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Czech Experimental Program on MSR Technology Development

Summary / Objectives:

The webinar will give an overview of the existing experimental development of Molten Salt Reactor (MSR) technology in the Czech Republic. A technology of nuclear reactor systems with liquid molten salt fuel has been investigated in the Czech Republic since 1999. After 2005, the studies cover also thorium - uranium fuel cycle technology, material research and development of selected components of the MSR technology. Today a new, four-year (2017 – 2020) project of MSR technology development is the key component of the Czech MSR R&D program on fluoride salt-cooled nuclear reactor systems. The aim of the project is to contribute to the development of MSR and FHR reactor technology in the area of reactor physics, nuclear – chemical engineering and material research.

Meet the Presenter:

Dr. Jan Uhlíř works for the Research Centre Řež, Czech Republic as a Senior Researcher of the Nuclear Fuel Cycle Program. Prior to that, he worked for more than 30 years for the ÚJV Řež - Nuclear Research Institute, which is the mother company of the Research Centre Řež. From 1990 to 2012 his positions were Head of Fluorine Chemistry Department and Deputy Director of Fuel Cycle Division. His long-term expertise is mainly in the development of Fluoride volatility reprocessing method and other fluoride pyrochemical partitioning technologies, recently of those devoted to MSR fuel cycle. Jan Uhlíř has been a leader of several national projects devoted to the nuclear fuel cycle, pyrochemistry and molten salt technology granted mainly by the Ministry of Industry and Trade of the Czech Republic. He was also responsible for the chemical part of the national project SPHINX devoted to the experimental development of MSR technology. He participated in several European projects devoted mainly to pyrochemical partitioning and MSR technology. Dr. Uhlíř is a representative of the Czech Republic in the Working Party on Scientific Issues of the Fuel Cycle of the OECD-Nuclear Energy Agency, a member of the MSR Provisional System Steering Committee of the Gen IV International Forum as a representative of EURATOM and a member of the High Scientific Council of the European Nuclear Society. He earned his M.S. in Chemical Engineering and PhD. in Nuclear Fuel Technology from the University of Chemistry and Technology in Prague.

1. Main aims of the Czech Program on MSR Technology Development

The R&D program in Czech covers MSR technologies such as reactor physics, structural material, and Th-U fuel cycle, with experimental verifications.

Main aims of the Czech Program on MSR Technology Development

- To appropriately contribute to the knowledge of MSR reactor physics, core design and safety, structural material development and to the technology of Th – U fuel cycle.
- To focus on R&D of technologies applicable within the MSR on-line reprocessing of liquid fuel.
- To verify experimentally selected important areas of MSR technology and to solve existing bottlenecks.
- Three main domestic projects solved or launched during the first decade of the century contributed to the development of MSR technology:
  - "Transmuter LA-10"
  - "System SPHINX with liquid fluoride fuel"
  - "Fluoride reprocessing of spent fuel from GEN-IV reactors"
- Moreover Czech scientists and researchers also actively participated in several MSR projects of EC-EURATOM, IAEA and contributed to the work of Gen-IV as representatives of EURATOM.

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2. Structural material development

A new nickel-alloy called MONICR has been developed and further technological activities on the production, corrosion, high temperature integrity, and irradiation damage are ongoing.

Main experimental activities

Structural material development

- Development of structural material for MSR technology, which started in ŠKODA JS - Nuclear Machinery and continued in COMTES FHT company, was crowned in 2011 by experimental production of tubes and sheets from new nickel-alloy called MONICR (Ni-Mo-Cr type super-alloy)

Present development of MONICR alloys is under way in COMTES FHT in the collaboration with other companies including the Research Centre Řež.

The composition of original MONICR alloy is:

Ni	Mo	Cr	Fe	W	Al	Ti	C	Co, Nb, Zr
bulk	13.2 %	6.85 %	2.27 %	< 0.1 %	< 0.1 %	< 0.1 %	< 0.1 %	< 0.1 %

COMTES FHT company reached the experimental pilot production of MONICR alloy (ingots, sheets, wires, tubes).

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3. Experimental activities within the present MSR program

The new MSR project broadening the existing project was approved by Ministry of Industry and Trade. The collaboration with US-DOE is included in this program.

Experimental activities within the present MSR program

The present program is a follow up and the broadening of existing Czech activities in MSR. The new MSR project was approved by Ministry of Industry and Trade and is granted by the Technological Agency of the Czech Republic.

The project has also the technological character and is also solved by a consortium of Czech research institutions and industrial companies.

Organizations and companies involved in the consortium solving the project are:

- Research Centre Řež (leading company) – MSR physics, neutronics, fuel cycle, material testing
- ÚJV Řež – pyrochemical partitioning (electrochemistry of molten salts)
- COMTES FHT – further development of nickel alloys
- ŠKODA JS – development of selected equipment for MSR technology (impellers)
- MICo – development of selected equipment for MSR technology (flanges-gaskets systems)

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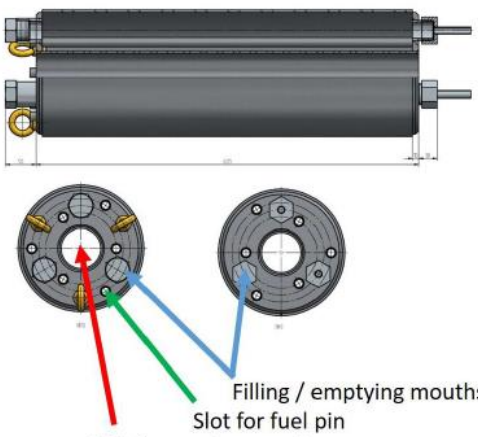
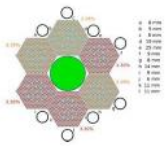
4. Results achieved in MSR physics and salt neutronics with in-pile experiments

Measurements at room temperature with FLIBE showed perfect agreement in neutron spectrum, the results of k eff are influenced by content of 6 Li in the salt.

Inserted zone for Li-7 FLIBE neutronics measurement at room temperature





Measurements with FLIBE showed perfect agreement in neutron spectrum, the results of k_{eff} are influenced by content of ^{6}Li residuum in supplied salt.

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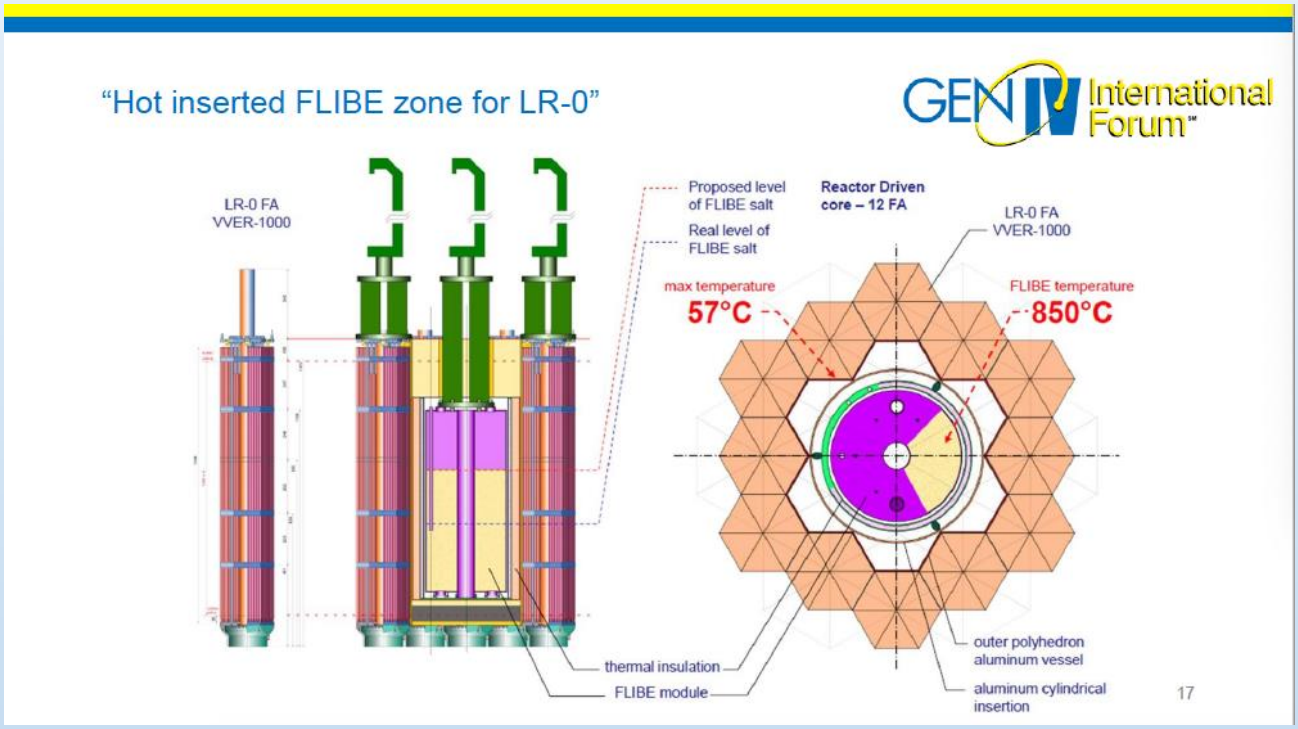
5. In-pile test of FLIBE under high temperature condition using LR-0 reactor.
The new heated inserted FLIBE zone (for the measurement at the temperature range 500 -750 ° C) is under development.



6. Studies on MSR fuel cycle technologies
Electrochemical behavior in molten salts and the electrochemical extraction of U, Th and several Lns are investigated