

Current status of Czech activities in experimental development of thorium – uranium fuel cycle technology dedicated to Molten Salt Reactor system

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Abstract

The experimental development of molten salt technologies devoted to Molten Salt Reactor (MSR) has been an invisible part of Czech MSR research and development program. A technology of nuclear reactor systems with liquid molten salt fuel has been investigated in the Czech Republic since 1999. The original effort came from the national Partitioning and Transmutation concept based on the subcritical Accelerator Driven System for incineration of transuranium elements with liquid fluoride fuel and pyrochemical partitioning fuel cycle technology. After 2005, the original R&D intentions were gradually converted to classical MSR technology and to thorium – uranium fuel cycle.

Existing research and development studies in chemistry and chemical technology were focused on the verification of liquid MSR fuel processing – experimental production of UF_4 and ThF_4 at semi-pilot level, experience with the handling of MSR coolant salt FLIBE at high temperature, basic electrochemical studies of actinide / fission product separation from fluoride molten salt media and the flow-sheet studies of the single-fluid and double-fluid on-line pyrochemical reprocessing of MSR thorium-breeder.

Special attentions has been paid to the experimental development and verification of suitable partitioning methods applicable within the MSR on-line reprocessing technology. The program of electrochemical partitioning have been focused on the development of experimental set-up for molten fluoride salt media – including the development of reference electrode based on the $\text{Ni}^0/\text{Ni}^{2+}$ red-ox couple and the evaluation of red-ox potentials for uranium, thorium and selected fission products in individual selected molten fluoride salts (LiF-NaF-KF – FLINAK, LiF-BeF_2 – FLIBE and LiF-CaF_2).

Finally the studies also covered the discussion about the non-proliferation and physical protection aspects of the thorium – uranium fuel cycle within the MSR system. The present effort and future directions cover the development and experimental verification of fused salt volatilization technique proposed for the extraction of uranium (in the chemical form of UF_6) from the MSR fuel salt.