Chemical States of Volatile and Corrosive Fission Products in Thorium Based Fuels from Thermodynamic Studies

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The Advanced Heavy Water Reactor (AHWR) uses thorium-based fuel having uranium content of about 3.5 mol%. The fuel chemistry with thorium is not expected to be the same as that experienced with uranium of the conventional reactors, though the same fission products with quite similar yields are formed and settle down inside the respective fuel matrices made of fluorite lattices with similar crystal radii of the cations, Th^{+4} and U^{+4}. The difference in chemistry originates from the rigid nature of four valence of Th in its compounds as against the flexible valence of four to six seen in the U case. The valence rigidity of Th(IV) in its compounds will result in a higher oxygen pressure growth during the burning of thorium-based fuel. But there is very little information on the chemistry of fps in such situation. For the analysis of the fuel-clad integrity during the long irradiation period, the knowledge of chemical states of the fission products, particularly those of volatile and corrosive ones are absolutely essential. For the analysis of the possible chemical states one thus investigates the thermodynamic and transport properties of the fuel and fission products. The investigated properties help address the evaluation of concentration built up of gaseous and corrosive volatile species at the fuel-clad interface and inside the fuel matrix, the possible extent and paths ways of chemical damage of the clad by the corrosive volatiles, and the extent of fuel swelling and disintegration by the gas accumulation and different solid phase formations. The chemical picture that would emerge out of the evaluation helps in the analysis of fuels performance in normal and also off normal situations of the reactor operation. This paper details the results of thermodynamic and transport properties presently studied in our laboratory, and then conclude on the specific characteristics of fission products chemistry in thorium based fuel.