ASSESSEMENT OF ELECTROCHEMICAL BEHAVIOUR AND OF CORROSION CURRENT DENSITY OF THE CARBON STEEL API 5L X65 IN CONTACT WITH CEMENT GROUT IN A NUCLEAR WASTE DISPOSAL PROGRAM

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Nuclear Waste Disposal (NWD) programs mainly focus on deep geological storage, as this is the most appropriate strategy for ensuring the long-term safety of people and environment. Cigeo is a future deep NWD facility for high-level and intermediate level long-lived radioactive waste, to be built in France, at 500 m depth within the clayey Callovo-Oxfordian formation (COx). High-activity radioactive waste will be placed in linings made of carbon steel API 5L X65. The space between the steel and the COx will be filled with a basic cemento-bentonic material (FS10B, but can still evolve), and which allow a better control of corrosion by maintaining the steel passivation.

The cementeous media, without agitation, separates into two phases: a clear supernatant one, rich in sulfides, and a compact lower phase, hardening over time, and whose conductivity decreases significantly over the 90 days of experiment. Initially of gray color, the lower cement phase takes after a few days a green tint, attributed to the progressive anaerobiosis of the media and the presence of polysulfides in the blast furnace slag used in CEM III/A cement production. A specific methodology consisting of several loops of various electrochemical techniques around the Open Circuit Potential (OCP) (-700 mV/ESH using Ag/AgCl as solid reference) is used to determine the corrosion rate of the steel by calculating the polarization resistance. The Stern-Geary parameter found while fitting Buttler-Volmer relation with VaOCP data, allows us to obtain the corrosion current values. The combination of Linear Polarization and Electrochemical Impedance Spectroscopy (EIS) leads to understand the mechanims under which the corrosion occurs. It is then found to be limited by the diffusion of protons H^+ in absence of oxygen in a very basic media (pH >12). The current densities start very low (<2 µA/cm²), increases significantly to reach 70 µA within 6 days, then decreases and stabilizes around 10-13 µA/cm² during the last half of the experiment, causing the appearance of a new interface at the steel surface (EIS curves).