Towards Understanding the Effect of Residual Stress on Atmospheric Chloride-Induced Stress Corrosion Cracking of Austenitic Stainless Steels

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The safe use of stainless steels in chloride-containing atmospheric environments is dependent on the presence and resistance of the passive surface layer. However, under certain circumstances this passive layer can break down, and coupled with exposure to tensile stress or stress gradients, Atmospheric Induced Stress Corrosion Cracking (AISCC) can occur in the presence of chlorides. For the prediction of propensity of component or structural failure, microstructural susceptibility indicators need to be identified; such indicators are not currently fully understood. In this paper, work towards the establishment of critical performance parameters to establish an envelope where AISCC failures can occur in samples containing weld residual stresses is described.The effect of residual stress due to welding on the propensity for AISCC at near ambient temperatures for austenitic (Types 316L, 304L) stainless steels was investigated. Test plates were subjected to automated circular welding and the resultant residual stresses characterised by X-ray diffraction measurement prior to sample exposure under controlled climatic conditions. The environmental conditions included the application of salt-laden MgCl2 and synthetic sea water droplets, with exposure at near-ambient temperatures and 30 % relative humidity for durations up to 4 months. After the exposure period, residual stress was re-measured and the position, orientation and size of any cracks evaluated. This paper will discuss timescales for onset of AISCC in stainless steels (316L and 304L) and the influence of residual stress on crack initiation and crack orientation.