COOLANT CHEMISTRY CONTROL - OXYGEN MASS TRANSPORT IN LEAD BISMUTH EUTECTIC

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Abstract

Structural materials of lead-alloy cooled transmutation devices require due to their reduced compatibility corrosion barriers like in-situ formed oxide scales. In lead-bismuth cooled transmutation systems, oxygen, dissolved in the coolant at defined quantities, is required for stable long term operation by assuring the formation of such protective oxide scales. The type of steel and the local temperature define the amount of oxygen needed at each location in the reactor. Extracted oxygen must be permanently delivered to the system and distributed in the entire core. Therefore, coolant chemistry control involves detailed knowledge on oxygen mass transport. A core might have beside the different flow regimes also stagnant areas at which oxygen delivery can only be realized by diffusion. The difference between oxygen transport in flow paths and in stagnant zones is one of the targets of such experiments.

To investigate oxygen mass transport in flowing and stagnant conditions a dedicated facility was designed based on computational fluid dynamics (CFD). To avoid large scale flow instabilities an asymmetric flow field was targeted by specific design issues. CFD also was applied to define the position of oxygen sensors and ultrasonic Doppler velocimetry transducers for flow measurements. Five oxygen sensors always accompanied by thermocouples are placed at strategically defined positions, one of them in a dedicated dead water zone area. First experiments are performed in the following way: After equilibrium of oxygen content in the liquid, the gas phase composition is changed and the reading of the different oxygen sensors is monitored until changes become negligible. These results will be compared to CFD simulations that consider mass transfer of oxygen.

This contribution will present the test facility, design relevant CFD calculations, and results of first tests performed.