

Defining Safe Service Limits for Austenitic Stainless Steel Fasteners in Saline Environments



**RESEARCH
PROGRAMME
CONCEPT
PROP304146**

Summary

Austenitic stainless steel bolts and fasteners are used in many safety critical applications in several industries, including oil and gas and wind power. However, austenitic stainless steel bolts are susceptible to chloride stress corrosion cracking (CI-SCC), and are very difficult to inspect through non-destructive techniques. When failures occur, they are often catastrophic and have significant financial, environmental and reputational implications.

There is therefore a need to define the safe operational limits for austenitic stainless steel bolts and fasteners in chloride-containing environments. Unfortunately, such information is currently only available for wrought materials, which is not necessarily applicable to threaded fasteners.

This research project aims to address this need by undertaking testing to define the safe service limits of various grades of austenitic stainless steel threaded components in chloride-containing environments. Testing will be conducted according to NACE TM0177-96 and the safe service limits will be defined for:

- A range of austenitic stainless steel made to various Standards (such as ASTM A193, A320, F593 or ISO 3506 A4-70);
- A range of temperatures;
- Rolled and machined threads.

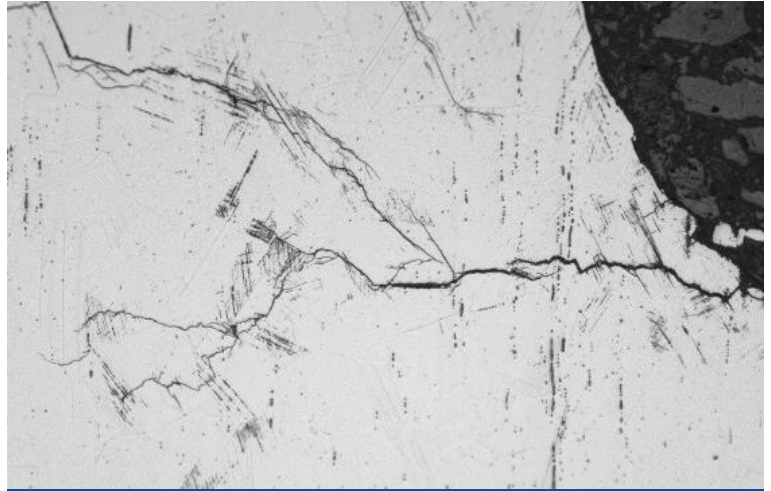
It is envisaged that the information gained from this project will contribute to the development of Standards for the safe use of these materials in threaded fasteners.

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Project Concept

Austenitic stainless steels are often used in chloride-containing environments where they are subject to high levels of stress and are therefore susceptible to SCC. This is particularly the case for fasteners made from these materials, where the threads act as notches along the length, providing areas of stress concentration, and thus enhancing susceptibility to SCC.

In addition, bolts and fasteners are notoriously difficult to inspect using non-destructive techniques, such as ultrasonic inspection. SCC produces characteristically fine and branched cracking, meaning changes in material density, to which the inspection techniques are sensitive, are minimal. The high environmental cracking susceptibility, as well as poor inspectability of these components, mean failures are often catastrophic, leading to large amounts of downtime and high costs associated with repair.



Stress corrosion cracking in austenitic stainless steel, under atmospheric conditions

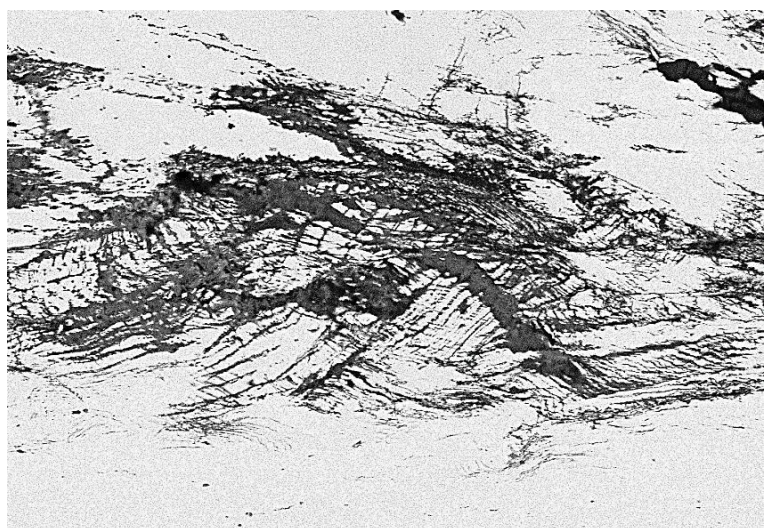
The likelihood of catastrophic failure would be reduced, if data on the safe use of austenitic stainless steel threaded components were widely available. Environmental limits for the safe use of wrought materials are available, however these limits are non-conservative when applied to bolts and fasteners which have inherent stress concentrating features at the threads. This research project primarily aims to address this need by undertaking testing to define the safe service limits of various austenitic grades of stainless steel, in the form of threaded components in chloride environments. Testing will be conducted according to NACE TM0177-96 and the safe service limits will be defined for:

- A range of stainless steels;
- A range of temperatures;
- Rolled and machined threads;
- A range of chloride levels including those typical of topside as well as subsea service.

The generated data will be used to produce a guidance document which will complement existing Standards on environmental limits by being specific to threaded components. This guidance will allow for appropriate selection of materials for particular environments, a reduction in any unnecessary over-conservatism and will also provide cost-savings, as the likelihood of failure, associated downtime and reputational damage, is reduced.

Another challenge faced is the limited availability of fastener material grades, so that 300 series stainless steels become an 'off-the-shelf' option for the applications discussed above, without necessarily being an appropriate material for the specific service conditions encountered.

In some cases, a more appropriate replacement material might be considered: for instance, in topside oil and gas applications, a carbon steel, which is more resistant to SCC than 304



Stress corrosion cracking of austenitic stainless steel under topside conditions

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stainless steel, might be more suitable. This would, of course, provide further cost savings. Equally, a higher alloy stainless steel might be used for high temperature applications. In all cases. The safe limits and associated cost savings require assessment.

Objectives

Determine the safe service limits to avoid chloride SCC for a range of austenitic stainless steel (and appropriate replacement materials):

- At different temperatures;
- At different stress and chloride concentrations;
- In components in which threads have been prepared using different techniques (i.e. machined or rolled threads);

Benefits

- Cost benefits: avoidance of over-design and potential use of cheaper materials;
- Definition of safe service limits for austenitic stainless steel bolts and fasteners;
- Optimisation of materials selection;
- Avoidance of down-time and reputational damage as well as increased safety and environmental protection.

Approach

The programme will comprise the following tasks:

- Consultation with project partners to define the most appropriate austenitic stainless steel grades and test specimens, i.e. bolt or fastener size;
- Testing of the selected specimens according to NACE TM0177-96 bearing in mind other relevant materials selection Standards such as Norsok M001;
- Definition of safe service limits for the use of austenitic stainless bolts in chloride environments.

Deliverables

- Safe service limits for the use of austenitic SS bolts in chloride environments;
- Development or supplementation of Standards with safe service limits for austenitic SS threaded components.

Further Information

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