INTERNATIONAL STANDARD

ISO 18070

First edition
2015-11-01

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

Corrosion des métaux et alliages — Dispositif d'essai de corrosion par crevasse avec rondelles ressort pour échantillons plats ou tubulaires en acier inoxydable

Reference number
ISO 18070:2015(E)

International Organization for Standardization

COPYRIGHT PROTECTED DOCUMENT

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

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 meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information.

The committee responsible for this document is ISO/TC 156, *Corrosion of metals and alloys*.

Introduction

The working party on Marine Corrosion in the European Federation of Corrosion (EFC) has found that there is an industrial need for crevice corrosion testing for seawater applications that can estimate the maximum service temperature in natural seawater for stainless steels. Several aspects of crevice corrosion testing were elucidated by a research project.[1] It was found that an important factor is the crevice forming technique, and in order to have controlled crevices, the disc spring loaded crevice former was introduced. The general idea is that the disc springs shall keep the clamping force as constant as possible. In addition to the crevice forming technique for plate specimens, a technique for a crevice former for tubular specimens was developed, which has given reproducible results.

Round robin testing for the crevice forming technique was performed for both laboratory testing and in natural seawater and it showed improvement compared to traditional crevice formers. Good correlation was found between the laboratory testing and natural seawater.

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

1 Scope

This International Standard specifies a crevice forming technique and crevice former which are intended to be used for crevice corrosion testing of flat specimens or tubes of stainless steels, in corrosive solutions. This International Standard specifies no information concerning how the crevice corrosion testing shall be performed and how the attack shall be evaluated. The crevice former specified in this International Standard can be used for electrochemical measurements, if the specimens are designed for electrical connections.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3696, *Water for analytical laboratory use — Specification and test methods*

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

ISO 6344-3, *Coated abrasives — Grain size analysis — Part 3: Determination of grain size distribution of microgrits P240 to P2500*

DIN 2093, *Disc springs — Quality specifications — Dimensions*

3 Terms and definitions

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

4 Symbols

LBL Length Before Loading

LAL_1 Length After Loading

LAL_2 Length After Loading and exposure

ΔL_1 Deflection before exposure

ΔL_2 Deflection after exposure

5 Test specimen

5.1 Specimen specifications

Both flat specimens and tubes made from stainless steels can be used as specimens in the crevice corrosion formers specified in this International Standard. The specimen outer surface area shall be at least 100 cm^2.

NOTE 1 A squared specimen with a centre hole is preferred since the distance between the anode and cathode area might be critical in solutions with low conductivity.

NOTE 2 If an electrode potential is applied, a smaller specimen can be used.

5.1.1 Flat specimens

A hole, 7 mm in diameter, shall be drilled in the middle of each specimen.

NOTE To hang up of specimen and for electrical connection, a small hole can be drilled at one end of the specimen.

5.1.2 Tubes

A hole, 7 mm in diameter, shall be drilled in the middle of the tubes in radial dimension. The hole shall be drilled at both sides of the tube allowing a bolt to be inserted in the hole without alignment. The length of the tubes shall be at least 30 mm.

NOTE To hang up of specimen and for electrical connection, a small hole can be drilled at one end of the specimen.

5.2 Surface preparation of the specimens

5.2.1 The surface finish shall be as reproducible as possible. Any test surface may be tested but it is recommended that all surfaces, including cut edges and drilled holes, shall be abraded down to at least P120 grit paper, according to ISO 6344-3. Care shall be taken to avoid overheating the surface.

NOTE Ultra sonic cleaning after abrading can be used.

5.2.2 After abrading and cleaning, the specimens shall be left in air at a temperature higher than the dew point temperature for at least 24 h before testing, to be able to form a stable oxide.

5.2.3 The specimens shall be cleaned immediately prior to immersion in the solution by degreasing, rinsing in high-purity water with a conductivity less than 1 µS/cm, (ISO 3696, grade 2) followed by ethanol or a similar solvent and air drying. After degreasing, care shall be taken not to contaminate the test surface of the specimens.

6 Crevice former and assembly

6.1 General

Both flat specimens and tubular stainless steels can be used as specimens in the crevice corrosion formers specified in this International Standard, see Figure 1 and Figure 2.

6.2 Disc springs

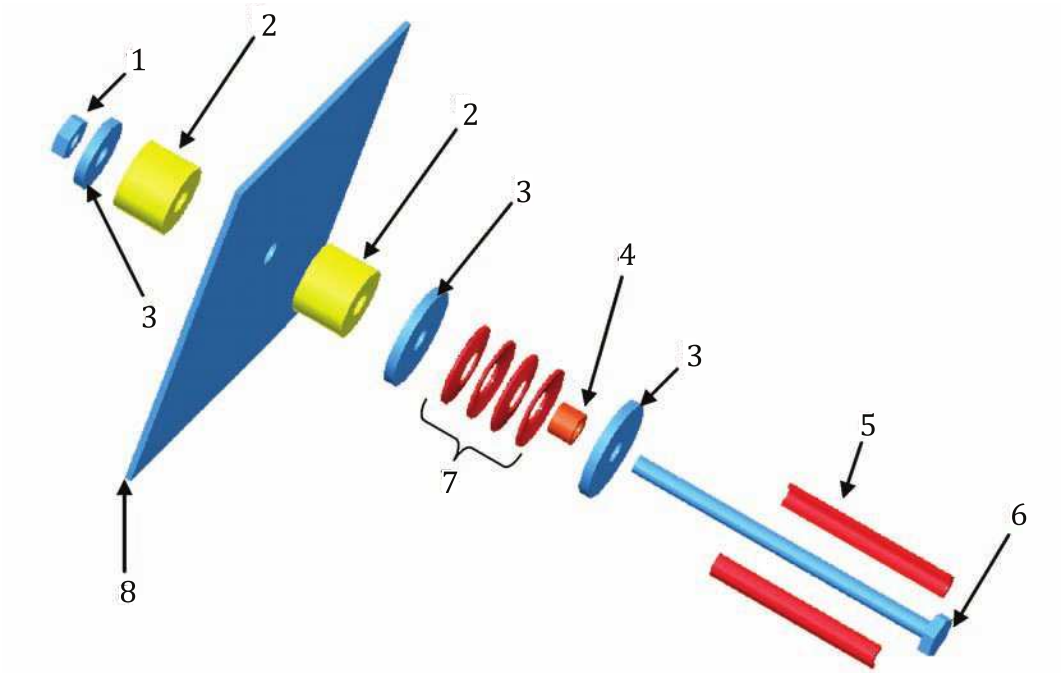
Disc springs with a linear force versus deflection relationship shall be used. The relation between the force and deflection of the setup of the disc springs shall be known. For disc springs according to

DIN 2093, the deflection that corresponds to 0,9 kN is 0,9 mm; for other disc springs, the deflection that corresponds to a force of 0,9 kN shall be measured with a tensile machine.

NOTE In the USA, disc springs are called Belleville washers.

6.3 Crevice former

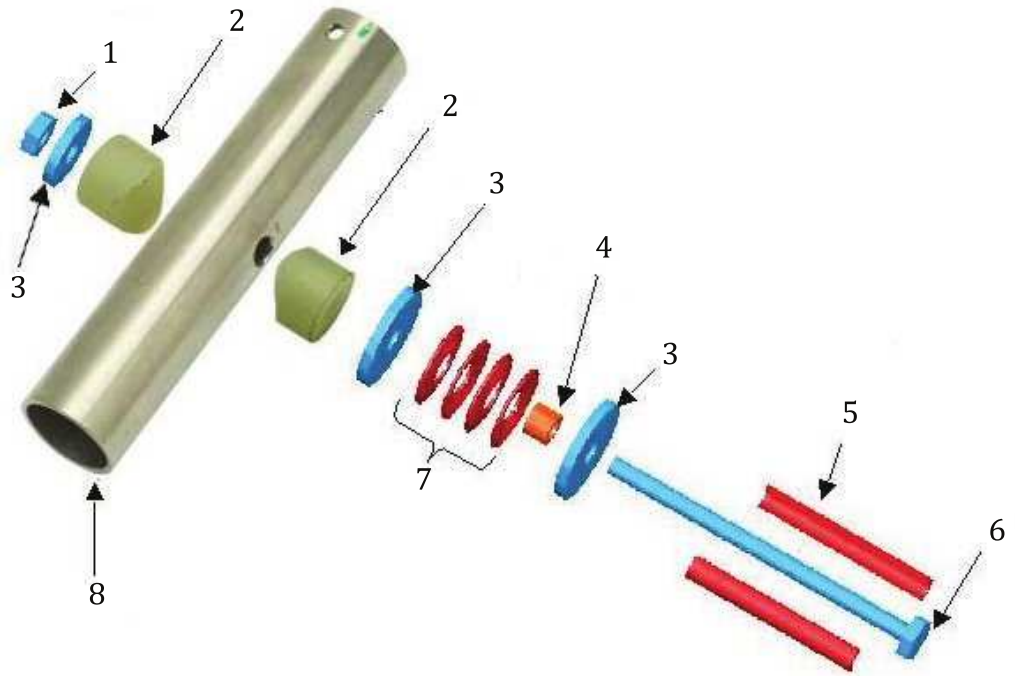
The crevice assembly is of the spring loaded type. Nut, bolt, and washers (rings) are made from titanium. The thickness of the washers is between 2 mm and 4 mm. Outer diameter of the washers shall be at least 20 mm and the inner diameter at least 5,2 mm. Bolt diameter shall be 5 mm (M5 threads) and the length is about 75 mm. A PVC (polyvinyl chloride) or PE (polyethylene) hose is mounted around the bolt, from the head of the bolt to the crevice former at the nut side, to prevent electrical contact between specimen and the assembly and to centre the rings, disc springs, and specimen. A schematic drawing of the assembly for flat specimens is shown in Figure 1 and for tubes is shown in Figure 2. A ring of inert polymeric material, like PTFE (polytetrafluoroethylene) is mounted to centre the disc springs, as shown in Figure 1 and Figure 2. The disc springs are made of titanium or nylon coated steel. The disc spring shall be according to DIN 2093 or with a calibrated deflection-force relationship. A set of four springs is used to obtain a load of ~0,9 kN (this corresponds approximately to a torque of 3 Nm, with the crevice assembly applied using DIN 2093 disc springs). The crevice formers are made of PVDF (polyvinylidene fluoride) and can be used up to 95 °C. The outside diameter is 20 mm and the inside diameter is 7 mm and height is 15 mm.



Key

1	nut	5	insulation hose (split only for imaging purpose)
2	crevice former	6	bolt
3	washer	7	disc springs
4	centralizing ring	8	test specimen

Figure 1 — Sketch of spring loaded crevice former for flat specimens



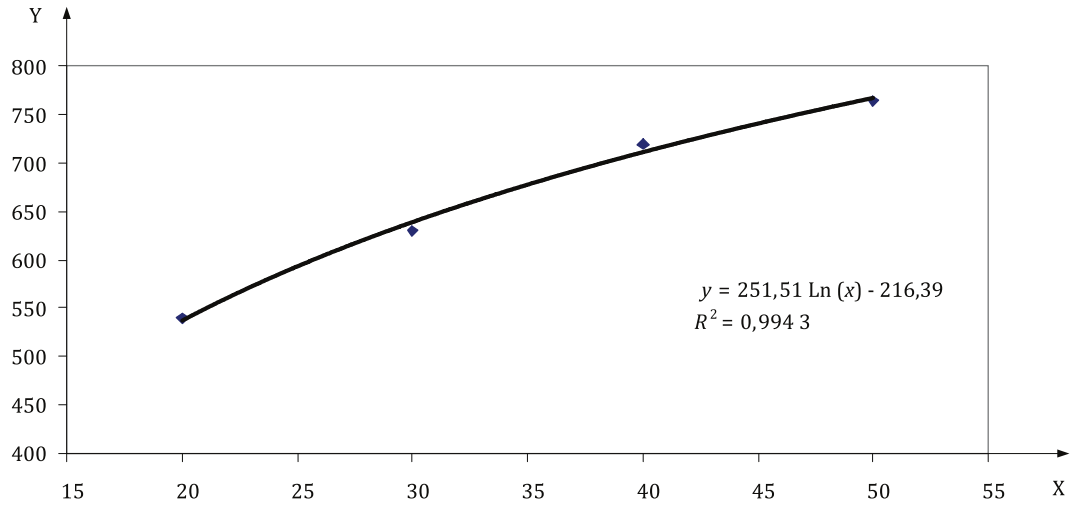
Key

1	nut	5	insulation hose (split only for imaging purpose)
2	crevice former	6	bolt
3	washer	7	disc springs
4	centralizing ring	8	test specimen

Figure 2 — Sketch of the crevice assembly for tubes

6.4 Crevice formers for tubes

The specifications for crevice formers for tubes are given in 6.3. In addition, on one side, a curvature shall be machined with same radius as the outer diameter of the tube. The crevice former shall not be thinner than 5 mm. Examples of the calibration curves for the force and torque that shall be used for tubular specimens are shown in Figure 3 and Figure 4, respectively. The force from Figure 3 shall be used for calculating the corresponding deflection using the linear relationship between the force and deflection for the spring assembly. The tube shall be thick enough to ensure no deflection of the tube during the test.

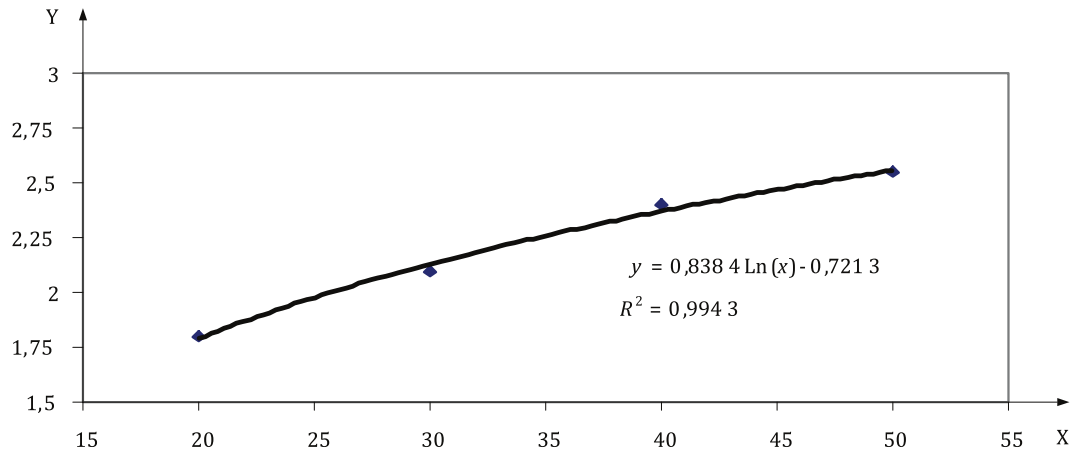


Key

X outer tube diameter (mm)

Y force (N)

Figure 3 — Calibration curve for the force that shall be used for tubular specimens



Key

X outer tube diameter (mm)

Y torque (Nm)

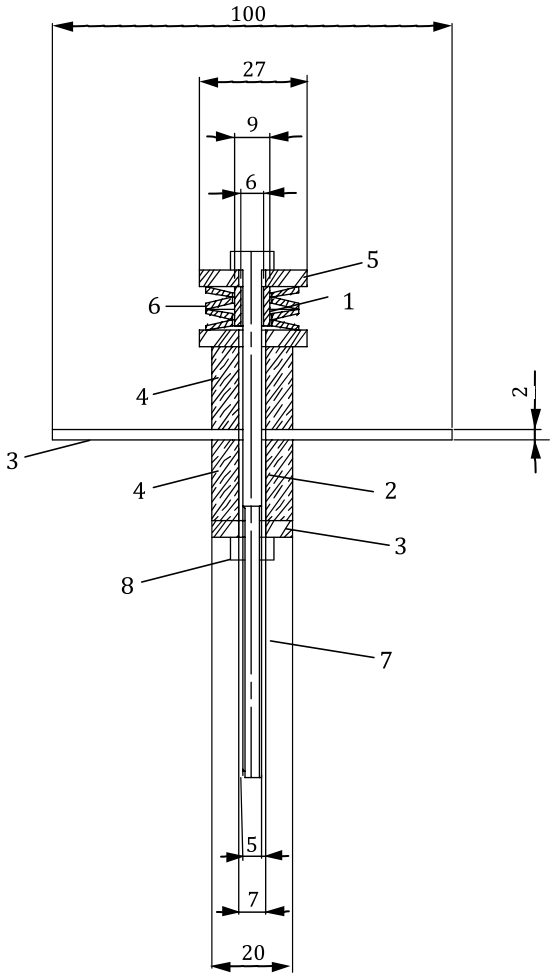
Figure 4 — Calibration curve for the torque that shall be used for tubular specimens

6.5 Preparation of the crevice formers surfaces

The crevice formers shall be wet ground with at least P1200 grit paper, according to ISO 6344-3, starting with lower grit paper. Make sure that all grooves from machining are completely removed. When reusing the crevice formers, grinding with P1200 grit paper is sufficient. Make sure that there are no visible corrosion products on the crevice former.

6.6 Crevice assembly

6.6.1 The parts are mounted on the bolt in the following order, relative to the bolt head: washer, 4-disc springs in position, washer, crevice former, specimen, crevice former, washer, nut. A schematic drawing of the assembly for flat specimens is shown in Figure 5.



Key

1	centralizing ring	5	washer
2	hose	6	disc springs
3	test specimen	7	bolt
4	crevice former	8	nut

Figure 5 — Sketch of spring loaded crevice former for flat specimens

6.6.2 The bolt shall be insulated, as mentioned above, to avoid electrical contact with the specimen (see Figure 1 and Figure 2). This shall be checked with an Ohm-meter.

6.6.3 In order to make sure that the torque on the specimens is constant during the exposure, the distance between washers shall be measured before and after exposure. An example of a test report is given in Annex A. The nut is turned on the thread by use of a torque wrench to 0,2 Nm. In this position, the distance between the washers mounted towards the springs is measured (e.g. with a vernier calliper measurement gauge) in four positions around the circumference (3 o'clock, 6 o'clock, 9 o'clock and 12 o'clock). The average value is calculated, recorded, and designated *LBL*.

6.6.4 The nut is then loaded to the specified torque, which is 3 Nm for flat specimens using DIN 2093 disc springs, with the torque. The distance between the washers mounted towards the springs is measured again at the same positions as prior to loading. The average value is calculated, recorded, and designated LAL_1. The deflection ΔL_1, is calculated as $\Delta L_1 = LBL - LAL_1$ and should be according to the deflection force curve within 0,1 mm for DIN 2093 disc springs. If out of this range, the calibration status of the torque wrench should be controlled and reassembling has to be done. These values are obtained for the threads used in this test. The assembly is now ready for immersion in the test solution.

6.7 Ending test

Before dismounting the assemblies, check the deflection, $\Delta L_2 = LBL - LAL_2$, by measuring again the distance between the washers mounted towards the springs, at the same positions as prior to loading and exposure (see 6.6.3 and 6.6.4).

6.8 Cleaning

After dismantling, the crevice former shall be washed in warm water and brushed with a soft bristle brush. If necessary, the titanium parts can be cleaned in 20 % nitric acid, HNO_3. The crevice formers shall be wet ground to a surface finish of at least P1200 grit paper before reuse.

7 Documentation

The documentation shall include the following information:

— reference to this International Standard, i.e. ISO 18070;

— full description of the test material from which the specimens were taken, including composition, surface finish and structural condition, type of product, and section thickness;

— specimen ID;

— applied torque (Nm), LBL, LAL_1, LAL_2 and resulting deflections ΔL_1 and ΔL_2;

— test assembly.

Annex A
(informative)

Example of test report format of deflection measurements

Deflection measurements (mm)	**Clock position** (mm)				
	3 o'clock	*6 o'clock*	*9 o'clock*	*12 o'clock*	**Average**
Distance between washers at a torque of 0,2 Nm (LBL)					
Distance between washers at a torque of 3,0 Nm (LAL_1)					
Deflection (ΔL_1)					
Distance between washers measured after exposure (LAL_2)					
Deflection (ΔL_2)					

Bibliography

[1] Huizinga, S. and J.G. de Jong. Crevice corrosion test of stainless steel - with a controlled crevice geometry, European Federation of Corrosion Publications No. 33, ISBN 1-86125-151-3, IOM Communications Ltd., London 2001, in applicable parts

ICS 77.060

Price based on 9 pages