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Corrosion of metals and alloys — Corrosion test method for disinfectant — Spray test method

Corrosion des métaux et alliages — Méthode d'essai de corrosion pour les désinfectants — Méthode d'essai par pulvérisation

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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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

Disinfection is an important means to prevent the spread of infectious diseases. However, there is no standard on detecting the corrosiveness of disinfectants using the spray method. And, in the current environment, it is highly practical to establish International Standards on the spray test method for the corrosiveness of disinfectants. This document provides a basis for the corrosion detection of disinfectants and helps prevent potential hazards caused by the improper use of disinfectants worldwide.

Corrosion of metals and alloys — Corrosion test method for disinfectant — Spray test method

WARNING — This document does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this document to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1 Scope

This document specifies an aerosol spray method for testing the corrosivity of disinfectants against metallic materials. The test method involves the cyclic exposure of test specimens to a mist of disinfectant and to a ventilation condition. After the cycles, the specimens are studied to identify if there is a change in mass, or changes to the specimen surface. This document provides details on the instruments, reagents, preparation and pretreatment of the test specimens, test conditions, test methods, calculation of corrosion rate, reports, etc.

A feature of this document is a corrosion test method which can stimulate exposure to the real disinfection environment for metal materials. This document is applicable to the determination of corrosion of disinfectant aerosol spray to metal materials.

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

ISO 6353, *— Reagents for chemical analysis*

ISO 8044, *Corrosion of metals and alloys — Vocabulary*

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

ISO 8486-1, *Bonded abrasives — Determination and designation of grain size distribution — Part 1: Macrogrits F4 to F220*

ISO 11463, *Corrosion of metals and alloys — Guidelines for the evaluation of pitting corrosion*

3 Terms and definitions

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

4 Apparatus

4.1 Test cabinet

The distribution of the spray within the cabinet shall be homogenous. The volume of the test cabinet should be 1 m^3. If the distribution of temperature, humidity and spray are homogeneous, a test cabinet of another volume may be used. All components of the test cabinet which are in contact with the disinfectants shall be constructed of materials resistant to any corrosion caused by the disinfectant. The construction materials should also not influence the corrosivity of the test disinfectant.

Features of the test cabinet shall include:

— a temperature adjustment system (user adjustment of at least 20 °C to 25 °C);

— a humidity adjustment system (relative humidity controlled at least 70 % to 80 %) ;

— a ventilation device.

An automatic control system shall also be a feature of the test cabinet. The system should control:

— temperature

— humidity

— spray time

— disinfection maintain time

— ventilation time

— cycle number

NOTE A schematic diagram of one possible design of test cabinet and associated apparatus for disinfectant corrosion test in the spray conditions is shown in Annex B.

4.2 Spray equipment

The spray equipment shall comprise an air compressor, pressure gauges, a metering pump and a sprayer. The sprayer should produce ejected aerosols with a diameter of 50 µm or less. In addition, the diameter of more than 90 % aerosol particles should be 1 µm to 10 µm.

4.3 Specimen supporting device

The supporting device for the specimen shall be made of an inert non-metal material, such as a glass or a plastic. The material used to suspend the specimen shall not be metallic but shall be synthetic fibre, cotton thread or another inert insulation material. The specimen support and the material used to suspend the specimen should be inert to the test disinfectant and the specimen. The contact area between the suspending material and the specimen should be as small as possible.

4.4 Oven

The oven shall be capable of controlling temperature in excess of 120 °C. The precision of temperature controlling should be ±3 °C.

4.5 Analytical balance

The precision of analytical balance for weighing shall be ±0,1 mg.

4.6 Vernier caliper

The precision of vernier caliper should be ±0,02 mm.

5 Reagents and materials

5.1 Experimental water

The experimental water used shall conform to the specification of grade 3 water in ISO 3696.

5.2 Acetone

The acetone used shall conform to the specification in ISO 6353.

5.3 Ethanol

The ethanol used shall conform to the specification in ISO 6353.

5.4 Abrasive paper

The abrasive paper shall meet the requirements of ISO 8486-1.

6 Test specimens

6.1 The material of the specimen is carbon steel, stainless steel, copper, aluminium or zinc. Take test specimens of a given metal material from the same sheet stock, which shall be in new or like-new condition, and measure 50 mm × 25 mm × 2 mm with a 5 mm diameter mounting hole suitably located at one end of the specimen. The size and thickness of the selected specimens should be consistent.

6.2 Specimens should be clearly marked, for example by stamping with letters or numbers.

6.3 The surface of the specimens should be ground. The specimen should be used only once.

7 Pretreatment of test specimens

7.1 The specimens shall be free from oil and grease. Prior to use, the surface shall be degreased, for example with ethanol or acetone.

7.2 All sides of specimens shall be ground with at least 120 grit abrasive paper. The grade of the final abrasive paper used should be reported. Each sheet of abrasive paper can grind only one kind of metal material.

7.3 The specimens shall be rinsed with grade 3 water which conforms to ISO 3696. Then, the specimens shall be rinsed with ethanol and dried using either hot air or an oven. Finally, the specimens shall be placed into a desiccator.

8 Arrangement of the test specimens

8.1 The test specimens should be situated in a location where the disinfectants do not spray directly onto the specimens.

8.2 The test specimens shall not contact the test cabinet. Three specimens of the same material shall be arranged in the test cabinet. The specimens shall be arranged in the middle of the test cabinet and at

the same level. The horizontal space of adjacent specimens shall be larger than 50 mm. The position of the specimens in the test group (the experimental medium is disinfectant solution) and comparison group (the experimental medium is water) shall be consistent.

9 Operation condition

9.1 Test environment

Two test cabinets are recommended: one is used for the test and another is used for comparison. Another option is one cabinet which conducts the test and comparison respectively. During the test period, the temperature, humidity, illumination, airtightness and ventilation conditions of the test cabinet and comparison cabinet shall be consistent.

9.2 Disinfectant solution concentration and the disinfectant solution usage

Unless otherwise specified, the disinfectant solution in the test is prepared according to the instructions (concentration and usage) and the cycle number. The grade 3 water that conforms to ISO 3696 is recommended to dilute the disinfectant to the specified concentration.

9.3 Temperature

The test temperature should be 20 °C to 25 °C, unless otherwise specified. Other test temperatures can be used by agreement between the interested parties. This shall be stated in the test report.

9.4 Duration of the test

The duration of the test is given by Formula (1).

$$t_T = t_C \times n \tag{1}$$

where

t_T is the duration of the test;

t_C is the single cycle time;

n is the number of cycles (45).

The single cycle time is given by Formula (2).

$$t_C = t_S + t_M + t_V \tag{2}$$

where

t_S is the spray time;

t_M is the disinfection maintain time (equal to the disinfect time in the disinfectant instructions);

t_V is the ventilation time (30 min).

The spray time is given by Formula (3).

$$t_S = (V \times c_d) / r_S \tag{3}$$

where

V is the volume of the test cabinet;

c_d is the disinfectant concentration in the test cabinet;

r_S is the spray flow rate.

10 Procedure

10.1 Weigh the specimens in the test group and comparison group to the nearest 0,1 mg.

10.2 Treat the specimens according to 8.1 and 8.2. Then, place the weighed specimens in the test cabinet and comparison cabinet respectively.

10.3 The disinfect solution used in the test group is prepared according to the requirement listed in 9.2. If the active ingredient in the disinfectant solution is unstable, for example the disinfectant is oxidative, the disinfectant solution shall be prepared on the day that the disinfectant is used. The comparison group uses grade 3 water that conforms to ISO 3696 as an experiment solution.

10.4 Set the temperature of test cabinet and comparison cabinet according to 9.3. Set the relative humidity of the test cabinet and the comparison cabinet to 70 % to 80 %. Other relative humidity values can be used on agreement between the interested parties. If this takes place, this shall be stated in the test report. Set the spray time, disinfection maintain time, ventilation time and cycle number according to 9.4. Start the automatic control system of the test cabinet and comparison cabinet.

NOTE A single cycle includes processes for constant temperature and humidity, spray, disinfection maintenance and ventilation. First, the temperature and humidity control system adjusts the temperature and humidity to the set value. Second, if the temperature and humidity reach the set value, the automatic control system of the test cabinet starts the spray system. At the same time, the temperature and humidity control system switches off. Humidity increases during the spray period. Third, the spray system switches off and disinfection is maintained at the set disinfection time. Fourth, the ventilation system starts and runs to the set ventilation time. The cycle is then complete. The system automatically runs to the next cycle. If the cycle number runs to the set cycle number, the cycle is over.

10.5 After the cycle, remove the specimens to check and record the extent of corrosion on the specimens. The following visible changes are recorded:

a) discoloration and dulling

b) pitting

c) morphology of corrosion products

d) presence of other corrosion features

10.6 Evaluate the pitting in accordance with ISO 11463. Record the amount, area, depth and distribution of pitting.

10.7 The corrosion products formed on specimens shall be removed using a suitable method from ISO 8407. The specimens shall be reweighed to the nearest 0,1 mg.

10.8 During the whole test, the test should not be interrupted. If the test is interrupted, it will be classed as a fail and a new test shall be started.

10.9 The procedure for the comparison group is the same as the test group except for the disinfectant, which shall be replaced by grade 3 water that conforms to ISO 3696. After the cycle, take out the specimens

in the comparison group and treat the specimens using the same method as the test group specimens. Calculate the mass loss of the specimens in the comparison group.

11 Calculation of the corrosion rate

11.1 The corrosion rate for each specimen is given by Formula (4).

$$V_{corr} = 8{,}76\times10^{7}\times\frac{W_0 - W_1}{S\times t\times\rho} \tag{4}$$

where

V_{corr} is the corrosion rate, expressed in mm per year (mm/a);

W_0 is the mass of the specimens before the test, expressed in g;

W_1 is the mass of the specimens after the test, expressed in g;

S is the surface area, expressed in cm^2;

t is the test time, expressed in h;

ρ is the material density of the specimen, expressed in kg/m^3.

11.2 The result of corrosion rate is given by Formula (5).

$$V = \overline{V_{corr1}} - \overline{V_{corr0}} \tag{5}$$

where

V is the result of the corrosion rate, expressed in mm/a;

$\overline{V_{corr1}}$ is the average corrosion rate of the test group, expressed in mm/a;

$\overline{V_{corr0}}$ is the average corrosion rate of the comparison group, expressed in mm/a;

12 Report

Report the data for each test performed on a form as illustrated in Table A.1.