KNOO
Keeping the Nuclear Option Open

Towards a Mechanistic Understanding of Atmospheric-Induced Stress Corrosion Cracking (AISCC) in Austenitic Stainless Steels

Tony Cook, Stuart Lyon and Andrew Sherry

Materials Performance Centre, School of Materials, The University of Manchester

BACKGROUND

Intermediate level waste containers are fabricated from 304L and 316L austenitic stainless steels (ASS). These materials are, under certain combinations of sea-salt deposition, temperature and relative humidity (RH), susceptible to (AISCC); a localized corrosion phenomenon that occurs under a thin atmospherically produced electrolyte layer. In this poster we present some initial results from experiments designed to map the potential across stress corrosion cracks

RESEARCH AIMS

- Develop an understanding of the localized corrosion characteristics of ASS in thin electrolyte layers via both physical and electrochemical means
- Quantify the conditions under which AISCC occurs in austenitic stainless steels with regards to:
  - Environmental variables
    RH, chloride level and other surface contaminants, temperature
  - Materials issues
    Stress state, surface finish, sensitisation

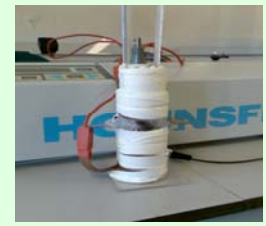
EXPERIMENTAL

AISCC

- AISCC of 304L was effected by holding a wedge shaped specimen, containing a $MgCl_2$ salt film (100 µg cm^{-2}) on its gauge length, at nominally constant load under humidity control (60 % RH at 60 °C); test duration 2 weeks – stress distribution along the specimen's gauge length $0.65\sigma_y \rightarrow 1.6\sigma_y$.

SURFACE POTENTIAL MAPPING

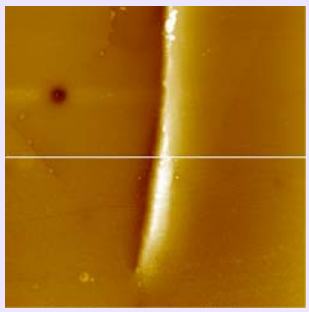
- Topographic and surface potential mapping was performed using a Veeco Dimension 3100 Atomic force microscope (AFM). Surface mapping (topography and potential) carried out at a scan rate of 0.2 Hz (0.2 scan lines per second).
- Positive deviations in surface potentials correspond to potentials that are locally anodic to the background



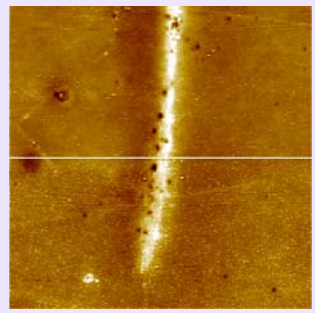
Humidity Chamber

Typical Tensile Specimen

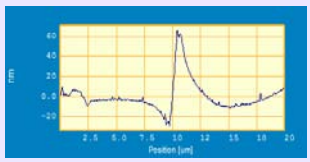
RESULTS



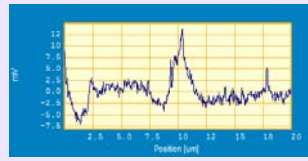
(a) Topographic image



(b) Surface potential image



(c) Height variation along line



(d) Potential variation along line

Net anode

Net cathode

Surface potential mapping
Lift height 100 nm - Open crack; 30 micron scan range

SUMMARY

- Sensitized 304L SS undergoes intergranular AISCC under magnesium chloride deposits at a RH of 60 % and a temperature of 60 °C
- Under the experimental conditions, stresses exceeding the yield stress are required to initiate cracking.
- Surface potential measurements allow mapping of the potential distributions across cracks – If the same success is achieved with cross-sectional specimens then the technique may prove valuable in providing input data for future models of the cracking process itself

ACKNOWLEDGEMENTS

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The University of Manchester