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Industrial Member Report Summary – Key Findings for Industry

Atmospheric-Induced Stress Corrosion Cracking for Welded Stainless Steels

TWI Core Research Programme

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Industrial need

This report describes a research project on atmospheric-induced stress corrosion cracking (AISCC) which is relevant to welded austenitic steel structures exposed to airborne salt particles in a humid atmosphere. The specific application of the research was to austenitic stainless steel containers used for storing intermediate level nuclear waste (ILW) within the UK. The general assumption is that stress corrosion cracking (including AISCC) of austenitic stainless steels does not occur at temperatures below 60°C. This has now been proven incorrect: SCC does occur at ambient temperature as demonstrated by recent published work (Cook et al, 2010; Shoji, 1993). The surface storage period of the waste containers has now been extended to up to 150 years; thus there is a need to maintain their structural integrity during this period to avoid cracking and loss of containment.

Key Findings

- AISCC will occur only if the relative humidity (RH) in the atmosphere is higher than the DRH (deliquescence RH) of the salt at any given temperature. For many common salts, a RH of 30% or more will be sufficient to create a risk of AISCC.
- There was no apparent effect of the different microstructure of welds and parent materials on the susceptibility to AISCC. However a residual surface compressive stress was measured in the parent material and not in the weld metal, suggesting that the parent material would be at much less risk than the weld metal of AISCC over long time periods.
- AISCC can occur at 80°C with a stress (residual or imposed) of 400MPa or more in longitudinal direction within six months if the other necessary conditions are present. Cracking at 80°C can be avoided if the surface stress is reduced to the order of 170MPa within the timeframe studied in this work.
- The maximum residual stress associated with the TIG (tungsten inert gas) welds of the ILW container supplied is close to the measured 0.2% proof stress of the work hardened material of 400MPa in the longitudinal direction.
- The logical prevention method is to avoid particles settling on container surfaces before and during the storage period. A simple washing process to rinse off the residues of dust and aerosol particulates from the outer surface of the ILW container would minimise any contamination caused by either an airborne mechanism or manual handling. Subsequent storage should be equipped with effective ventilation and a filter system to prevent any entry of particulates into the storage space.

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References

Cook A, Stevens N P C and Duff J, 2010: 'Atmospheric corrosion of nuclear waste containers. In DIAMOND'10 Conference Decommissioning, Immobilisation and Management of Nuclear Waste for Disposal, 15-16 December, Manchester, UK.

Shoji S, 1993: 'Atmospheric corrosion of stainless steel'. *Corrosion Engineering (Japanese)*, 42:747–749.