Mini-Pool reactor to determine interaction and mass transport of oxygen and other impurities in flowing LBE – Design and Design supporting CFD calculations

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A vessel-type experimental device containing ~200 kg molten LBE will be used to investigate mass transport and interaction phenomena of oxygen and other impurities in and with LBE. Among these phenomena are the absorption of oxygen from the cover gas under regular operating conditions and accidental ingress of oxygen into the cover gas, the entrainment of oxides floating on the liquid-metal surface, the oxygen absorption from water vapour introduced below the liquid-metal surface (HEX leak) and the mass-transport of dissolved metals, especially nickel.
Quantitative (local oxygen activity, dissolution of metals) and qualitative (dispersion of dissolved metals) measurements of mass-transfer and transport are targeted to form the basis for integrating these phenomena in a CFD code. Ultrasonic Doppler velocimetry measurements of the liquid metal flow during the experiments are used for verifying these calculations. Mass transport and interaction phenomena will be integrated into a CFD code and validated against the experimental data derived from the specific design of the Mini-pool reactor.
To ensure CFD relevant and compatible experiments the design of such a mini-pool reactor is accompanied and supported strongly by CFD calculations especially to optimize it's design and the position of oxygen sensors, cooled probes for deposition of dissolved metals and the location of the ultrasonic probe for the velocity measurement.
This paper will present design supporting CFD calculations and the final design of the experimental device.
The main flow topology consists in a large scale vortex with an inclined core situated in the center of the pool. This flow structure results from an asymmetric arrangement of 3 horizontal orifices at the top of a vertical tube containing the impeller driving the flow.
Up to 3 sensors will track oxides along flow paths. One will be located in a specifically design stagnant zone to determine the differences in transport regarding forced convection and diffusion.
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