Corrosion Testing of New Alloys and Accompanying On-Line Redox Measurements in ORNL FLiNaK and FLiBe Molten Salt Flow Loops

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ABSTRACT:
Corrosion data is required for the selection of appropriate structural alloys to successfully implement FHR technology. A number of new alloys with properties beyond those of Hastelloy-N are now available for the high temperature molten fluoride salt applications. These alloys have better stability and mechanical properties at temperatures above 704°C, which was a limit for the use of Hastelloy-N. Long term corrosion data are needed for these alloys in molten fluoride salts representing FHR environments. The fluoride salt mixture, LiF and BeF_2 (Li_2BeF_4, known as FLiBe) will likely be the primary salt mixture used in FHRs. Another fluoride salt mixture, eutectic of LiF-NaF-KF (46.5-11.5-42mol%, known as FLiNaK), is also a candidate for secondary cooling loop in FHRs. Long term corrosion tests will be done in both fluoride salts in ORNL molten salt flow loops. ORNL has an existing FLiNaK-LSTL, and a newly designed FLiBe test loop is expected to be available in early FY19. One of the compelling reasons for generating the required corrosion data in ORNL flow-loops is the well-developed procedure and facilities at ORNL available for the purification of FLiNaK and FLiBe to be used in salt loops, which is very important for the required corrosion data.

It is essential to know the redox condition of molten salts during corrosion tests as well as during the operation of molten salt loops, or actual FHR. Stable and robust reference electrodes for FLiNaK and FLiBe tests will be designed and tested for an *in-situ* monitoring of the redox potential of molten salts in FHRs. Correlation of redox potential of molten salts with the corrosion behavior of structural alloys will provide a better corrosion mitigation strategy for FHRs. Thorough post-corrosion-test characterization of tested samples will provide the required corrosion data as well as further our knowledge on the corrosion mechanisms for the selected alloys in FHR environments.

Main objectives of this project are to:

- Generate fundamental corrosion data for commercially available low chromium alloys as well as for the new alloys, developed at ORNL for the fluoride salt-cooled high-temperature reactor (FHR) applications, in FLiNaK and FLiBe under flow conditions.
- Develop robust and stable reference electrodes for the two molten fluoride salt flow loops to measure the reduction-oxidation (redox) potential in molten salts and correlate it to the corrosion behavior of selected alloys in respective environments.

This work directly addresses the expressed need in *ID No. RC-4.2*: "Fluoride salt cooled high temperature reactors – Flow loop testing"