Comparison of Advanced and Conventional Austenitic Structural Alloys for Use in Molten Salts

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The near-term deployment schedule of advanced non-light water reactor (non-LWR) designs in the U.S. necessitates the use of existing ASME qualified structural materials, which may limit component performance based on the alloy's high temperature mechanical properties, corrosion resistance, or susceptibility to environmentally assisted cracking. However, the U.S. DOE is qualifying an advanced austenitic stainless steel (Alloy 709) with superior high temperature strength to support the swap-out of existing ASME qualified structural materials for an nth-of-a-kind deployment to either enhance the structural margins or to increase thermal efficiency. The U.S. DOE is also assessing the potential for using corrosion resistant materials to clad coolant boundary components constructed from existing ASME qualified materials to extend the component lifetime in molten salt environments. This paper compares and contrasts the performance of selected austenitic alloys and their weld filler metals at temperatures and in environments pertinent to the Kairos Power Fluoride-Cooled High Temperature Reactor (KP-FHR). The alloys of interest are assessed for their mechanical properties up to 750°C, thermal stability (40 years at temperature), corrosion performance in both oxidizing and reducing salts, and potential susceptibility to environmentally assisted cracking. Additionally, ongoing research at Kairos Power to demonstrate the performance of 316H in the environments of the Kairos Power Fluoride-Cooled High Temperature Reactor (KP-FHR) are summarized.