

SPB4. Weldability Evaluation Of Several Solid Solution Strengthened Nickel-Based Filler Metals

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Introduction

Solidification cracking is a common problem among nickel-base superalloys. This phenomena, which occurs when liquid films are present in the weld microstructure, can be a hindrance to the repair of gas turbine engine applications. There is a need for determining the solidification cracking susceptibility of various alloys used to repair turbine blades. The objectives of this work were: 1) implementation of the Varestraint weldability test to determine and rank the solidification cracking susceptibility of five nickel-based filler metals, and 2) Metallographic evaluation of the materials' microstructures and fracture behavior using

Technical Approach & Results

The filler metals used in this work were Alloy 625, Hastelloy X, Hastelloy W, Haynes 230W, and Alloy 617. They were used to prepare four-layer weld metal buildups on Alloy 600 plate by GTAW with cold filler wire addition. After welding, samples were removed and used in the varestraint weldability tests. The Varestraint (VARIABLE RESTRAINT) Test is an inexpensive method to test and evaluate solidification cracking susceptibility. Three geometries of the test include transverse, longitudinal, and spot and all three can provide results accurately and quickly. The geometry of the particular test that was utilized was the transverse Varestraint test.

The transverse Varestraint testing results allowed measurement of Maximum Crack Distance (MCD), Total Number of Cracks (TNC) and determination of Solidification Cracking Temperature Range (SCTR). Both Maximum Crack Distance and Solidification Cracking Temperature Range (°C) were used to determine solidification cracking susceptibility during transverse Varestraint testing.

The weldability test samples were also analyzed metallographically using optical microscopy. The fracture surfaces were analyzed by SEM.

Conclusions

- All solidification cracking occurred along solidification grain boundaries and the difference in solidification cracking susceptibility was statistically significant.
- Eutectic constituents were observed in all weld metals and alloy 625 had more eutectic than Alloy 617.
- Fracture Surfaces exhibited a dendritic morphology. Some difference in morphology was a result of percent eutectic present during solidification.
- Based on SCTR at 5% strain, the order of ranking of filler metals (most to least susceptible) was: Alloy 625, Hastelloy X, Hastelloy W, Haynes 230W, and Alloy 617.