A Thermodynamic Database for Salt Systems in Nuclear Applications

O. Beneš and R.J.M. Konings

Institute for Transuranium Elements
European Commission, Joint Research Centre, Germany

Abstract

The Molten Salt Reactor (MSR) is one of the six reactor concepts of the Generation IV (GenIV) initiative. In this concept the fissile material (^{233}U, ^{235}U and ^{239}Pu) is dissolved in the molten fluoride matrix circulating in the primary circuit from the reactor core to the heat exchanger and back. Compared to solid fuel reactors, the additional advantage of the MSR is the possibility of fuel purification during the operation. Since the salt is in liquid form it can be extracted, either online or in batches, and cleaned from the fission products in chemical processing plant. This process increases the effectiveness of the reactor because most of the fission products cause parasitic neutron capture and their accumulation would slow down the chain reaction.

Currently there are two main approaches of the MSR. The first are moderated and non-moderated breeder reactor based on the ^{232}Th/^{233}U cycle, for which respectively ^{7}LiF–BeF_2 and ^{7}LiF are considered as an ideal matrix. When designed as an actinide burner the fuel will be most likely PuF_3 with possibly small addition of minor actinide trifluorides (AmF_3, NpF_4, …). For better solubility of these compounds and a favourable melting temperature of the fuel, the matrix based on the ^{7}LiF–NaF –BeF_2 system is the prime candidate.

At the *Institute for Transuranium Elements* relevant phase diagrams in the LiF-BeF_2-ThF_4-UF_4 and the LiF-NaF-BeF_2-PuF_3 systems have been evaluated based on existing literature data using FactSage™ software. Both polynomial models and quasi-chemical models have been employed. The results have been used to optimise the compositions of the candidate fuels.