NUCLEAR ENERGY RESEARCH INITIATIVE

Candidate Materials Evaluation for the Supercritical Water-Cooled Reactor

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Collaborators: University of Michigan

Related Program: Gen IV

Project Description

The supercritical water-cooled reactor (SCWR) system is being evaluated as a Generation IV concept because it builds on currently proven light water technology to provide high thermal efficiency and plant simplification. Developing, testing, and selecting suitable materials for cladding and internal components are central to designing such a reactor, as supercritical water presents unique challenges to the long-term performance of engineering materials.

The objective of this research is to investigate degradation of materials in the supercritical water environment. In particular, corrosion and stress corrosion cracking (SCC) have been identified as critical problems because the temperature and the oxidative nature of supercritical water may accelerate the processes. In addition, radiation can influence corrosion and SCC both by altering the material's microstructure and by accelerating corrosion and SCC, due to the generation of oxygen and other free radicals via radiolysis. Existing data on corrosion and stress corrosion cracking of materials in supercritical water is sparse and data on the behavior of irradiated alloys is non-existent.

Work Scope

- Study representative alloys (ferritic-martensitic steels, austenitic stainless steels, and nickel-based alloys) for their corrosion and stress corrosion cracking resistance in supercritical water. Conduct corrosion and SCC tests at various temperatures, exposure times, and water chemistries.
- Modify the near-surface chemistry, microstructure, and stress state of the alloys prior to corrosion testing by applying emerging plasma surface modification and grain boundary engineering technologies.
- Examine the effect of irradiation on corrosion and SCC of alloys in the as-received and modified/engineered conditions by irradiating samples using high-energy protons and then exposing them to supercritical water.

All these tests will be performed in close coordination with and as a complement to the Generation IV testing programs on radiolysis corrosion/SCC of neutron irradiated materials in supercritical water.