

High Temperature Chemical Interaction between corium and neutron absorbers during a severe accident in a Sodium Fast Reactor

The aim of this thesis is to build a thermodynamic database on the high temperature chemical interactions occurring during a severe accident in a fourth generation sodium fast reactor (SFR). The interaction between (U,Pu)O₂ fuel, structural materials and neutron absorbers could lead to the melting of the core, and to the formation of a complex mixture called "corium". Some mitigation actions are foreseen to maintain the long term cooling down of the corium. Among these solutions, some neutron absorbers (B₄C, HfB₂, HfO₂) may be inserted from the top of the reactor core. A first version of the database of the complex system U-Pu-O-B-C-Fe-Hf is under development using the Calphad method.

This database will be coupled to CEA calculation tools to better predict the sequence of events of accidental scenarios. Furthermore, it will be possible to calculate complex phase diagrams to predict the long-term behavior of the corium mixture. The objective of the PhD project is to give a significant contribution to CEA teams involved in the design of ASTRID reactivity control system as well as those in charge of the studies on severe accident scenarios.

However, further investigations are needed to improve the reliability of the thermodynamic modeling of the corium pool. Literature data and new experimental measurements performed during the PhD will be used for this task. The main experimental devices used during this thesis will be:

- A laser heating device to measure high temperature solid/liquid transitions up to 3000°C in the complex system B-C-Fe-Hf-U-O,
- A furnace (T_{max}=2150°C) coupled with a mass spectrometer to perform heat treatments and to measure the release of the gaseous species during heterogeneous reactions.

Experimental results (mass spectrometry, calorimetry) on Pu-containing samples will be obtained in collaboration with JRC Karlsruhe.

These experimental apparatus may be also used to study the high temperature degradation kinetics of the fuel materials.

Useful information

PhD Salary: ≈1600 € per month

Location: CEA center of Saclay www-centre-saclay.cea.fr/

PhD will start in October 2018

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