Corrosion behaviour of aluminum alloy 5754 in cement-based matrix simulating nuclear waste disposal conditions

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Depending on the lifetime and level of radioactivity of radioactive waste, different disposal facilities are considered. While low and intermediate level short-lived waste can be disposed in surface disposal facilities, deep geological disposal is considered for high and intermediate-level long-lived waste. In France and Belgium, long-term disposal is studied in Clay host rock media.

For aluminum, disposal concept is often based on an encapsulation of the waste in a cement-based matrix that is then stored in surface waiting for a placement in a deep geological disposal. Depending on the storage conditions prior to the placement in a disposal and finally deep geological conditions, different conditions could be encountered leading to possible various hydric environments, from drying to water resaturation of the cement matrix by exposition to high relative humidity and then liquid water.

It is also well-known that aluminum suffers from severe corrosion in sufficiently alkaline environments leading to possible hydrogen production. In order to ensure the safety of the disposal facilities, the amount of aluminum that is disposed in each waste package must be specified and is limited. Considering the very high pH of most of the cements during the initial stage (preparation, casting, curing time) and later prior to any chemical degradation in the disposal the possible humidification or water resaturation could lead to significant variation of the corrosion rate. These evolutions have to be assessed regarding the disposal conditions evolutions.

In the present study, the corrosion resistance of an aluminium alloy (grade 5754) in two different cement matrix was studied in different configurations at room temperature:

In solution simulating the pore water or the resaturation water in equilibrium with a Claystone In fresh cement (curing time) In sound cement resaturated with Claystone Water In sound cement under controlled relative humidity.

In each case, evolution of the hydrogen production was monitored to address the corrosion rate variation versus time.