Assessment and Prediction of Stress Relaxation Cracking

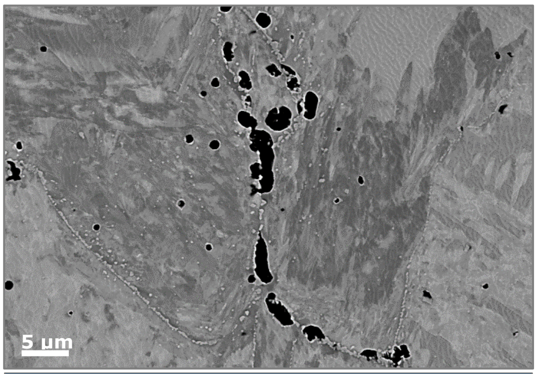
Concept

Stress relaxation cracking (SRC) is a high-temperature failure mode that has plagued refineries and power-plants over a number of decades. Although some advice exists on how to mitigate against the failure mode, there have been instances where failures have occurred despite following all advice and best practice. SRC failures are generally catastrophic and might have severe cost consequences, as well as personnel health and safety implications. There is therefore a need to develop methodologies to assess and predict cracking, allowing judgements to be made as to whether components are fit for service.

SRC is generally considered to arise from the relaxation of locked-in stresses in a constrained weld, where stress relief must be accommodated by plastic deformation. During high-temperature service, there can be a competition between the processes of stress relief, by creep, and precipitation hardening. It is hypothesised that if the precipitation kinetics are sufficiently rapid, strengthening of the grain interiors proceeds more rapidly than stress relief, with the consequence that the subsequent deformation is accommodated by grain boundary cracking. However, the environmental contribution to the failure mode has not been explored, and experience from failure investigations undertaken by TWI has shown that microstructural evolution, linked with service conditions, has led to localised damage, associated with grain boundaries, and subsequent cracking, even under conditions of limited stress.

It is critical that an understanding of the failure mode, and effect of environment, are understood so that the correct assessment and mitigation strategies can be implemented. This joint industry project (JIP) therefore aims to establish the environmental contribution to SRC, which will later provide the knowledge to allow quantified, and evidence based judgements to be made concerning the fitness for service of the materials and operating conditions involved. Validation of procedures to quantify SRC risk will be considered in Phase 2 of this project.

Stress relaxation cracking in a high-temperature nickel alloy



Grain boundary damage and cracking in a high-temperature austenitic stainless steel

Objectives – Phase 1

- Quantify the environmental contribution to SRC, and establish the interrelationships between microstructure, environment and high temperature performance.
- Review literature related to long term aging, oxidation and testing of high-temperature, austenitic corrosion resistant alloys.

Benefits

Successful completion of this project, as a whole, will enable the incidence of SRC to be predicted and will also allow the efficacy of mitigating strategies to be demonstrated by testing.

Price and Duration – Phase 1

The estimated price and duration for the work are £81,000 (excluding VAT) and 9 months, respectively. It is anticipated that the project will commence with a minimum of 3 Sponsors (£27,000 per sponsor).

Further Information

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