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Stress Corrosion Cracking Susceptibility of Nuclear Waste Container Materials

Ken Chiang

Center for Nuclear Waste Regulatory Analyses (CNWRA®), Southwest Research Institute, San Antonio, Texas 78238, USA

Contact: K. Chiang, kchiang@swri.org, Telephone: +1-210-522-2308

Abstract

The engineered barrier system for the disposal of high-level radioactive waste generally consists of a waste container made of highly corrosion-resistant material, such as stainless steel. Fabrication of nuclear waste containers requires multiple processes, including welding and solution annealing. High-level waste containers are expected to provide near-complete containment of radionuclides for several thousand years after disposal. For undisturbed repository conditions, corrosion is expected to be the primary degradation process limiting waste container life. One of the corrosion degradation modes for the waste container is stress corrosion cracking. Stress corrosion cracking susceptibility of the nuclear waste container is dependent on the metallurgy and microstructure of the material, environmental conditions, and magnitude of applied and residual stresses in the component. Stress corrosion cracking could occur in a disposal system when groundwater contacts the waste container.

The objective of this paper is to present a methodology to evaluate the stress corrosion cracking susceptibility of waste container material using short-term laboratory slow strain rate tests. The methodology considers (i) material properties including fabrication processes such as welding and heat treatment; (ii) environmental conditions including groundwater chemistry, temperature, and electrochemical potential; and (iii) stress conditions including residual stress in the welded area as well as stress generated by disturbing conditions such as seismicity. The overall methodology is intended to support performance assessments to evaluate consequences of potential waste container failure. Examples of the methodology used to develop simplified models as part of a performance assessment are provided, and the extent of experimental information sufficient to support those abstracted models is discussed.

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