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Petroleum, petrochemical and natural gas industries — Test methods for quality control of microstructure of ferritic/austenitic (duplex) stainless steels



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- DNV-GL Oil and Gas
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Preface

This Standard was prepared by the Standards Australia Committee ME-092, Materials, equipment, structures and related services for petroleum, petrochemical and natural gas industries.

The objective of this document is to specify quality control testing methods and test conditions for the characterization of microstructure in relation to relevant properties in ferritic/austenitic (duplex) stainless steel components supplied in the solution annealed condition and fabrication welds in the as welded condition.

This document supplements the relevant product and fabrication standards with respect to destructive testing methods including sampling of test specimens, test conditions and test acceptance criteria to show freedom from deleterious intermetallic phases and precipitates in duplex stainless steels. In addition, this document specifies the documentation of testing and test results by the testing laboratory.

This document is based upon experience with duplex stainless steels in offshore oil and gas industry applications including topside and subsea hydrocarbon service, sea water service, as well as structural use.

The austenite spacing is relevant to the susceptibility of duplex stainless steels to hydrogen-induced stress cracking (HISC) in subsea applications where cathodic protection is applied. This falls outside the scope of this document.

This document is identical with, and has been reproduced from ISO 17781:2017, *Petroleum, petrochemical and natural gas industries — Test methods for quality control of microstructure of ferritic/austenitic (duplex) stainless steels*.

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The terms “normative” and “informative” are used in Standards to define the application of the appendices or annexes to which they apply. “Normative” appendix or annex is an integral part of a Standard, whereas an “informative” appendix or annex is only for information and guidance.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*.

Introduction

The aim of this document is to establish common test methods for quality control of microstructure of ferritic/austenitic (duplex) stainless steels for the oil and gas industry, enabling the manufacturers to apply the same test procedures for their clients.

Duplex stainless steels have a dual phase microstructure consisting of ferrite and austenite. Ideally, these phases are present in equal proportions; although in alloys which are commercially available, the ferrite phase volume fraction can vary between 35 % and 65 % for products in the solution annealed condition. They are characterized by high-chromium (19 % to 33 %) and low-nickel contents compared with austenitic stainless steels.

Duplex stainless steels are prone to precipitation of intermetallic phases, carbides and/or nitrides possibly causing embrittlement and reduced corrosion resistance. The formation of intermetallic phases such as Sigma, σ , and Chi, χ , occurs depending on exposure time in the approximate temperature range 590 °C to 1 000 °C (1 094 °F to 1 832 °F) and decomposition of ferrite to Alpha prime occurs in the range 300 °C to 540 °C (572 °F to 1 004 °F).

The microstructure of components or fabrication welds is affected by among others the thermal-mechanical history associated with hot working, solution annealing and with subsequent forming and welding. The destructive test methods with acceptance criteria specific to the application are considered relevant to verify that exposure time at above stated temperature ranges have been within acceptable limits and to ensure that desired corrosion resistance and mechanical properties are obtained in final products.

NOTES

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Petroleum, petrochemical and natural gas industries — Test methods for quality control of microstructure of ferritic/austenitic (duplex) stainless steels

1 Scope

This document specifies quality control testing methods and test conditions for the characterization of microstructure in relation to relevant properties in ferritic/austenitic (duplex) stainless steel components supplied in the solution annealed condition and fabrication welds in the as welded condition.

This document supplements the relevant product and fabrication standards with respect to destructive testing methods including sampling of test specimens, test conditions and test acceptance criteria to show freedom from deleterious intermetallic phases and precipitates in duplex stainless steels. In addition, this document specifies the documentation of testing and test results by the testing laboratory.

NOTE 1 This document is based upon experience with duplex stainless steels in offshore oil and gas industry applications including topside and subsea hydrocarbon service, sea water service, as well as structural use.

NOTE 2 The austenite spacing is relevant to the susceptibility of duplex stainless steels to hydrogen-induced stress cracking (HISC) in subsea applications where cathodic protection is applied. This falls outside the scope of this document. Reference is made to DNV/GL RP-F112^[4].

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 148-1, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

ISO 15614-1¹⁾, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*

ASTM A 370, *Standard test methods and definitions for mechanical testing of steel products*

ASTM A 1058, *Standard test methods and definitions for mechanical testing of steel products — Metric*

ASTM A 1084, *Standard test method for detecting detrimental phases in lean duplex austenitic/ferritic stainless steels*

ASTM E 3, *Standard practice for preparation of metallographic specimens*

ASTM E 562, *Standard test method for determining volume fraction by systematic manual point count*

ASTM F 1245, *Standard practice for determining the inclusion or second-phase constituent content of metals by automatic image analysis*

ASTM G 43, *Standard test methods for pitting and crevice corrosion resistance of stainless steels and related alloys by use of ferric chloride solution*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms and definitions apply.

1) For the purpose of this document, the following documents are considered equivalent: ASME Boiler and pressure vessel code, section IX Welding and brazing qualifications^[2].