ID de Contribution: **83** Type: **Oral Presentation**

Development of a Dynamic Reference Electrode for redox potential measurements in fluoride molten salt.

lundi 9 mai 2016 18:00 (15 minutes)

The molten salt fast reactor (MSFR) is an innovating concept of the molten salt reactor (MSR) developed by CNRS (France) since 2004. This reactor is designed for the use of a liquid nuclear adapted to work under Thorium fuel cycle (Th232-U233). The nuclear fuel retained for the MSFR will be composed for the fluoride molten salt mixture, LiF-ThF4-(UF4-UF3) (77–19–4) mol%. A current subject in the development of the MSFR is related to the structural materials corrosion, prevention and mitigation. The development of methods for the corrosion prevention is the most important way to avoid the chemical damage.

It has been demonstrated that corrosion directly depends on the redox potential of the salt and the redox potential depends on the ratio [UF4/UF3], this ratio being controlled by addition of metallic uranium which reacts with UF4 to produce UF3. Therefore the control of the redox potential can be used for the materials oxidation prevention. The redox potential has to be measured in situ in the reactor core since the potential of the fuel salt increases with the operation time due to the continuous fission reaction. Several reference electrodes have been studied to reach stable and accurate measurements of the redox potential in the fuel salt. However, these references are made of (glass or ceramic) tubes filled with the fluoride molten salt containing a redox system. The use of glass or ceramic is not secured for the MSFR. Therefore the fuel salt redox potential control within the reactor core requires the development of a metallic reference electrode.

The work of the second year of PhD is focused to the evaluation of the performance of the dynamic reference electrode (DRE) in LiF-ThF4-(UF4/UF3) molten salt system. Firstly, the system was developed in an inactive molten salt. Then, our study was focused on the active molten salt. Redox potential measurements are obtained by the in situ generation of the Th4+/Th redox system on tungsten electrode. The preliminary results of DRE have yielded good results. A good correlation of redox potential with the logarithmic uranium molar fraction is obtained for UFx/U system in LiF-ThF4-(UF4/UF3) molten salt at 650 ℃.

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Classification de Session: Nuclear reactors and medical physics

Classification de thématique: Nuclear Physics