HolosGen, LLC
partnered with
Argonne National Laboratory

NE-19-19020, Advanced Coolant Enclosure Solutions for Micro Gas Cooled Reactors with Enhanced Efficiency and Safety

YEAR AWARDED: 2019

TOTAL PROJECT VALUE: $625k (DOE: $500k, HolosGen: $125k)

STATUS: Completed

PRINCIPAL LAB INVESTIGATORS: Yinbin Miao (ANL), Claudio Filippone (HolosGen)

DESCRIPTION: The Holos-Quad gas-cooled microreactor concept being developed by HolosGen LLC features unique separate Sealed Power Modules (SPMs), each of which house a portion of the "whole core," which is formed when multiple subcritical SPMs are neutronically coupled. As a result, the traditional pressurized vessel used in conventional gas-cooled reactors is eliminated and implements an alternative "coolant enclosure" approach to isolate the high-pressure helium coolant from the rest of the reactor components that are under ambient pressure. Argonne's advanced coolant enclosure technology, which is based on a combinational utilization of ceramic matrix composite, refractory metal liner, and advanced heat-resistant functional coating, has been designed to be a high-performance pressure and chemistry boundary that can survive the harsh in-core environment of gas-cooled reactors. Supported by the GAIN Nuclear Energy Voucher project, Argonne's advanced coolant enclosure technology has been optimized for the Holos-Quad core.

BENEFIT: The technology readiness level (TRL) of the Holos-Quad core technology has been increased through a tradeoff analysis as well as comprehensive out-of-pile testing of two key components: advanced functional coating and graphite-silicon carbide (SiC) bonding solution.

IMPACT: The success of the advanced coolant enclosure development will be important for all High Temperature Gas Reactor (HTGR) developers to overcome the current challenges in increasing operating temperature. This technology further impacts safe and reliable operations of high-temperature heat exchangers (HTHE) to increase thermodynamic efficiency.

SIGNIFICANT CONCLUSIONS: Two crucial components of Argonne's coolant enclosure solutions -- advanced protection coating and SiC-graphite bonding -- have been optimized, fabricated and tested. Through tests executed at different operating conditions, the advanced coating demonstrated stability at elevated temperatures and robust resilience against thermal cycling, high irradiation, and corrosion with a self-healing capability. Additionally, an innovative surface modification recipe has been developed for both SiC and graphite surfaces to enable wettable and sustainable contact between liquid metal and solid phases.

NEXT STEPS: Detailed tradeoff analyses have proven the benefits compared to traditional HTGR design configurations. Based on the performance of the advanced coolant enclosure solutions when applied to the operating conditions of the Holos-Quad microreactor design, further optimizations validated by prolonged testing can be planned to further increase the resilience of HTGRs, and in turn, accelerate the deployment of a first-of-a-kind Holos-Quad microreactor.