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OSCAR-Na validation against sodium loop experiments

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The OSCAR-Na code has been developed 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 modeling is based on the solution/precipitation of the different elements of the steel. These elements dissolve mainly at the hot surfaces, and precipitate on the cold surfaces, and then induce the shifting of the metal/sodium interface (bulk corrosion or bulk deposit). The diffusion in the steel is also taken into account and allows calculating the preferential release of the most soluble elements (nickel, chromium, and manganese).

The code uses a numerical method for solving the diffusion equation in the steel and the complete mass balance in sodium for all elements, allowing the calculation of the metal/sodium interface shifting and of the flux of each element through this interface.

Code validation has already been carried out against PHENIX contamination on heat exchanger surfaces for the main radionuclides. This paper presents the continuation of the validation process against experimental results obtained on sodium loops, namely STCL and TIGIBUS, with well controlled experimental conditions. Different parameters of the model are adjusted to match concentration profiles in the metal and elementary releases measured at 600 ℃. These parameters are the solubility in the sodium and the diffusion coefficient in the steel for each element, as well as the oxygen-enhanced iron dissolution rate. The new values are compared to those published in the literature and discussed. Moreover the modeling allows reproducing the effects of temperature, sodium velocity, and oxygen concentration which were varied in the experiments. The effect of the length of an isothermal pipe (downstream effect) observed in the loops is also considered.

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