Oklo Inc.

partnered with

Argonne National Laboratory

NE-21-26096: Experimental and Systems-level validation of thermal-hydraulic behavior in sodium-cooled fast reactors

YEAR AWARDED: 2021

TOTAL PROJECT VALUE: $500,000 (DOE: $400k, Oklo $100k)

STATUS: Completed

PRINCIPAL LAB INVESTIGATORS: Yeongshin Jeong (ANL), Pat Everett (Oklo)

DESCRIPTION: Oklo Inc. is an advanced nuclear technology company that is designing and deploying advanced fission power plants to provide clean, reliable, affordable energy. Oklo's Aurora Powerhouses generate heat in liquid metal-cooled fast reactors. Two of the largest sources of uncertainty in systems-level modeling of liquid metal-cooled fast reactors are thermal stratification and transition to natural circulation. This project sought to address the gap in high-resolution and high-quality data in various conditions of interest related to these phenomena. Oklo partnered with Argonne National Laboratory (ANL) to generate high-quality experimental data to help to validate the systems analysis codes SAS4A/SASSYS-1 and SAM, both of which can be used to inform advanced reactor designers on thermal-hydraulic behavior during transients. These phenomena were studied through prioritized experimental activities within the Thermal Hydraulic Experimental Test Article (THETA) facility, which is a newly installed component of the Mechanisms Engineering Test Loop (METL) facility at ANL.

BENEFIT: The benefits of this project include the ability to use higher temperatures and yield higher power operations through reduced conservatism. This improves economic competitiveness and reduces uncertainties associated with thermal-hydraulic modeling of these phenomena, which can lead to more efficient safety margins.

IMPACT: By performing dedicated experiments with high-resolution and high-quality data, the THETA facility provides a unique experimental capability. Its scaling and geometry characteristics are prototypic of the temperature distributions and flow characteristics in pool-type SFR designs. The test article utilizes modern instrumentation and can facilitate measurements of the key global and localized thermal phenomena, which may be necessary when utilizing the data for validation of systems-level analysis codes.

SIGNIFICANT CONCLUSIONS: This project demonstrated the full capabilities of the THETA facility, including the coupled behavior of the primary and secondary sodium coolant systems. During Phase 1 testing under this project, it was observed that the temperature responses of the hot and cold pools were dominantly impacted by thermal leakage from the core heater to the cold pool. Following the installation of a core insulator, the heater outlet temperature had significant oscillation, which could not be attributed to signal noise and could be indicative of large-scale mixing in the heater.

NEXT STEPS: At this time, it is worth investigating global system behavior that showed sensitivity by local heat transfer from adjacent components and corresponding complex flow pattern of sodium. Therefore, it is strongly recommended to utilize the test data generated within THETA for validation of analysis codes, including both systems-level and computational fluid dynamics codes.