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Corrosion of metals and alloys — Guidelines for corrosion testing of metals and alloys exposed in deep sea water

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Contents

Page

Foreword

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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).

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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 156, *Corrosion of Metals and Alloys*.

Introduction

With the development of offshore oil and gas industry, the exploration and production of oil and gas has moved into deep sea. Many subsea equipment and systems for oil/gas production have been deployed in the deep-sea water. There are also some instruments placed in subsea for environmental observation and scientific exploration. Corrosion is a crucial problem for these valuable installations because it affects seriously the performance, the reliability and the safety of these equipment and systems.

This international standard gives guidance on the corrosion testing of metals and alloys exposed in deep sea water, including selection of test site, components and assembly of test system, specimen preparation, testing procedure, evaluation after the retrieval from exposure sites and test report. So, the testing can be conducted based on the specified conditions and procedures, and the meaningful comparisons may be made for different tests.

This standard applies to the general corrosion exposure testing of metals and alloys as well as local corrosion tests such as galvanic corrosion test, crevice corrosion test, stress corrosion cracking (SCC) test of specimens exposed in deep sea water.

Corrosion of metals and alloys — Guidelines for corrosion testing of metals and alloys exposed in deep sea water

1 Scope

This international standard gives guidance on the corrosion testing of metals and alloys exposed in deep sea water, including selection of test site, components and assembly of test system, specimen preparation, testing procedure, evaluation after the retrieval from exposure sites and test report.

This standard applies to the general corrosion exposure testing of metals and alloys as well as localized corrosion tests such as stress corrosion cracking (SCC) testing, galvanic corrosion testing and crevice corrosion testing of specimens exposed in deep sea water.

Testing with exposure in deep sea of other materials such as composites and elastomers can also be carried out with reference to these guidelines, but the evaluation of these materials after the retrieval is different from that of metals and alloys.

This standard does not include the performance testing of sacrificial anodes for cathodic protection in the field of deep sea, which can be conducted using specified testing cells and equipment in the deep-sea exposure. However, this guidance can also provide useful information as reference for the conducting of performance testing of sacrificial anodes in deep sea water.

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 8044, *Corrosion of metals and alloys — Basic terms and definitions*

ISO 8407, *Corrosion of metals and alloys — Removal of corrosion products from corrosion test specimens*

ISO 7539-2, *Corrosion of metals and alloys — Stress corrosion testing — Part 2: Preparation and use of bent-beam specimens*

ISO 7539-3, *Corrosion of metals and alloys — Stress corrosion testing — Part 3: Preparation and use of U-bend specimens*

ISO 7539-5, *Corrosion of metals and alloys — Stress corrosion testing — Part 5: Preparation and use of C-ring specimens*

ISO 7539-8, *Corrosion of metals and alloys — Stress corrosion testing — Part 8: Preparation and use of specimens to evaluate weldments*

ISO 11306, *Corrosion of metals and alloys — Guidelines for exposing and evaluating metals and alloys in surface sea water*

ISO 11463, *Corrosion of metals and alloys — Evaluation of pitting corrosion*

ISO 18070, *Corrosion of metals and alloys — Crevice corrosion formers with disc springs for flat specimens or tubes made from stainless steel*

ASTM G71, *Standard guide for conducting and evaluating galvanic corrosion tests in electrolytes*

ASTM G78, *Standard guide for crevice corrosion testing of iron-base and nickel-base stainless alloys in seawater and other chloride-containing aqueous environments*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8044 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
deep sea water
sea water zone with depth generally ranging from several hundred to thousands of meters

Note 1 to entry: Deep sea has a corrosive environment with parameters such as temperature, salinity, dissolved oxygen content of sea water quite different from those in surface sea water.

3.2
test site
location where corrosion tests exposed in deep sea are performed

3.3
service environment
environment for which the corrosion data is required

3.4
test rack
structure within which the specimens or modules of specimens are housed

4 Selection of test site

The selection of test site is very important for corrosion tests exposed in deep sea water because the environment may vary obviously at different test sites.

The selected test site should be suitable for conducting the testing. Generally, the test site should be selected with consideration of the following requirements:

a) The environmental parameters of the test site should be representative of the service environment.

b) The seabed at the test site should be generally flat without protruding rocks or deep traps, and the slope should be smaller than 3%. The sediment at the seabed should be stable.

c) The test site should be in an open area, where seawater can flow freely without being blocked in a valley or a basin.

d) The test site should be in the place where the assembly will not be damaged by shipping, trawling or other foreseeable activities. Also, the as-set assembly at the test site should not affect the safety of foreseeable activities such as shipping and trawling.

5 Assembly and components

5.1 Assembly

5.1.1 The assembly should have at least the following functions:

a) carrying the specimens reliably during the test in the deep sea

b) gathering the key environmental parameters related to corrosion at the test site;

c) locating the assembly in the deep sea;

d) retrieving the assembly at the end of testing.

5.1.2 The assembly is mainly composed of the following parts:

a) buoy(s)

b) tension rope

c) test rack(s)

d) release system

e) environmental parameter collection and storage unit

f) surface water location unit and under water location unit

g) anchor system

5.1.3 The typical assembly of test system is shown in the diagram of Figure 1. There may be a single test rack in the assembly. Alternatively, there may be several test racks deployed at different elevations on the assembly. This assembly with multiple test racks is longer and more complicated than the assembly with only one test rack.

5.1.4 The assembly should be designed carefully to have high reliability and safety, and to be easy for the operation of deployment and retrieval. It should be fixed at the test site with an anchor system. The assembly should have enough buoyancy to bring it to the surface when released from the anchor system.

5.2 Test rack

5.2.1 Test rack may be made of corrosion resistant materials with proven performance in deep water environments. Alternatively test rack may be made of carbon steel provided it is protected from corrosion using coating and sacrificial anode cathodic protection, which should be carefully designed to avoid interference on specimens.

5.2.2 The test rack should have mechanical stability for the long-time service in the deep-sea water. It should be suitable for the particular types of specimen to be deployed. Refer to clause 6.1 for guidance appropriate to different types of specimen.

5.3 Other parts and equipment

5.3.1 Equipment for environmental monitoring

Equipment for measuring environmental parameters should be located in or close to the test rack, so that environmental data collected is representative of the conditions to which the specimens are exposed.