SENSITIZATION AND STRESS CORROSION CRACKING BEHAVIOR OF ALLOY 800

by

Jonathan S. Janssen

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Daniel J. Lewis, Thesis Adviser

Rensselaer Polytechnic Institute
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ABSTRACT

The commercial structural metal INCOLOY Alloy 800 (Fe-32Ni-21Cr) is a material commonly used in high temperature, aqueous corrosive environments in which intergranular stress corrosion cracking (SCC) is the dominant failure mode. Higher strength variants of Alloy 800 such as Alloy 800H and 800HT contain levels of interstitial carbon above 0.05 mass %. Because of this high carbon content, the material is known to be susceptible to intergranular corrosion via the formation of Cr-rich grain boundary $M_{23}C_6$ carbides after exposure to temperatures between 550 °C and 1000 °C, a process known as sensitization. Materials selection practices recommend testing for sensitization in accordance with ASTM Standard A232 and avoidance of sensitized materials in any application in which SCC is likely. This has been extended to environments in which high purity, de-aerated water (<1 ppb O_2) is used. For these environments, it has been previously suggested in the literature that the relationship between sensitization and SCC of high Ni-content alloys is dubious at best. Such premises have not been fully investigated for Alloy 800.

The present study seeks to determine the applicability of the widely recommended ASTM A232 Practice C "Huey" test, in which samples of material are boiled in 70% nitric acid for an extended period of time, to prediction of SCC performance in high purity aqueous environments. Samples of Alloy 800H with carbon content of 0.075 mass % were sensitized at 621 °C for 24 hours. Two samples of this heat treatment, as well as 20% cold-worked mill annealed material were tested by measuring SCC crack growth rate in pre-cracked compact tension samples subjected to 2000 ppb O_2 water at 288 °C. Samples of the same heat of Alloy 800H were subjected to additional sensitization heat treatments to determine the worst case degree of sensitization via the Huey test. These samples were examined by TEM to characterize the Cr depleted zone. The SCC test showed that the sensitized material exhibited a markedly high resistance to SCC despite degrees of sensitization nearly twice that of the failure criterion, in which Cr content was measured as 14 atomic %. The Cr content of samples with the highest degree of sensitization, more than 3 times the failure criterion, was a minimum of 14 atomic %. These results served to invalidate the Huey test as an acceptable method of determining SCC resistance in high purity aqueous environments.