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Exploration of Dextran for Application as Corrosion Inhibitor for Steel in Strong Acid Environment: Effect of Molecular Weight, Modification, and Temperature on Efficiency

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SUBJECTS:
- Carbohydrates,
- Electrochemistry,
- Inhibition,
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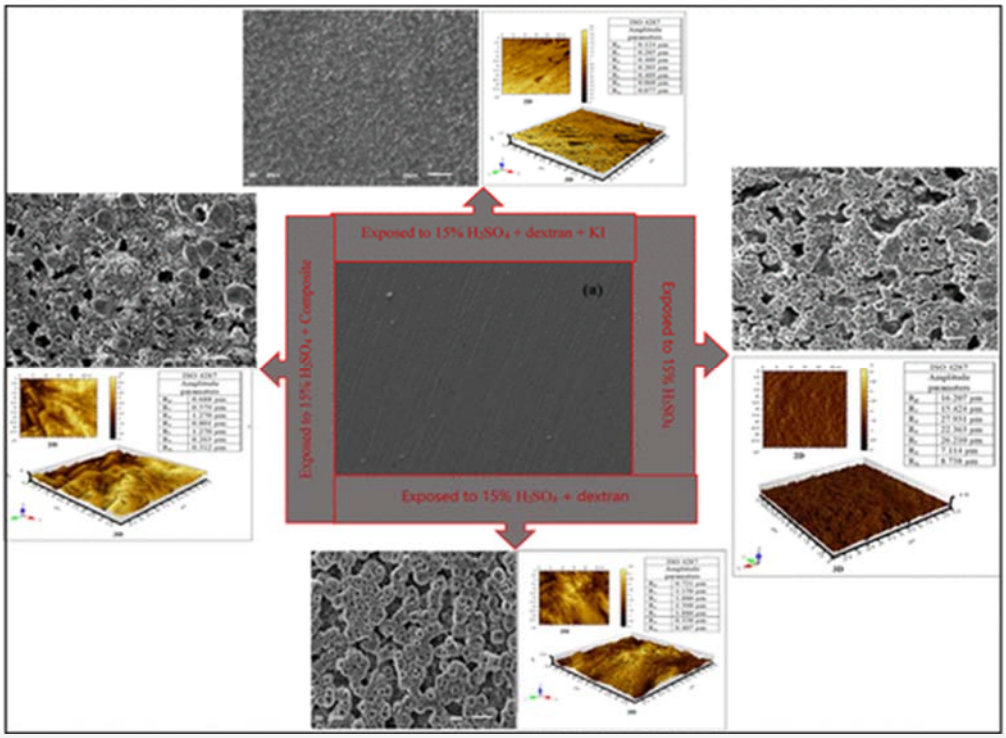
Abstract



The possibility of utilizing dextran as a green corrosion inhibitor for steel in strong acid environment was explore using weight loss, electrochemical (electrochemical impedance spectroscopy (EIS), electrochemical frequency modulation (EFM), potentiodynamic polarization (PDP), and linear polarization (LPR)) supported with surface analysis via scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDAX), atomic force microscopy (AFM), and X-ray photoelectron spectroscopy (XPS) techniques. The effect of molecular weight, temperature, and modification on the inhibition efficiency of dextran was also studied. Results from all the applied techniques reveal that dextran exhibit moderate anticorrosion property toward St37−2 steel dissolution in 15% H_2SO_4 solution. Dextran with molecular weight of 100 000−200 000 g/mol (Dex 1) exhibited the highest inhibition efficiency of 51.38% at 25 °C. Based on PDP results, dextran behaved as a mixed type corrosion inhibitor. Inhibition efficiency of dextran varies inversely with molecular weight but directly with temperature. Two modification approaches, namely incorporation of silver nanoparticles (AgNPs) into dextran matrices and combination with 1 mM KI were adopted to enhance the inhibition efficiency of dextran and the approaches proved effective. The protective capability of Dex 1 has been upgraded from 51.38% to 86.82% by infusion of AgNPs and to 94.21% by combination with KI at 25 °C. Results from the study on the effect of temperature reveals that Dex 1 + KI mixture could synergistically offer 99.4% protection to St37−2 steel in 15% H_2SO_4 environment at 60 °C. Surface analysis results confirm the presence of additives molecules on the studied metal surface. XPS results disclose that AgNPs are in oxide form while iodide ions are in the form of triiodide and pentaiodide ions on the metal surface. Modified dextran is a promising candidate for application as corrosion inhibitor in acid induced corrosive environment.

KEYWORDS:

- metals corrosion
- inhibition
- dextran
- molecular weight
- modification

The Supporting Information is available free of charge on the ACS Publications website at DOI: 10.1021/acsami.8b09487.

- Additional information as noted in the text (PDF)