing exposure duration. Furthermore, an equivalent circuit is proposed for modeling the impedance data, and the charge transfer resistance (R_2) decreased with exposure time during 6 months and increased from 6 months to 24 months, demonstrating that the corrosion rate increased first and then decreased with exposure time.

Keywords: Carbon steel; Corrosion behavior; Rust evolution; Electrochemical properties; Tropical marine environment

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