Sulfide stress corrosion cracking of the X80/Inconel 625 dissimilar weld joint: Effect of welding and post weld heat treatment

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Abstract The research aimed to reveal the mechanisms that influence sulfide stress corrosion cracking and establish the correlation between microstructure of the fusion boundary region. Research found that Island-like martensitic structures formed at the fusion interface of X80/Inconel 625 dissimilar welding joints by tungsten inert gas welding (TIG). The significant orientation difference and poor deformation coordination between martensite and austenite interfaces can result in hydrogen accumulation at the phase interfaces, which significantly increases the susceptibility to cracking. In contrast, low heat input cold metal transfer (CMT) welding optimized the microstructure of the heat-affected zone and fusion interface, mitigating the generation of brittle hard phases and improving the SSCC resistance of the welding joints. The tempering effect occurring in the overlap region help to transform the heat-affected zone into a microstructure comprising granular bainite and acicular ferrite, while inverse austenite formed at the fusion interface. This adaptation increased the number of effective hydrogen traps in the weld and further reduced susceptibility to cracking. Heat treatment of the heat-affected zone resulted in a predominantly fine ferrite microstructure, preventing SSCC in the welding joint. Similarly, appropriate post-weld heat treatment improved the SSCC resistance of the TIG weld joint. Furthermore, long-term heat treatment induced nucleation of inverse austenite at the low-energy boundary of martensite, leading to the plate-like morphology that could remain stable at room temperature and effectively reduced SSCC susceptibility.

Keywords sulfide stress corrosion cracking; dissimilar weld joint; post weld heat treatment