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Amino Acid Derivatives as Green Corrosion Inhibitors for Mild Steel in 1M HCl: Electrochemical, Surface and Density Functional Theory Studies

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Abstract : The amino acids based corrosion inhibitors 2-(3-(carboxymethyl)-1H-imidazol-3-ium-1-yl) acetate (Z-1),2-(3-(1-carboxyethyl)-1H-imidazol-3-ium-1-yl) propanoate (Z-2) and 2-(3-(1-carboxy-2-phenylethyl)-1H-imidazol-3-ium-1-yl)-3-phenylpropanoate (Z-3) were synthesized by the reaction of amino acids, glyoxal and formaldehyde, and characterized by the FTIR and NMR spectroscopy. The corrosion inhibition performance of synthesized inhibitors was studied by electrochemical (EIS and PDP), surface and DFT methods. The results show, the studied Z-1, Z-2 and Z-3 are effective inhibitors, showed the maximum inhibition efficiency of 88.52 %, 89.48 and 96.08% at concentration 200ppm, respectively. The results of potentiodynamic polarization (PDP) study showed that Z-1 act as a cathodic inhibitor, while Z-2 and Z-3 act as mixed type inhibitors. The results of electrochemical impedance spectroscopy (EIS) studies showed that zwitterions inhibit the corrosion through adsorption mechanism. The adsorption of synthesized zwitterions on the mild steel surface was followed the Langmuir adsorption isotherm. The formation of zwitterions film on mild steel surface was confirmed by the scanning electron microscope (SEM) and energy-dispersive X-ray spectroscopy (EDX). The quantum chemical parameters were used to study the reactivity of inhibitors and supported the experimental results. An inhibitor adsorption model is proposed.

Keywords : electrochemical impedance spectroscopy, green corrosion inhibitors, mild steel, SEM, quantum chemical calculation, zwitterions
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