

Investigation of Corrosion of Steel Buried in Unsaturated Soil in the Presence of Cathodic Protection: The Modified Voltammetry Technique

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Abstract : The aim of this study was to use voltammetry as a method to understand the behaviour of steel in unsaturated soil in the presence of cathodic protection (CP). Three carbon steel coupons were buried in artificial soil wetted at 65-70% of saturation for 37 days. All three coupons were left at open circuit potential (OCP) for the first seven days in the unsaturated soil before CP, which was only applied on two of the three coupons at the protection potential $-0.8\text{ V vs Cu/CuSO}_4$ for the remaining 30 days of the experiment. Voltammetry was performed weekly on the coupon without CP, while electrochemical impedance spectroscopy (EIS) was performed daily to monitor and correct the applied CP potential from the ohmic drop. Voltammetry was finally performed on the last day on the coupons under CP. All the voltammograms were modeled with mathematical equations in order to compute the electrochemical parameters and subsequently deduced the corrosion rate of the steel coupons. For the coupon without CP, the corrosion rate was determined at $300\ \mu\text{m/y}$. For the coupons under CP, the residual corrosion rate under CP was estimated at $12\ \mu\text{m/y}$ while the corrosion rate of the coupons, after interruption of CP, was estimated at $25\ \mu\text{m/y}$. This showed that CP was efficient due to two effects: a direct effect from the decreased potential and an induced effect associated with the increased interfacial pH that promoted the formation of a protective layer on the steel surface.

Keywords : carbon steel, cathodic protection, voltammetry, unsaturated soil, Raman spectroscopy

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