Development of Graded Transition Joints for Avoiding Dissimilar Metal Weld Failures

Allison Fraser

Follow this and additional works at: https://preserve.lehigh.edu/undergrad-scholarship-freed-posters

Recommended Citation

This Poster is brought to you for free and open access by the Undergraduate scholarship at Lehigh Preserve. It has been accepted for inclusion in David and Lorraine Freed Undergraduate Research Symposium Winning Posters by an authorized administrator of Lehigh Preserve. For more information, please contact preserve@lehigh.edu.
Introduction
Dissimilar Metal Welds (DMWs) are used in many applications but are susceptible to premature failure below the expected creep life. These failures can cost up to $1,000,000 per day in repair costs and lost revenue in power plant applications. When the DMW is aged, carbon diffuses across the weld interface from the ferritic to austenitic material. This creates a soft, carbon denuded zone in the ferritic steel, and a hard, carbon enriched zone in the austenitic steel. It is because of carbon diffusion and the formation of carbides that DMWs are susceptible to premature failure in service. A proposed solution is a joint whose composition changes gradually from ferrous to austenitic steel to slow carbon diffusion during aging, as two similar welds replace one dissimilar weld. The purpose of the following microhardness tests is to understand the change in hardness values due to aging of Graded Transition Joints (GTJs) and DMWs. This research proposes that the GTJ will exhibit less severe changes in hardness with increased aging than the DMW, as carbon diffusion will be limited.

Experimental
• DMW: Grade 22 welded to 347H with IN82 filler metal
• GTJ: Fabricated using gas tungsten arc welding (GTAW) with dual wire feeders, composition was adjusted by 2% dilution starting at 7% 347H across 46 mm until 100% 347H.
• Aging: 500, 1000, 2000 hrs at 460 °C
• 100 g microhardness trace with 125 μm spacing: DMW and GTJ
• 5 g microhardness trace with 25 μm spacing: DMW
• Perpendicular and steep-angle traces

Results
Figure 4. GTAW set up with dual wire feeders for GTJ fabrication. One wire feeds ferritic GR22 while the other feeds austenitic 347H, varying the concentration to create a plate of graded composition from 100% GR22 to 100% 347H.

Fabricating a graded joint with varying composition allows for gradual changes in microstructure and properties. DICTRA calculations to determine a suitable grade length for the GTJ. Carbon diffusion at 465 °C between 0 and 20 years was simulated for a 1 mm grade and a 20 mm grade. The 1 mm grade shows significant carbon diffusion across the joint after minimal aging at 465 °C, while the 20 mm grade shows little carbon diffusion after 20 years of aging. Creating a 20 mm grade suggests minimal carbon diffusion after significant aging.

Conclusions
• Carbon diffusion from aging causes decreases in hardness in the ferrous region and increases in hardness in the austenitic region, leading to premature failure of DMW
• Lack of compositional gradient in the GTJ limits carbon diffusion and reduces drastic changes in hardness values
• Aging continuously alters the hardness of DMWs, but further aging does not alter GTJs
• No local softening in the GTJ

Future Work:
• Age samples for 4000 hrs – investigate further carbon diffusion
• Finer spaced hardness traces – identify minute changes in hardness
• Tensile test with digital image correlation – record localized strain rate in samples
• Tensile test at room and elevated temperatures – investigate effect of heat on strength

Acknowledgements
David and Lorraine Freed Undergraduate Symposium, Lehigh University
Daniel Bechetti, Robert Hamlin, and Erin Barrick at Lehigh University
U.S. Department of Energy

References