A characterization of properties of the eutectic mixture of zirconium tetrafluoride and potassium fluoride for a molten salt nuclear reactor

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Transitioning to a non-carbon emitting energy source is one of the major challenges that the world currently faces as the impacts of a changing climate becomes more imminent. One of the main suggested sources during our transition to a new energy future will come from nuclear energy. In past decades, the use of uranium fuel rods has been used to generate heat to drive a turbine. There are current undertakings for the proposals of safer alternatives which have higher efficiency and electrical output. Terrestrial Energy is a company based out of Ontario that is developing a pilot plan that uses a eutectic ZrF_4-KF mixture to be used in a molten salt nuclear reactor. The physical-chemical properties of a eutectic mix of potassium fluoride and zirconium tetrafluoride have been previously untested in a laboratory, but will be the integral mix that will be used in the cooling system in the second loop of the proposed molten salt nuclear reactor. The predictable behavior of the eutectic mix is crucial for the stability and efficiency of such a proposed project. As such, the homogeneity of the mixture, purity and subsequent trace impurities of transition metals, and water moisture content within the crystal lattice will be measured. This has been accomplished by examination through laser ablation ionically coupled plasma mass spectrometry (LA ICP-MS), x-ray fluorescence (XRF), Arizona Instruments Computrac Vapour Pro XL for water moisture analysis, and a scanning electron microscope (SEM). Various standards are used to determine any impurities that could be within the lithium meta-/tetraborate mixture, which is used to melt and fuse the eutectic mixture. Before samples can be measured, they are internally spiked with indium oxide (In_2O_3) as a secondary standard for measurement to refine measurements from the singular primary standards. Using this method, it was identified that calcium, aluminum, sodium, copper, and silicon are the largest contributors to trace impurities within the eutectic mix. The individual components of the mixture have a range of water content trapped within the crystal lattices from 0.8 wt% to 14 wt%. All of the data that has been, and will be collected in the future, will be submitted to the Nuclear Energy Board of Canada for future projects that would involve this compound.

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