Kairos Power
partnered with
Argonne National Laboratory

NE-19-18417, Develop ASME Section III Division 5 Design Rules for Elevated Temperature Cladded Class A Type 316 Stainless Steel Components

YEAR AWARDED: 2019

TOTAL PROJECT VALUE: $500k (DOE Funds Awarded: $400k; Awardee Cost Share: $100k)

STATUS: Completed

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DESCRIPTION: Type 316 stainless steel has been identified as a construction material for the Kairos Power fluoride-salt-cooled, high-temperature reactor (KP-FHR) primary coolant boundary components. While Type 316 stainless steel provides adequate high temperature strength for the operating conditions of KP-FHR, it is not optimized for corrosion resistance to fluoride salts that could affect the required structural margins and the design lifetime of primary coolant boundary components. One solution is to use a corrosion-resistant cladding to lessen, or possibly eliminate, such restrictions. The use of cladded components is a well-established practice in the other applications including light water reactors and in the petrochemical industry. Under a GAIN voucher Kairos collaborated with Argonne National Laboratory, where staff highly experienced in the development of high temperature design methods are available to develop design rules and associated materials data for the design of cladded components made of Type 316 stainless steel and cladded by non-code qualified corrosion resistant materials. Kairos was particularly interested in commercially pure nickel and tungsten, which show excellent corrosion resistance against fluoride salts and have been used industrially for cladding Type 316 stainless steel.

BENEFIT: Corrosion or corrosion driven cracking could limit the design life of structural components in molten salt reactors. A near-term solution to this limitation that avoids the lengthy and expensive process of qualifying a new structural material is the use of cladded components, which necessitates the development of design methods for cladded components that do not require long-term testing of clad materials in order to support the near-term deployment of MSRs. The work undertaken by ANL and Kairos developed a methodology along with a complete set of rules presented in a format compatible with an ASME nuclear Code Case.

IMPACT: The report on this investigation developed a set of design rules for constructing Type 316 stainless steel Class A components cladded with either nickel or tungsten for elevated temperature service in molten salt reactors. It provided three sample design problems – (a) a single tube in a 316H heat exchanger cladded with nickel, (b) a 316H flat head vessel cladded with nickel, and (c) a 316H flat head vessel cladded with tungsten – that can be used to educate reactor designers and other potential users of the draft Code Case rules on executing the design process.