

Electrochemical Investigation of Steel Corrosion in Saline Media

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Steel is planned to encapsulate the high-level nuclear waste under the chosen repository for long-term. One of the possible repository formations is Salt Rock. Even though genuine rock salt is largely impermeable, for the safety assessments contact of saline brines with the surface of the steel must be investigated in order to study corrosion behaviour and thus to decide on the suitability of the material as a technical barrier. For this purpose, AISI 309S and Spheroidal Graphite Iron (SGI)'s corrosion properties are examined with electrochemical methods. Microscopic and spectroscopic analytics are used for examining surface alteration and corrosion product formation. Anoxic conditions were ensured during corrosion experiments and surface analyses.

Steels were cut into discs, and polished with carbide papers and diamond paste, followed by cleaning in an ultrasonic bath to be used as working electrode. Ag/AgCl (sat. KCl) and Pt are used for reference electrode and counter electrode, respectively, for a three-electrode cell. Prior to each experiment, electrolytes (variable ionic strengths (*I*) set by NaCl and MgCl₂ concentrations) were deaerated with argon gas and samples were cathodically cleaned at -1.2V for 5 min.

For corrosion potentials (E_{corr}) and the tendency of passivation as well as of pit formations, potentiodynamic polarization tests were applied. Passivity and pit corrosion potentials are observed only on AISI 309S, while SGI showed uniform corrosion although different corrosion potentials were measured depending on *I*. The corrosion product of SGI mainly consists of Fe(OH)₂, confirmed by XRD, with slight contribution from Fe⁺³ as was observed by XPS. SGI shows lower values for E_{corr} than AISI 309S. It is clear from the polarization experiment results that the E_{corr} decreases with increasing *I*. In case of AISI 309S, a thin passivation layer was detected at the surface at lower *I* and pit formation took place at more positive potentials. However at higher *I*, thicker passivation layers formed and pits formed at more negative potentials. Pits and the plane surface were analysed by XPS and SEM-EDX, displaying rather different types of corrosion layers. Secondary phases in pits enriched Cr⁺³, and the rest of the surface passive area are combination of Cr⁺³ and Fe⁺³. Cyclic voltammetry was applied to study dynamics of electrochemical processes. Results indicated that the first cycle does not show any significant current (due to passivity) until to the point where pits start to form. At each cycle, the observed current increase in the anodic region is due to the propagation of pit formation. This hints that aroused peaks at cathodic regions are the results of the pit formation and conversion of corrosion products formed mainly on the pits.