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Study of the galvanic corrosion behaviour of Mg and Mg alloys in a Na-geopolymer and in its synthetic pore solution

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ABSTRACT

Geopolymers are currently studied at CEA as new binders for the conditioning of cladding wastes (mainly made of Mg alloys) generated from the reprocessing of spent fuels coming from UNGG (Uranium Natural Graphite Gas) nuclear reactors in France. The alumino-silicate matrix considered here is activated with NaOH solution in the presence of sodium fluoride (Na-Geo/NaF), fluoride ion being a corrosion inhibitor for Mg and its alloys [1, 2, 3].

Galvanic corrosion may occur in the geopolymer matrix due to the direct contact of Mg cladding wastes with residual graphite materials (e.g. Aquadag[®]), initially present in the fuel assemblies or steel from the container. Mg and its alloys acts as anode in most galvanic corrosion processes, leading to the acceleration of the corrosion rate of Mg and the significant hydrogen evolution [4, 5].

The aim of this work was to study the general corrosion of Mg and Mg alloys, and their galvanic corrosion when coupled to Aquadag[®] or Steel S235JR. Electrochemical methods, weight loss measurements and surface analysis were performed after short-term exposure to synthetic Na-Geo/NaF pore solution.

Corrosion rates of pure Mg, Mg-0.5%Zr alloy and Mg-0.5%Zr alloy coated with Aquadag[®] were obtained from EIS and polarization curves at different immersion times. Corrosion currents were graphically estimated from polarization curves assuming Tafel behaviour. On the other hand, Electrochemical Impedance Spectroscopy (EIS) data were analysed by using a methodology based on complex impedance analysis [3]. Corrosion rates obtained for the case of galvanic coupling Mg-0.5%Zr with Steel S235JR were obtained using the mixed potential theory and ZRA measurements. The effect of cathode/anode surface ratio was studied, showing higher corrosion rate when the cathode was larger than the anode surface. Besides, it was observed that the corrosion rates obtained for the general corrosion of Mg and Mg alloy were considerably lower than those obtained when they were galvanically coupled.

On the other hand, general corrosion of pure Mg, Mg-0.5%Zr and Mg-1.2%Mn, and also galvanic corrosion with Steel S235JR and Aquadag[®] were studied by weight loss measurements. Coupons were embedded in Na-Geo/NaF geopolymer or immersed in its synthetic pore solution during 180 days. First results obtained with Mg and Mg-1.2%Mn will be discussed.

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