U.S. DEPARTMENT OF ENERGY
INTERNATIONAL NUCLEAR ENERGY RESEARCH INITIATIVE
DOE/Canada

ABSTRACT

Evaluation of Materials for Supercritical Water-cooled Reactors

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To meet the goals of the Generation IV (GEN IV) Reactor research initiative, international collaborations are critical in terms of shared resources and shared expertise. Both Canada and the United States (US) have a shared interest in the development of advanced reactor systems that employ supercritical water as a coolant. The goal of this project is to establish candidate materials for supercritical water reactor (SCWR) designs and to evaluate the mechanical properties, dimensional stability, and corrosion resistance. This project will address critical issues related to radiation stability, corrosion and stress corrosion cracking performance in candidate materials for SCWR.

Supercritical water presents unique challenges to the long-term operation of engineering materials. In addition to developing materials with adequate response to radiation damage, materials must be developed with adequate corrosion and stress corrosion cracking response to high temperature and high-pressure supercritical water. The high temperature and pressure, along with the generation of oxygen and oxidizing species (OH, H_2O_2, HO_2/O_2^-) generated by transient radiolytic decomposition may result in higher corrosion and stress corrosion cracking rates than experienced with other reactor designs. In addition, radiation may accelerate or assist the stress corrosion cracking in the reactor region, and stress corrosion cracking and accelerated corrosion may occur in the preheat and cool-down sections of the circuit. The existing data base on the corrosion and stress corrosion cracking of austenitic stainless steel, ferritic-martensitic steels, and nickel based alloys in supercritical water is very sparse. Data on the behavior of irradiated alloys is non-existent.

This U.S.-Canada I-NERI project is intended to be only a portion of the GIF evaluation of materials for SCWR. Other future participants are expected to eventually include Korea, Japan and the E.U.