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Preliminary Evaluation of the Cold Crucible Induction Melter for the Treatment and Conditioning of Idaho Calcine

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More than 4,400 m³ of high-level calcine waste are stored at the Idaho National Laboratory (INL) site. Vitrification of High-Level Waste (HLW) is an internationally recognized standard as it enables volume reduction, chemical stabilization of the waste, and efficient containment of radioelements in a glassy or glass-ceramic matrix.

Most of the HLW streams present some challenging constraints such as:

- i) a wide range of radiological compositions;
- ii) a wide range of chemical compositions;
- iii) challenging physical properties;
- iv) a high content of fission products;
- v) a high content of noble metals, and;
- vi) high corrosiveness.

In this context, Orano and CEA have developed several vitrification technologies to meet the challenges of processing and immobilizing such complex waste streams.

Three technologies developed by Orano and French Alternative Energies and Atomic Energy Commission (CEA) have been considered to vitrify the Idaho Calcine waste: Induction Heated Metallic Melter (IHMM), Cold Crucible Inductive Melter (CCIM) and DEM&MELT In-Can Melter (ICM). Several types of glass matrix have been developed and designed considering the temperatures reachable with the different vitrification processes.

The CEA team has worked on the CCIM glass formulation at a laboratory scale. A temperature of 1350°C was considered. Three glass matrices covering the Idaho calcine main streams (respectively Zr based, Al based and Al-Na blend) were designed.

Dedicated bench-scale tests were then implemented to characterize the off-gas composition of the vitrification process. These experiments allowed the measurement of the total loading in the off-gas state as well as the concentration of each constituent present in the surrogate feed. As fluorine is present in relatively high concentration in the Zr based calcine, the partitioning of this compound from the glass into the off-gas stream was specifically measured to provide outputs regarding potential corrosion issues related to the compatibility of the melter and off-gas treatment system materials.

This paper presents the methodology applied, from laboratory to bench-scale tests, for the preliminary evaluation of the CCIM vitrification process for Idaho calcine treatment and conditioning.