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Electrochemical characterization of stainless steels passive layers in hypersaline solution

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Biofilm formation can strongly influence the composition of the surface oxide layer of metals and thus their electrochemical behaviour when immersed in solutions containing microorganisms. Actually, bacteria activity can locally change the interactions occurring at the interface between the solution and the material, modifying the stability of the material in that environment and its corrosion rate. Because of this, great differences can be encountered between abiotic and biotic conditions.

This work deals with the characterization of two stainless steels immersed in a hypersaline solution containing bacteria inoculum, in order to assess the different composition and stability of the surface passive layers formed in this environment. Materials under study were AISI 304 and AISI 316 stainless steels. The electrolytic solution was a Starkey medium, with the addition of 45g/L NaCl and salt marsh sediments as inoculum (10 vol%). Samples of both materials were immersed in the solution for 15 days and electrochemical measurements were carried regularly. Cyclic voltammetry and Electrochemical Impedance Spectroscopy (EIS) were performed in order to assess the corrosion rate and the surface oxide layer stability. At the end of test, morphological characterizations were carried out using epifluorescence microscopy, SEM and EDS. XPS measurement were used in order to identify the different oxides formed on the sample surface during immersion in this hypersaline medium and correlate them to the results coming from electrochemical characterizations.

A different electrochemical behaviour could be highlighted for the two stainless steels immersed in the hypersaline solution containing the salt marsh sediments. The surface oxide layer was more protective for AISI 316 samples than for AISI 304 ones, where the layer was less compact and continuous. In addition, when comparing biotic and abiotic (sterile) conditions, a lower corrosion rate was evaluated for samples immersed in the presence of microorganisms. This difference could be attributed to the microbial activity which, by consuming the oxygen in the solution, creates less aggressive anaerobic conditions for steel.