NACE SP0170-2012
(formerly RP0170)
Item 21002

Standard Practice

Protection of Austenitic Stainless Steels and Other Austenitic Alloys from Polythionic Acid Stress Corrosion Cracking During a Shutdown of Refinery Equipment

Revised 2012-06-23
Revised 2004-03-27
Reaffirmed 1997-Mar-10
Revised October 1993
Revised December 1984
Approved October 1970
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ISBN 1-57590-039-4

Foreword

This standard practice provides mitigation methods to protect austenitic stainless steels and other austenitic alloys from polythionic acid (PTA) stress corrosion cracking (SCC) that can occur during a shutdown of refinery equipment. A shutdown includes the actual downtime period and the contiguous periods required to shut down and start up the equipment. This standard is directed toward preventing stress corrosion cracking (SCC) caused by polythionic acid (PTA) that can be formed by reaction of oxygen and water with sulfide corrosion products (i.e., metal sulfides) or with other oxidizable sulfur species (e.g., sulfur, hydrogen sulfide [H_2S]).

Primary mitigation methods to prevent PTA SCC include appropriate selection of materials and fabrication practices, nitrogen purging to exclude oxygen, alkaline washing of equipment surfaces, and use of dry air to prevent liquid water formation. Special considerations for protection of reactors are also discussed.

This standard is intended primarily for petroleum refinery materials and corrosion engineers as well as inspection, operations, and maintenance personnel. While the main focus of this standard is on equipment in refinery process units such as desulfurizing, hydrocracking, and hydrotreating, in which the incidence of PTA SCC has been comparatively high, it may be applied to equipment in other refinery process units that use austenitic stainless steels and other austenitic alloys, such as crude distillation units, lube distillation units, coking units, and fluid catalytic cracking units (FCCUs), when the user may have a concern for PTA SCC.

This standard was originally prepared in 1970 by NACE Task Group (TG) T-8-19, revised in 1984 and 1993, and reaffirmed in 1997 by Group Committee T-8. It was revised in 2004 and 2012 by TG 173, "Refinery Equipment, Polythionic Acid SCC Prevention: Review of NACE Standard RP0170." TG 173 is administered by Specific Technology Group (STG) 34, "Petroleum Refining and Gas Processing." TG 173 is sponsored by STG 39, "Process Industries—Materials Applications and Experiences," and STG 60, "Corrosion Mechanisms." This standard is issued by NACE International under the auspices of STG 34.

In NACE standards, the terms *shall, must*, *should,* and *may* are used in accordance with the definitions of these terms in the *NACE Publications Style Manual.* The terms *shall* and *must* are used to state a requirement, and are considered mandatory. The term *should* is used to state something good and is recommended, but is not considered mandatory. The term *may* is used to state something considered optional.

NACE International
Standard Practice

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Section 1: General

1.1 This standard practice provides mitigation methods to protect austenitic stainless steels and other austenitic alloys from PTA SCC that can occur during a shutdown of refinery equipment.

1.1.1 For the purposes of this standard, a shutdown includes the actual downtime period and the contiguous periods required to shut down and start up the equipment.

1.1.2 For the purposes of this standard, the term *austenitic materials* includes austenitic stainless steels and other austenitic alloys.

1.1.3 For the purposes of this standard, the term *other austenitic alloys* refers to those alloys of nickel, iron, and chromium that may be susceptible to PTA SCC.

1.1.4 For the purposes of this standard, the term *purging* is defined as a flow of inert gas (in this case dry nitrogen) to free the system of impurities (oxygen).

1.2 This standard is directed toward preventing SCC caused by PTA that can be formed by reaction of oxygen and water with sulfide corrosion products (i.e., metal sulfides) or with other oxidizable sulfur species (e.g., sulfur, H_2S). Appendix A (nonmandatory) provides background information about PTA SCC, including factors that contribute to PTA SCC, and where and under what conditions PTA SCC has been experienced.

1.3 The critical levels of sensitization and tensile stress required to initiate PTA SCC are not well understood. Therefore, austenitic stainless steel and other austenitic alloy process equipment that may be exposed to PTA should be protected using one or more of the PTA SCC mitigation methods presented in this standard, except in those cases when the equipment operates below the sensitizing temperature range and the austenitic material has not been sensitized by any prior fabrication practices (e.g., hot forming, welding, heat treatment). PTA SCC mitigation methods are listed in Paragraphs 1.3.1 through 1.3.4, and more details on each mitigation method are provided in later sections of this standard. Users may select one or more of these mitigation methods depending on their needs and assessment of exposure risk, which includes the ability of the selected mitigation method(s) to reduce the PTA SCC risk and the possibility of creating additional exposure risks when implementing the selected mitigation method(s).

1.3.1 Selection of Materials and Fabrication Practices

Selection of materials and fabrication practices are made that result in a fabricated component or process equipment resistant to sensitization, supported by an assessment of the risk of PTA SCC associated with such selections. When the risk associated with potential PTA SCC is judged to be acceptable, the user may not require the application of other mitigation methods.

1.3.2 Nitrogen Purging to Exclude Oxygen

A dry nitrogen purge is used to exclude oxygen from the equipment. Use of a dry nitrogen purge may also exclude water from the equipment.

1.3.3 Alkaline Washing of Equipment Surfaces

Alkaline washing of equipment surfaces is used to neutralize any PTA that may form. Field experience has demonstrated that austenitic stainless steels and other austenitic alloys are effectively protected when alkaline wash solutions are properly applied to all equipment surfaces.

NOTE: The user must consider other factors such as the effect of the alkaline chemicals on catalysts, as well as the appropriate means and protective equipment required for handling these chemicals.

1.3.4 Dry Air to Prevent Liquid Water Formation

The use of dry (dehumidified) air for protection from PTA SCC is acceptable if the dew point temperature of the air entering the equipment is maintained a minimum of 22 °C (40 °F) lower than the internal surface metal temperature.[1]