DEVELOPMENT OF A THERMODYNAMIC DATABASE FOR CORROSION MODELING IN MOLTEN SALT REACTORS

Luchina K.A.[(1)], *Ignatiev V.V.*[(1)], *Kupriyanov K.S.*[(1)], *Potapov A.M.*[(2)]
[(1)] National Research Centre "Kurchatov Institute"
123182, Moscow, Akademika Kurchatova Sq., 1
[(2)] Ural Federal University
620002, Ekaterinburg, Mira st., 19

During molten salt reactor (MSR) operation, fuel salt composition changes continuously because of burn-up, fissile make-up, accumulation of soluble fission products, removal of gaseous and volatile fission products to the gas-off system, deposition of insoluble phases on in-circuit components, and ingress of corrosion products from container materials to the molten salt mixture. These changes modify the physicochemical state of the fuel salt and cause tight coupling between neutronic, thermochemical, corrosion, and thermal-hydraulic phenomena in the reactor circuit. Therefore, proven MSR calculations require a unified thermodynamic and thermophysical database [1-4].

At the National Research Centre "Kurchatov Institute", an extensible database of thermodynamic and thermophysical properties for applicable molten salt mixtures is being developed within the MULTIMSR calculation complex, which can be used by the thermal-hydraulic, neutronic, and corrosion modules of the package [1] and follows current international approaches to special thermochemical and thermophysical databases for multiphysics analysis of MSR.

For molten 0,73LiF-0,27BeF_2-AnF_3 and 0,66LiF-0,34BeF_2 salt mixtures, considered as the fuel salt and intermediate coolant for test and full-scale MSRs, recommended values of liquidus temperature, heat of fusion, density, volumetric thermal expansion coefficient, heat capacity, thermal conductivity, and viscosity have been determined in the temperature range from the liquidus to 750-800 °C. Thermodynamic constants required for modeling mainly chromium corrosion, have also been evaluated and justified. The database accounts for changes in thermophysical properties throughout the reactor campaign due to fuel burn-up, as well as accumulation of soluble fission and corrosion products.

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