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First fully adjusted set of parameters for the corrosion product contamination code OSCAR-Na

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The OSCAR-Na code has been developed during the last decade to calculate the mass transfer of corrosion products and related contamination in the primary circuit of sodium fast reactors (SFR). Indeed, even if fuel cladding corrosion appears to be very limited, the contamination of the reactor components plays an important role in defining the design, the maintenance and the decommissioning operations for SFR.

The transfer of metallic elements between steel and sodium is due to dissolution and precipitation at the interface, as well as to diffusion in the steel and through the sodium boundary layer. The key parameters of the transfer model are 1) element diffusion in steel, considered to be enhanced under irradiation 2) element diffusion through the sodium boundary layer 3) element equilibrium concentration in the sodium at the interface and 4) oxygen enhanced iron dissolution rate.

For the first time, a full set of parameters has been evaluated for each element (Fe, Ni, Cr, Mn, Co) as a function of temperature through comparison of simulations with measurements in sodium loops and in sodium fast reactors. Thus, concentration profiles in steel at the interface (local depletion due to preferential release of the mostly soluble elements) and mass losses after 6000 hours of sodium exposure at 538 ℃ and 604 ℃ have been correctly simulated for the different elements in the STCL sodium loop, as well as the contamination profile along a PHENIX intermediate heat exchanger for Mn-54, Co-58 and Co-60 after about two years of operation.

These results provide a satisfying calibration of the OSCAR-Na code, which validation domain is for the time being restricted to sodium temperature between 400 ℃ and 650 ℃, sodium velocity higher than 4 m/s and oxygen content in the sodium lower than 5 ppm. The considered steel is supposed to be 316 SS.

This paper presents the values of the different parameters retained in OSCAR-Na modeling. They are compared to published values. The discrepancy between adjusted and published values for element diffusivity in steel (higher in the code) and element solubility in sodium (lower in the code) is discussed. The validation process of the OSCAR-Na code will be pursued to extend the validation domain.

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