The Protection of Electrogalvanised Steel by Passivation Treatment with Trivalent Chromium and Cobalt Ions

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Electroplated zinc coatings have been largely employed as active galvanic protection for steel substrates. However, as zinc is highly electrochemically active, its corrosion rate may be very high. For this reason, a post treatment to increase the lifetime of the coatings is necessary, which, in industrial practice, consists of immersion in a chemical bath that forms a conversion layer on plated zinc. This layer must be a dielectric passive coating with high corrosion resistance that also offers good adherence to paints. The main problem of conventionally used post treatments is the presence of Cr^{6+} salts which are carcinogenic substances whose usage was forbidden by European regulations. In this work the effect of trivalent chromium and Co ions in solution of passivation treatments on the corrosion resistance of electrogalvanised steel has been investigated in 0.1 M Na_2SO_4 solution by electrochemical impedance spectroscopy (EIS) and polarization curves. Prior and after the corrosion tests, the chemical composition and morphology of the electrogalvanised surface was characterized by SEM and XPS. The EIS results showed that impedance values associated to the surface with Cr^{3+} + Co treatments were inferior to those exhibited by the Cr^{6+} treated ones. The higher impedances related to the Cr^{6+} samples could be explained by the self-healing effect of this type of coating. The SEM analyses revealed coating cracks associated to the surface of the Cr^{6+} treated samples whereas for those treated in the Cr^{3+} + Co solution, elongated fissures were seen. These last samples presented inferior corrosion resistance to that of the Cr^{6+} passivated ones. The cobalt addition to the trivalent chromium containing solution was not sufficient to increase the corrosion resistance to acceptable levels in comparison to the Cr^{6+} conversion coating.