INTERNATIONAL STANDARD

ISO 24020

First edition
2022-02

Corrosion of metals and alloys — Standard test method for particle-free erosion corrosion of metallic materials by jet-in-slit

Corrosion des métaux et alliages — Méthode d'essai normalisée de corrosion-érosion en l'absence de particules par jet issu d'une fente

Reference number
ISO 24020:2022(E)

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 of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 156, *Corrosion of metals and alloys*.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Particle-free erosion corrosion is a major problem in metallic materials of industries which handle liquids flowing rapidly that are corrosive. Specifically, the metallic materials include copper, copper alloys and steels, and the liquids are various types of liquids such as seawater, tap water, industrial water, chemical water (e.g. acid and alkali aqueous solution), waste water, etc. Particle-free erosion corrosion usually leads to rapid metal loss with possibly catastrophic consequences. In order to either prevent, mitigate or control, or all, the problems, it is important to determine the particle-free erosion corrosion behaviour of materials for plant construction. This can be achieved by standardizing the test methods which can reproduce the specific mode of corrosion in those materials. This test method can be applied to various types of metallic materials by choosing appropriate test solutions and conditions.

Corrosion of metals and alloys — Standard test method for particle-free erosion corrosion of metallic materials by jet-in-slit

1 Scope

This document specifies a test method for particle-free erosion corrosion of metallic materials by use of jet-in-slit which is flow induced corrosion in single phase flowing liquids. The test method can be used for ranking materials performance, selecting candidate materials and testing the effects of corrosion inhibitors.

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 — Vocabulary*

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 terminology databases for use in standardization at the following addresses:

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

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

3.1
erosion
progressive loss of original material from a solid surface due to mechanical interaction between that surface and a fluid, a multicomponent fluid, an impinging liquid or solid particles

Note 1 to entry: For more details, see Reference [1].

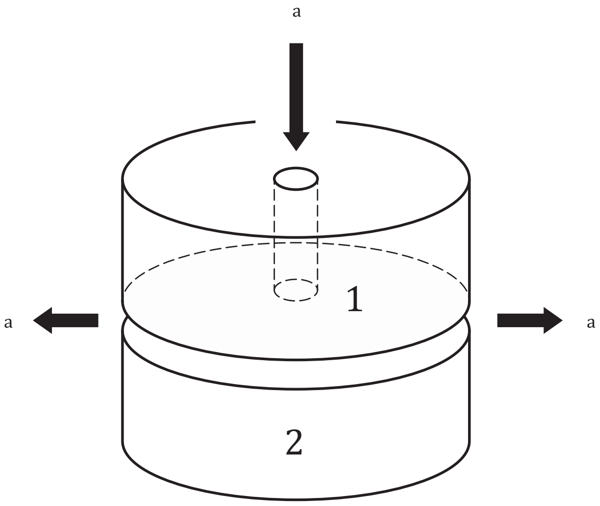
3.2
erosion corrosion
process involving conjoint corrosion and *erosion* (3.1)

3.3
particle-free erosion corrosion
erosion corrosion (3.2) of metallic materials in single phase flowing liquids free of solid particles and gas bubbles

4 Principles

4.1 Schematic of jet-in-slit test

The schematic of jet-in-slit test can be seen in Figure 1. Two circular discs with the same dimensions are set face-to-face to form a narrow gap (slit) between them. A bore hole is drilled-through at the centre of the upper disc to make a nozzle. A jet of test solution from the nozzle impinges at a right angle to the specimen and then to flow in a radial direction through the slit.



Key

1 nozzle

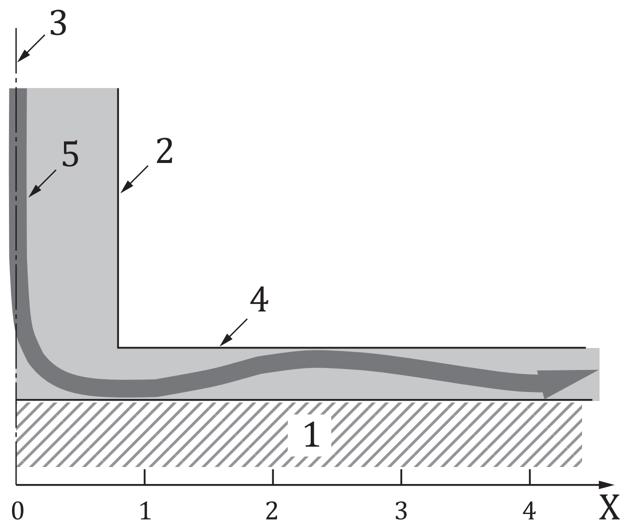
2 specimen

a Solution flow.

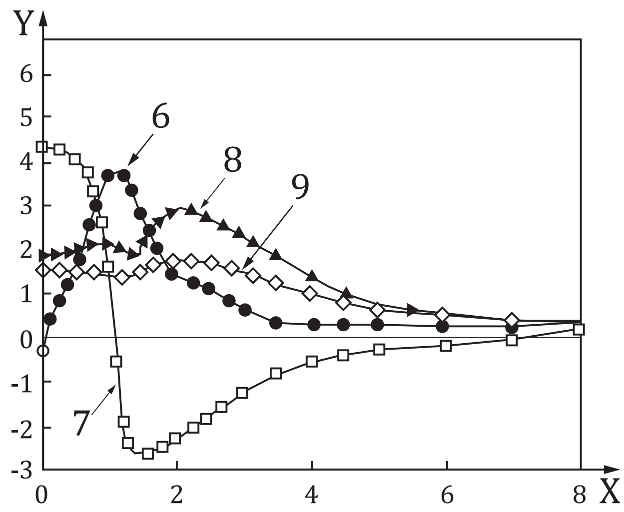
Figure 1 — Schematic of jet-in-slit test

4.2 Hydrodynamic conditions on the specimen

The hydrodynamic conditions of jet flow on the specimen surface in the nozzle and slit are shown in Figures 2 a) and b)[2]. The vertical flow velocity (see Figure 2, Key 7) is highest at the centre (see Figure 2, Key 3) of the nozzle (see Figure 2, Key 2), or the specimen (see Figure 2, Key 1), but is reciprocally the highest (reverse direction) at the location approximately 1,5 mm from the centre, in the jet flow (see Figure 2, Key 5). The flow rebounds after impinging on the specimen surface and causes boundary layers peeling followed by flow fluctuation. The shear stress caused by fluid running over the surface of specimen is proportional to the velocity gradient normal to the surface and it is usually higher at higher flow velocity, as the shear stress in jet in impingement testing[3]. The horizontal flow velocity (see Figure 2, Key 6) shows a maximum at the location approximately 1 mm from the centre and gradually lowered as the circumference is approached. The fluctuation of horizontal (see Figure 2, Key 8) and vertical (see Figure 2, Key 9) flow velocities are highest at the location approximately 2 mm from the centre. In general, the fluctuation of flow velocity represents the intensity of turbulence in fluid flow.



a) Schematic model of jet flow



b) Distribution of flow velocity and its fluctuation

Key

X distance from the centre of the specimen, in mm

Y flow velocity, in m·s^{-1}

1 specimen (16 mm in diameter)

2 nozzle (1,6 mm in diameter)

3 centre of nozzle and specimen

4 slit (0,4 mm in width)

5 schematic model of jet flow

6 horizontal flow velocity (→)

7 vertical flow velocity (↓)

8 horizontal flow velocity fluctuation (←→)

9 vertical flow velocity fluctuation (↓↑)

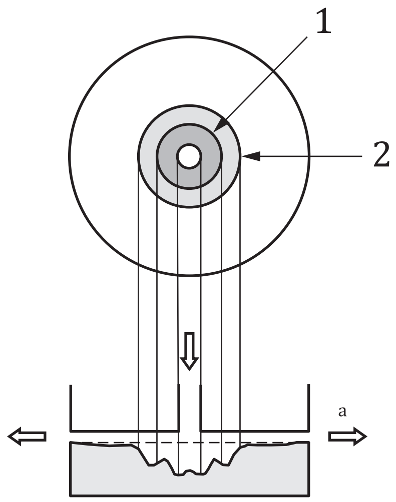
Figure 2 — Hydrodynamic condition of jet flow in nozzle and slit

4.3 Typical damage pattern

A typical damage pattern after jet-in slit test is shown in Figure 3[4]. Damage ring 1 is formed by the separation of corrosion product film by the highly vertical and horizontal velocity, i.e. shear stress (see Figure 2, Key 3 and Key 4), whereas damage ring 2 is formed due to that by turbulence in the flow (see Figure 2, Key 5 and Key 6).

4.4 Material and solution

This document can be applied to various types of metallic materials by choosing appropriate test solutions and conditions. For copper and copper alloys, the solution examples are in seawater or industrial water environments. This test method has already been put to practical use in the industry. For steels and steel alloys, the solution examples are in various boiler water environments. This test method has been validated in the laboratory[5],[6].



Key

1 inner damage ring

2 outer damage ring

a Solution flow.

Figure 3 — Surface and cross-section of a pure copper specimen after jet-in-slit test in 12,7 g ($CuCl_2 \cdot 2H_2O$) /l cupric chloride (II) solution[4]

5 Apparatus

5.1 Nozzle and specimen

The required size and arrangement of nozzle and specimen is shown in Figure 4. The specimen shall be set coaxially with nozzle. The meeting surfaces of nozzle and specimen shall be finished with JIS P600[7] or finer abrasive cloth or paper after machining. The surfaces shall be polished to a maximum surface roughness of 0,8 µm. The circular edges of the specimen shall be smooth, but the chamfer or radius shall not exceed 0,15 mm.

NOTE The number of JIS P600[7] corresponds to ISO P600[8].

