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# Stress Corrosion Cracking Assessment of CEDM Nozzle Materials Exposed to PWR Hydrogenated Primary Water

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## Abstract

Stress corrosion cracking (SCC) in reactor pressure vessel head penetration nozzles and their welded parts has been a challenging issue in pressurized water reactors (PWRs). The failure mechanism has not been fully understood up to now. However, precise and non-destructive measurement of a crack length and its resultant crack growth rate (CGR) during SCC have been recognized as key parameters to properly assess the reliability and integrity of nuclear core components. In the present study, the results of a CGR test and on the microstructural characterization of the environmentally assisted cracking of Alloy 600 and 690 alloys are given. 1/2T compact tension specimens were used in the CGR test using a direct current potential drop method. The test was conducted under a simulated PWR primary water environmental condition. The average CGR of the Alloy 600 specimen was measured to be 7.6 x $10^{-9}$ mm/s. However, the crack growth of Alloy 690 was not found under the same test conditions. The fracture morphology of the Alloy 600 specimen showed that the cracks propagated along the grain boundaries, which means that the cracking mode was intergranular. The leading grain boundaries ahead of the crack tips in Alloy 600 were attacked owing to the oxygen penetration into the specimen. On the other hand, intergranular oxidation was not found in Alloy 690, which has a much higher resistance to SCC than Alloy 600. Therefore, it is believed that the intergranular oxidation phenomenon can be a precursor to primary water SCC in Alloy 600.