9. Summary

Potentiostatic simulation of the effect of oxidants on corrosion on UO_2 have been investigated. The potential at the interface of the semiconductors UO_2 representing simfuel or spent fuel and an aqueous redox solution depends on the concentration of oxidants in solution, because the Fermi level of UO_2 is shifted by the Fermi level of the redox system of the contact solution. The electrode potential on the other hand can be adjusted by shifting the Fermi level of UO_2 by potentiostatic polarization.

Potentiostatic simulation of the effects of oxidants is used to obtain reliable data in systems with rapidly varying oxidant concentrations.

Valve metals and their alloys are widely used in various fields of nuclear technology as for instance Titanium, for Pollux containers for disposal of spent fuel elements, and Zircaloy-4, the cladding material of fuel rods. Because of their practical importance it is an urgent need to investigate the corrosion behavior of these valve metals in relevant brines, the relevant electrolyte system being saturated NaCl-solution, Q-brine and Bentonit Porewater. The experiments were performed at various temperatures (25°C, 55°C and 80°C) applying the Radioisotope Method (RIM), which combines neutron activation analysis with classical electrochemical procedures as potentiodynamic and potentiostatic measurements and also impedance measurements, to be carried out simultaneously.

Due to the high price of Titanium it was proposed to use carbon steel and stainless steel alone as materials for Pollux containers. However, in addition one might also rely on the resistance of Zircaloy-4 cladding towards corrosion in brines.

From these results obtained it can be clearly seen, that in brines of practical importance at negative potentials the resistance of Zircaloy-4 towards corrosion is slightly better than that of Ti99.8Pd but in the range of positive potentials the corrosion resistance of Zircaloy-4 collapses. The resistivity of Ti99.8Pd on the other hand still remains.

H_2O_2 does not influence Zircaloy-4 corrosion at the temperatures aforementioned on condition that the H_2O_2 concentrations do not drastically exceed those existing in practice (~ 10^{-6} M).

Impedance measurements demonstrate that the thickness of the ZrO_2 layer varies within the relevant brines. In Q-brine because of its Magnesia content an oxide layer of higher resistance towards corrosion is formed.
Moreover the conductivity of the oxide layer of Zircaloy-4 correlates with its corrosion resistance.

Detailed investigations were also performed on contact potentials of Zircaloy-4 with UO_2. Measurements on contact potentials show that in all relevant brines the mixed potential is dominated by UO_2.
So Zircaloy-4 can only be limited relied on as a material resisting corrosion due to its instability in the positive potential range.