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Title: Long-Term Electrochemical Criteria for Crevice Corrosion in Potential Repository Environments at Yucca Mountain, Nevada

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Abstract

Alloy 22 (Ni-22Cr-13Mo-3W-4Fe) is the candidate material for the outer container of waste packages for disposal of high-level nuclear waste in a potential geologic repository at Yucca Mountain (YM), Nevada. This alloy may exhibit rapid propagation of crevice corrosion, once initiated under specific environmental conditions. The rapid propagation may in turn lead to corrosion penetration through the wall of the container in a relatively short period compared to a geological time period (e.g., 10^5 years). Therefore, for the long-term assessment of crevice corrosion of Alloy 22, it is important to assess a threshold environmental condition under which crevice corrosion does not occur or is not initiated. An electrochemical condition, repassivation potential or breakdown potential, is often used to define the threshold environmental condition for the crevice corrosion initiation. This paper assesses long-term behavior of these two potentials and their appropriateness as the long-term threshold environmental condition. The assessments presented here are intended to help prepare for reviewing the U.S. Department of Energy's license application for the potential YM repository.

Normally during the time period of laboratory testing (e.g., a few days or years), the breakdown potential in the potentiodynamic polarization scan is used as the threshold electrochemical condition for crevice corrosion initiation. However, it is not certain whether the breakdown potential will remain constant with time for the geological time period under a defined environmental condition. The breakdown potential may decrease with time and, therefore, crevice corrosion may occur after a long latent time period. For this reason, the repassivation potential has been used as a threshold electrochemical condition over a long-term period (e.g., under a potential repository condition) instead of the breakdown potential. The repassivation potential is normally lower than the breakdown potential.

This paper presents perspectives in using the repassivation potential as the long-term threshold electrochemical condition for crevice corrosion initiation. Recent new data and re-interpretation of previous understanding of the breakdown potential and repassivation potential will be discussed here. Additionally, the long-term propagation of crevice corrosion is re-evaluated based on these two potentials.

Literature studies, experiments and modeling described in the paper suggest that crevice corrosion would occur below the breakdown potential, only when the current is forced to flow from the anode to the cathode. This forced current was initiated either by electrical means (e.g., applying an external potential) or adding strong oxidants (e.g., cupric chloride) to raise the corrosion potential above the breakdown potential. Some evidence is presented that shows that under natural conditions (i.e., at open-circuit potential) without forceful action, crevice corrosion would not be initiated. This study also evaluated models for pit initiation inside crevice near the breakdown potential. The evaluation suggests that the long-term (e.g., 10^5 years) breakdown potential might be very close to the measured values in laboratories under a defined environmental condition. The study also suggests that the current use of repassivation potential is conservative compared to the use of the breakdown potential for assessing the long-term susceptibility of Alloy 22 to the crevice corrosion.

(Abstract Word Limit: 500 to 1,000)