Kairos Power

partnered with

Argonne National Laboratory / Oak Ridge National Laboratory

NE-19-17638, Chemical Method Development for Quantifying Oxygen in Beryllium Salts

YEARS AWARDED: 2019

TOTAL PROJECT VALUE: $500k (DOE: $400k, Kairos: $100k)

STATUS: Completed

PRINCIPAL LAB INVESTIGATORS: Nicholas Condon (ANL), Alan Kruizenga (Kairos)

DESCRIPTION: Kairos Power is a nuclear energy technology and engineering company developing a high-temperature reactor (KP-FHR) that uses fluoride salt as a coolant. The KP-FHR design requires rigorous quantification of the reactor environment to characterize key compatibility interactions between the salt coolant and system materials. This GAIN-supported project involved developing an analytical method for characterizing trace-to-minor oxygen impurities in lithium fluoride (LiF) / beryllium fluoride (BeF_2) molten salt mixture – also called FLiBe. The goal of this project was to develop a method for analyzing the oxygen content using a commercial inert gas fusion analyzer. This included development of a calibration curve for the method, quantification of its performance, and testing on FLiBe samples from several sources, including ORNL-produced FLiBe as well as Kairos Power Flibe.

BENEFIT: Researchers were able to characterize salt purity and relate it to materials' reliability. By leveraging their respective capabilities, ANL and ORNL researchers were able to accommodate FLiBe purification and handling, generate standard mixtures of FLiBe and oxygen containing compounds (oxides and hydroxides), and deploy in-house expertise for analytical method development.

IMPACT: FLiBe coolant provides ~50% of neutron moderation. This high moderating power enables KP-FHR design to substantially reduce the required carbon-to-heavy metal (C/HM) ratio compared to modular high-temperature gas-cooled reactors. The coolant provides much more effective heat removal than helium, paving the way for reduced used fuel volume, high discharge burnup and reduced consumption of heavy metal and natural uranium. Rapid fuel depletion and on-line refueling enables rapid qualification of advanced KP-FHR fuel designs.

SIGNIFICANT CONCLUSIONS: The method of quantifying oxygen in Kairos Power Flibe and should be readily applicable to other FLiBe producers. Furthermore, this method is applicable to other fluoride-based salts and can be readily implemented. Quantification of oxygen in the molten salt melts has unlocked opportunities to compare these *ex-situ* measurements to real time sensors that can be placed in the molten salt, which can provide feedback to system operators.

NEXT STEPS: Kairos Power has been awarded two project partnerships through DOE-NE's U.S. Industry Opportunities for Advanced Reactor Development funding opportunity, which funds advanced reactor technology that will be deployed in the mid- to late-2020s. Two projects, totaling over $11 million ($5.5 million in DOE funds, $5.8 million in Kairos Power cost share), will support development and licensing activities to accelerate development of the KP-FHR.