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Composites and metal assemblies — Galvanic corrosion tests of carbon fibre reinforced plastics (CFRPs) related bonded or fastened structures in artificial atmospheres — Salt spray tests

Assemblages composites et métal — Essais de corrosion galvanique des structures en plastiques renforcés de fibres de carbone (CFRP) jointes ou fixées en atmosphères artificielles — Essais au brouillard salin

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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 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 61, *Plastics*, Subcommittee SC 13, *Composites and reinforcement fibres*.

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

This document specifies the testing method for galvanic corrosion of composites and metal assemblies subject to salt spray environment using a bonded or fastened specimen.

The potential benefits to CFRP-metal users of implementing a galvanic corrosion test based on this document are:

a) addressing corrosion risks relating CFRPs of drastically nobler galvanic potential than metals to form a global cell between CFRP and metal – new risks drastically exceeding the scope of ISO 9227 for a local cell of isolated metal – utilizing the resources of ISO 9227;

b) expanding CFRP applications to the fields of corrosive environments that still require the combinations with metallic components;

c) the detection or the prevention of galvanic current insulation loss, such as ion migration and time-related degradation in sealant film, injected calking layer and glass fibre reinforced plastics (GFRPs) layer;

d) demonstrating the conformity to specified conditions for type certification requirements in the engineering such as aircraft developments;

e) evaluating the corrosion related procedures for maintenance, repair and overhaul (MRO) in the engineering operations such of CFRP aircrafts.

It is not the intent of this document to imply the need for:

— omitting relevant field tests for CFRP related engineering;

— generally specifying the dimensions of test specimen to represent CFRPs related bonded or fastened structures;

— superimposing test results for specific applications of the parameters that exceed the range of this document;

— comparative testing as a means of ranking different protections with respect to corrosion resistance.

Composites and metal assemblies — Galvanic corrosion tests of carbon fibre reinforced plastics (CFRPs) related bonded or fastened structures in artificial atmospheres — Salt spray tests

1 Scope

This document specifies the apparatus, the reagents and the procedure to be used in conducting the neutral salt spray (NSS), acetic acid salt spray (AASS) and copper-accelerated acetic acid salt spray (CASS) tests for assessment of the galvanic corrosion resistance of joints and bonded structures between carbon fibre reinforced plastics (CFRPs) and metallic materials, with or without permanent or temporary insulation for the galvanic current.

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 1514, *Paints and varnishes — Standard panels for testing*

ISO 2808, *Paints and varnishes — Determination of film thickness*

ISO 3574, *Cold-reduced carbon steel sheet of commercial and drawing qualities*

ISO 6361-2, *Wrought aluminium and aluminium alloys — Sheets, strips and plates — Part 2: Mechanical properties*

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 17872, *Paints and varnishes — Guidelines for the introduction of scribe marks through coatings on metallic panels for corrosion testing*

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 https://www.iso.org/obp

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

3.1
reference material
material with known test performance

3.2
reference specimen
portion of the reference material that is to be exposed with the intention to check the reproducibility and repeatability of the test results for the test cabinet in use

3.3
test specimen
specific portion of the samples upon which the testing is to be performed

3.4
substitute specimen
specimen made of inert materials (such as ceramic or glass) used for the substitute of a test specimen

Note 1 to entry: Examples of inert materials are ceramic or glass.

3.5
control specimen
specimen made of CFRP, which is identical to the CFRPs of test specimen, used to check the reproducibility, repeatability and deviation or drift by solution absorption of the test results

3.6
neutral salt spray test
NSS
test method in which a 5 % sodium chloride solution is atomized under a controlled environment

Note 1 to entry: It particularly applies to:

— CFRPs and metals or their alloys in fastened or bonded form;

— sacrificial protections (anodic and cathodic);

— organic coatings on pinned or riveted joints of CFRPs and metals.

3.7
acetic acid salt spray test
AASS
test method in which a 5 % sodium chloride solution with the addition of glacial acetic acid is atomized under a controlled environment

Note 1 to entry: It is especially useful for testing CFRPs with lightning strike protection layer (LSP) of Cu or Al mesh or foil in acid-rain or exhaust gas environment.

3.8
copper-accelerated acetic acid salt spray test
CASS
test method in which a 5 % sodium chloride solution with the addition of copper chloride and glacial acetic acid is atomized under a controlled environment

Note 1 to entry: It is useful for modelling an aged structure of CFRPs with LSPs and Al alloys in fastened or bonded form in acid-rain or exhaust gas environment.

3.9
scribed specimen
specimen with organic or inorganic coating, which is intentionally line-damaged with scriber needle

3.10
purity of salt
mass fraction of sodium chloride excluding contaminant

4 Test solutions

4.1 Preparation of the sodium chloride solution

Dissolve a sufficient mass of sodium chloride in distilled or deionized water with a conductivity not higher than 20 µS/cm at 25 °C ± 2 °C to produce a concentration of 50 g/ l ± 5 g/l. The conductivity shall be measured just before the preparation, as dissolution of carbon dioxide in atmospheric environment

can drift the value. The sodium chloride concentration of the sprayed solution collected shall be 50 g/l ± 5 g/l. The specific gravity range of a 50 g/l ± 5 g/l solution is from 1,029 to 1,036 at 25 °C.

The sodium chloride shall contain less than 0,001 % mass fraction of copper and less than 0,001 % mass fraction of nickel, as determined by atomic absorption spectrophotometry or another analytical method of similar sensitivity. It shall not contain more than 0,1 % of a mass fraction of sodium iodide, or more than 0,5 % of a mass fraction of total impurities calculated for dry salt. Industrial salt is not recommended due to possible deviation of the impurities.

4.2 pH adjustment

4.2.1 pH of the salt solution

If necessary, control the pH of distilled or deionized water to 7,0 by the aeration of nitrogen gas - dissolution of carbon dioxide can drift the pH – in the preparation of the sodium chloride solution. Adjust the pH of the salt solution to the desired value on the basis of the pH of the sprayed solution collected.

4.2.2 Neutral salt spray test (NSS)

Adjust the pH of the salt solution (see 4.1) so that the pH of the sprayed solution collected within the test cabinet (5.2) is 6,5 to 7,2 at 25 °C ± 2 °C. Check the pH using electrometric measurement or in routine checks, with a short-range pH paper, which can be read in increments or 0,2 pH units or less. If pH electrodes are used, they shall be suitable for measuring pH in weakly buffered sodium chloride solutions in de-ionized water. Make any necessary corrections by adding hydrochloric acid, sodium hydroxide or sodium bicarbonate solution of analytical grade.

4.2.3 Acetic acid salt spray test (AASS)

Add a sufficient amount of glacial acetic acid to the salt solution (see 4.1) to ensure that the pH of samples of sprayed solution collected in the test cabinet (see 5.2) is between 3,1 and 3,3. If the pH of the solution initially prepared is 3,0 to 3,1, the pH of the sprayed solution is likely to be within the specified limits. Check the pH using electrometric measurement at 25 °C ± 2 °C. If pH electrodes are used, they shall be suitable for measuring pH in weakly buffered sodium chloride solutions in de-ionized water. Make any necessary corrections by adding glacial acetic acid or sodium hydroxide of analytical grade.

4.2.4 Copper-accelerated acetic acid salt spray test (CASS)

Dissolve a sufficient mass of copper (II) chloride dihydrate ($CuCl_2 \cdot 2H_2O$) in the salt solution (see 4.1) to produce a concentration of 0,26 g/l ± 0,02 g/l [equivalent to (0,205 ± 0,015) g of $CuCl_2$ per litre].

Adjust the pH using the procedures described in 4.2.3.

4.3 Filtration

Test solutions prepared using the procedures described in 4.1 and 4.2.1 in laboratory environment are suitable for the spraying applications. However, if necessary, filter the solution before placing it in the reservoir of the apparatus, to remove any solid matter or contaminant which might affect the apertures of the spraying device. Any incident relating to the solid matter shall be reported as described in 13.2 r).

5 Apparatus

5.1 Component protection. All components in contact with the spray or the test solution shall be made of, or lined with, materials resistant to corrosion by the sprayed solution and which do not influence the corrosivity of the sprayed test solution.

If necessary, electric insulation shall be devised for the apparatus to prevent the influence from inside or outside of the apparatus.

The supports for the test specimen shall be constructed such that different substrate types do not influence each other. It shall also be constructed so that the supports themselves do not influence the test specimens.

5.2 Spray cabinet. The cabinet for galvanic corrosion test shall be such that the conditions of homogeneity and distribution of the spray are met. Due to the limited capacity of cabinets smaller than 0,4 m3, the effect of the loading of the cabinet on the distribution of the spray and temperature should be carefully considered. The sprayed solution shall be fell down naturally on the test specimens, and the upper parts of the cabinet shall be designed so that drops of spayed solution formed on its surface do not fall on the test specimens being tested (see Annex A).

If a cabinet for galvanic corrosion test has been used once for an AASS or CASS test, or has been used for any other purpose with a solution differing from that specified for the NSS test, it shall not be used for the NSS test.

The size and shape of the cabinet shall be such that the collection rate of solution in the cabinet is within the limits specified in Table 3, measured as specified in 9.3.

Preference shall be given to apparatus that has a means for properly dealing with fog after the test, prior to releasing it from the building for environmental conservation, and for drawing water prior to discharging it to the drainage system.

5.3 Heater and temperature control. An appropriate system for galvanic corrosion test maintains the cabinet and its contents at the specified temperature (see Table 3). The temperature shall be measured at least 100 mm from the walls.

5.4 Spraying device. The device for spraying the test solution comprises a supply of clean air, of controlled pressure and humidity, a reservoir to contain the solution to be sprayed, and one or more atomizers.

The compressed air supplied to the atomizers shall be filtered to remove all traces of contaminants such as oil or solid matter, and the atomizing pressure shall be at an overpressure of 70 kPa to 170 kPa. The pressure should be 98 kPa ± 10 kPa.

In order to prevent the evaporation of water from the sprayed droplets (aerosol), the air shall be humidified before entering the atomizer by passing through a suitable humidifier. The humidified air shall be saturated such that the concentration of the fallout solution falls within the specifications of 4.1. The humidified air shall also be heated such that when mixed with the salt solution, there is no significant disturbance of the temperature in the cabinet. The appropriate temperature depends on the pressure used and on the type of atomizer nozzle. Temperature, pressure or humidification, or a combination thereof, shall be adjusted so that the rate of collection of the spray in the cabinet and the concentration of the collected spray are kept within the specified limits (see 9.3). A common used humidifier is the saturation tower, where temperature and pressure are controllable. Table 1 gives guidance values on temperature and pressure combinations for the saturation tower.

Table 1 — Guiding values of galvanic corrosion test for the solution temperature in the saturation tower

Atomizing overpressure	Guiding values for the temperature, in °C, of the hot water in the saturation tower when performing the different salt spray test	
kPa	Neutral salt spray (NSS) and acetic acid salt spray (AASS)	Copper-accelerated acetic acid salt spray (CASS)
70	45	61
84	46	63
98	48	64
112	49	66
126	50	67
140	52	69

The atomizers shall be made of inert material such as ceramic and glass. Baffles may be used to prevent direct impact of the spray on the test specimens, and the use of adjustable baffles is helpful in obtaining uniform distribution of the spray within the cabinet. For this purpose, a dispersion tower equipped with an atomizer may also be helpful.

The supply salt solution to the nozzle shall be kept stable to ensure a continuous and uniform fall out as described in 9.3. A stable level of spraying can be achieved by either controlling the level of salt solution in the reservoir or restricting the flow of salt solution to the nozzle such that a continuous spray is achieved.

Distilled or deionized water with a conductivity not higher than 20 µS/cm at 25 °C ± 2 °C shall be used for humidifier.

5.5 Collecting devices. Suitable collecting devices for galvanic corrosion test shall be available in such number that the homogeneity of the cabinet can be checked, at least two, consisting of funnels made of chemically inert material, with the stems inserted into graduated cylinders or other similar containers. Suitable funnels have a diameter of 100 mm, which corresponds to a collecting area of approximately 80 cm^2. The collecting devices shall be placed in the zone of the cabinet where the test specimens are placed, one close to an inlet of spray and one remote from an inlet. They shall be placed so that only mist, and not liquid falling from specimens or from parts or the cabinet, is collected.

6 Method for evaluating cabinet corrosivity

6.1 General

To check the reproducibility and repeatability of the galvanic corrosion test results for one piece of apparatus, or for similar items of apparatus in different laboratories, it is necessary to verify the apparatus at regular intervals as described in 6.2 to 6.4.

To determine the corrosivity of the tests, reference-metal specimens made of steel or aluminium shall be used.

As a complement to the reference-metal specimens made of steel or aluminium, high-purity zinc reference-metal specimens may also be exposed in the tests in order to determine the corrosivity against this metal as described in Annex B.

6.2 Reference specimens

To verify the apparatus, use four or six reference specimens of 1 mm ± 0,2 mm thickness and 150 mm × 70 mm, of CR4-grade steel in accordance with ISO 3574, or aerospace grade A1050 pure aluminium in accordance with ISO 6361-2, with an essentially faultless surface and a matt finish

(arithmetical mean deviation of the profile Ra = 0,8 µm ± 0,3 µm). Cut these reference specimens from cold-rolled plates or strips.

Clean the reference specimens carefully, immediately prior to testing. Besides the specifications given in 7.2 and 7.3, cleaning shall eliminate all those traces (dirt, oil, protective resin or other foreign matter) that could influence the test results.

Thoroughly clean the reference specimens with an appropriate organic solvent (such as a hydrocarbon with a boiling point between 60 °C and 120 °C) using a clean soft brush or an ultrasonic cleaning device. Carry out the cleaning in a vessel full of solvent. After cleaning, rinse the reference specimens with fresh solvent and then dry them.

Determine the mass of the reference specimens to ±1 mg. Protect one face of the reference specimens with a removable coating, for example an adhesive plastic film. The edges of the reference test specimens may be protected by the adhesive tape as well.

6.3 Arrangement of the reference specimens

Position four steel or aluminium reference specimens in four quadrants (if six specimens are available, place them in six different positions including four quadrants) in the zone of the cabinet where the test specimens are placed, with the unprotected face upwards, and at an angle of 20° ± 5° from the vertical.

The support for the reference specimens shall be made of, or coated with, inert materials such as plastics. The lower edge of the reference specimens shall be level with the top of the salt spray collector.

The cabinet should be verified during the testing of specimens. If this is the case, great care shall be taken that the specimens do not affect each other. Otherwise, the cabinet shall be filled with substitute specimens to maintain the homogeneity of the cabinet. The verification procedure shall be performed using the same settings as for the test runs.

6.4 Duration of tests

Neutral salt spray test (NSS): 48 h.

Acetic acid salt spray test (AASS): 24 h.

Copper-accelerated acetic acid salt spray test (CASS): 24 h.

6.5 Determination of mass loss (mass per area)

At the end of the test, immediately take the reference specimens out of the test cabinet and remove the protective coating. Remove the corrosion products by mechanical and chemical cleaning, for the case of steel specimen as described in ISO 8407.

After each stripping, thoroughly clean the reference specimens at ambient temperature with water, then with ethanol, followed by drying.

Weigh the reference specimens to the nearest 1 mg. Divide the determined mass loss by the area of the exposed surface area of the reference specimen in order to assess the metal mass loss per square metre of the reference specimen.

It is recommended that freshly prepared solution be used during each procedure for the removal of corrosion products.

6.6 Satisfactory performance of cabinet

The cabinet for galvanic corrosion test has performed satisfactorily if the mass loss of steel reference specimen is within the allowed ranges given in Table 2 and of Al 1050 reference specimen within 1,5 ± 0,5 g/m2 in NSS.

Table 2 — Allowed range of mass loss of the steel reference specimens during verification of the corrosivity of the cabinet

Test method	Test duration h	Allowed range of mass loss g/m^2
NSS	48	70 ± 20
AASS	24	40 ± 10
CASS	24	55 ± 15

7 Test specimens

7.1 The number and type of test specimens, their shape and their dimensions, shall be selected in accordance with the specification for the material or product being tested. When not specified, the parameters shall be mutually agreed between the interested parties. Unless otherwise specified or agreed, test panels with an organic coating to be tested shall be made from burnished steel complying with ISO 1514, or, passivative coated A1050 pure aluminium in accordance with ISO 6361-2, and of approximate dimensions 150 mm × 100 mm or 70 mm × 1 mm. Annex C describes how test panels with organic coatings shall be prepared for testing. Annex D gives supplementary information needed for testing specimens with organic coatings. Annex E gives recommended specimen geometries of metal and CFRP assemblies.

7.2 The test specimens shall be thoroughly cleaned before testing, if not otherwise specified. The cleaning method employed shall depend on the nature of the material, its surface and the contaminants and shall not include the use of any abrasives or solvents which may attack the surface of the specimens.

7.3 If the test specimens are cut from a larger coated article, cutting shall be carried out in such a way that the coating is not damaged in the area adjacent to the cut. Unless otherwise specified, the cut edges shall be adequately protected by coating them with a suitable material, which remains stable under the conditions of the test, such as paint, wax or adhesive tape.

8 Arrangement of the test specimens

8.1 The specimens for galvanic corrosion test shall be placed in the cabinet so that they are not in the direct line of travel of the spray from the atomizer.

8.2 The angle at which the surface of the test specimen is exposed in the cabinet is very important. The specimen shall, in principle, be flat and placed in the cabinet facing upwards at an angle as close as possible to 20° to the vertical. This angle shall, in all cases, be within the limits of 15° to 25°. In the case of irregular surfaces, for example entire components, these limits shall be adhered to as closely as possible.

8.3 The test specimens shall be arranged so that they do not come into contact with the cabinet and so that surfaces to be tested are exposed to free circulation of spray. The specimens may be placed at different levels within the cabinet as long as the solution does not drip from specimens or their supports at one level onto other specimens placed below. However, for a new examination or for tests with a total duration exceeding 96 h, location permutation of specimens is permitted.

8.4 The supports for the test specimens shall be made of inert non-metallic material. If it is necessary to suspend specimens, the material used shall not be metallic but shall be synthetic fibre, cotton thread or other inert insulating material.

9 Operating conditions

9.1 Operating conditions are summarized in Table 3.

Table 3 — Operating conditions for galvanic corrosion test

Test method item	Neutral salt spray (NSS)	Acetic acid salt spray (AASS)	Copper-accelerated acetic acid salt spray (CASS)
Temperature	35 °C ± 2 °C	35 °C ± 2 °C	50 °C ± 2 °C
Average collection rate for a horizontal collecting area of 80 cm^2	1,5 ml/h ± 0,5 ml/h		
Concentration of sodium chloride (collected solution)	50 g/l ± 5 g/l		
pH (collected solution)	6,5 to 7,2	3,1 to 3,3	3,1 to 3,3

9.2 Check the collection rate and other galvanic corrosion test conditions in the test chamber with the same setting as during the test. An empty or a completely filled cabinet behaves different. After it has been confirmed that the test conditions are within a specified range, stop spraying the salt solution, fill the test chamber with galvanic corrosion test specimens and start the test.

9.3 The solution collected in each of the collecting devices (5.5) shall have a sodium chloride concentration and a pH value within the ranges given in Table 3.

The average rate of collection of solution in each device shall be measured over a minimum period of 24 h of continuous spraying.

9.4 The test solution which has been sprayed shall not be re-used.

9.5 During operation, the tank for the solution shall be covered by a lid to prevent dust or others from influencing the solution and to prevent the concentration of sodium chloride and the pH from fluctuating.

10 Duration of tests

10.1 The period of test shall be as designated by the specification covering the material or product being tested. When not specified, this period shall be agreed upon by the interested parties.

Recommended periods of exposure are 2 h, 4 h, 6 h, 12 h, 24 h, 48 h, 96 h, 168 h, 240 h, 480 h, 720 h, 1 000 h, 3 000 h and 5 000 h.

10.2 Spraying shall not be interrupted during the prescribed test period. The cabinet shall be opened only for brief visual inspections of the test specimens in position and for replenishing the salt solution, if necessary, in the reservoir, if such replenishment cannot be carried out from outside the cabinet. The total opening time per day should not exceed 1 h.

10.3 If the end-point of the test depends on the appearance of the first sign of corrosion, the test specimens shall be inspected frequently with the requirements of 10.2.

10.4 A periodic visual examination of specimens under test for a predetermined period may be carried out, but the surfaces under test shall not be disturbed, and the period for which the cabinet is open shall be the minimum necessary to observe and record any visible changes.

11 Treatment of specimens after test

11.1 General

How to treat specimens after galvanic corrosion testing should, in line with good engineering practice, be included in the test specification or material specification given by the customer. It should be agreed with the test parties before starting the test.

11.2 Non-organic coated specimens: metallic and/or inorganic coated

At the end of the test period, remove the test specimens from the cabinet and allow them to dry for 0,5 h to 1 h before rinsing or disassemble, in order to reduce the risk of removing corrosion products. Before they are examined, if possible, remove the residues of spray solution carefully in pure water, at a temperature not exceeding 40 °C, and then to dry them immediately in a stream of air, at an overpressure not exceeding 200 kPa and at a distance of approximately 300 mm.

How to disassemble and remove the corrosion products should, in line with good engineering practice, be included in the test specification or certification process.

11.3 Organic coated specimens

11.3.1 Scribed organic coated specimens

Clean the surface of the organic coated specimens under running tap water directly after removing the specimens out of the salt spray cabinet. A soft sponge may be used to remove dirt and salt rests out of the scribed area but not to remove evaluable corrosion phenomena. Remove the delaminated area around the scribe by one of the following methods.

a) Using a knife. Carefully remove the loose coating using a knife blade held at an angle, positioning the blade at the coating/substrate interface and forcing the coating away from the substrate.

b) Using an adhesive tape.

Remove the organic coating (paint coating) depending on the kind of coating (paint) and its behaviour in wet condition. If agreed by the interested parties, let the specimens dry in room atmosphere for 24 h and then treat them as describe under a) and b). For specimens with CFRP, let them dry in 80 °C atmosphere for 24 h and then treat them as described under a) and b).

11.3.2 Organic coated but not scribed specimens

Coated but not scribed specimens shall be cleaned under running tap water so that corrosion products and/or corrosion phenomena which shall be evaluated aren't influenced by cleaning.

12 Evaluation of results

Many different criteria for the evaluation of the test results may be applied to meet particular requirements, for example:

a) appearance after the test;

b) appearance after removing superficial corrosion products;

c) number and distribution or corrosion defects, i.e. pits, cracks, blisters, rusting or creep from scratches in the case of organic coatings, etc.; these may be assessed by methods described in ISO 8993 or ISO 10289 and, for organic coatings, in ISO 4628-1, ISO 4628-2, ISO 4628-3, ISO 4628-4, ISO 4628-5 and ISO 4628-8 (see Annex D);

d) time elapsed before the appearance of the first signs of corrosion;

e) change in mass;

f) alteration revealed by micrographic examination;

g) change in mechanical properties;

h) electric resistance of specimen surface.

13 Test report

13.1 The test report shall indicate the outcome of the test according to the criteria for evaluation of results prescribed for the test. Report the result obtained for each specimen tested and, when appropriate, the average result for a group of replicate test specimens. Photographic records of the tested specimens may, if required, accompany the report.

13.2 The test report shall contain information about the test procedure. This information may vary according to the purpose of the test and the guidelines prescribed, but a general list of the details likely to be required is as follows:

a) a reference to this document, i.e. ISO 21746:2019;

b) type and purity of salt and water used;

c) description of the material or product tested;

d) dimensions and shape of the test specimen, and nature and area of the surface tested;

e) preparation of the test specimen, including any cleaning treatment applied and any protection given to edges or other special areas;

f) known characteristics of any coating, with an indication of the surface area;

g) number of test specimens subjected to the test representing each material or product;

h) method used to clean test specimens after the test with, where appropriate, an indication of the loss in mass resulting from the cleaning operation;

i) angle at which the tested surfaces were inclined;

j) frequency and number of specimen location permutation, if any;

k) duration of the test and results of any intermediate inspections;

l) properties of any reference specimens placed in the cabinet to check the stability of the operating conditions;

m) test temperature;

n) volume of the collected solution;

o) pH of the test solution and the collected solution;

p) salt concentration or density of the collected solution;

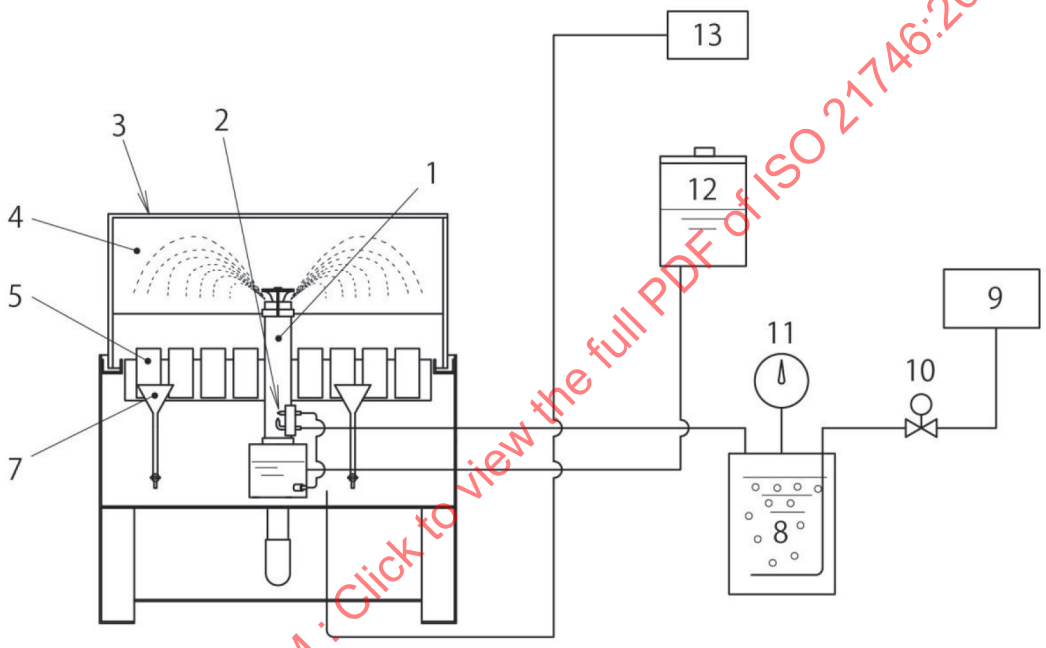
q) result of corrosion rate of reference specimens made of steel, aluminium, or for both steel and zinc (mass loss, g/m^2);

r) any abnormality or incident occurring during the entire test procedure;

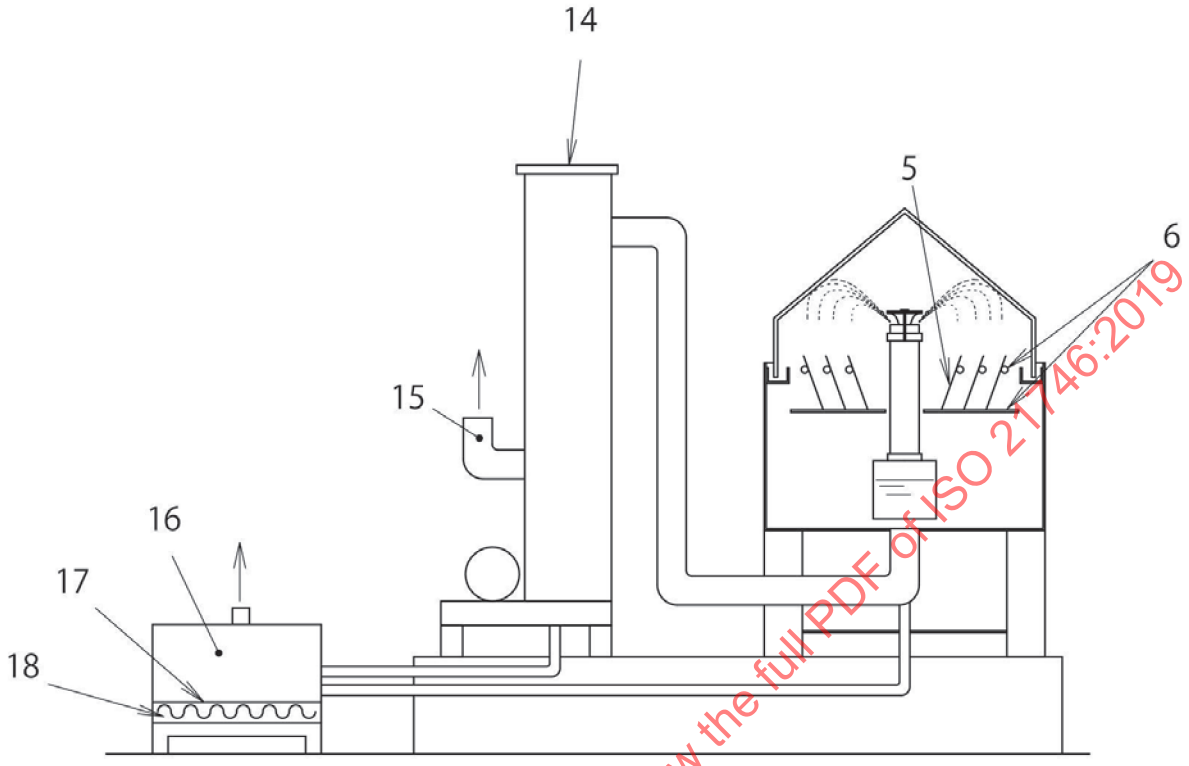
s) intervals of inspection.

Annex A
(informative)

Example schematic diagram of one possible design of spray cabinet for galvanic corrosion test with means for optional treating fog exhaust and drain



a) Front view



b) Side view

Key

1	dispersion tower	10	solenoid valve
2	atomizer	11	pressure gauge
3	cover	12	solution tank
4	test chamber	13	temperature controls
5	test specimen	14	exhaust air treatment unit
6	test-specimen support	15	air-outlet port
7	collecting device	16	drain-treatment disposal
8	saturation tower	17	salt tray
9	compressed air	18	heating elements

Figure A.1 — Schematic diagram of one possible design of spray cabinet for galvanic corrosion test

Annex B
(informative)

Complementary method for evaluating galvanic corrosion test cabinet corrosivity using zinc reference specimens

B.1 Reference specimens

As a complementary method for measuring cabinet corrosivity in accordance with this document, at least four or six reference specimens of zinc with an impurity level of less than 0,1 %, in mass fraction, may be used. The reference specimens should have dimensions of 50 mm × 100 mm × 1 mm.

Before testing, the reference specimens should be cleaned carefully with a hydrocarbon solvent in order to remove all evidence of dirt, oil, or other foreign matter liable to influence the result of the corrosion rate determination. After drying, the reference specimens should be weighed to the nearest 1 mg.

Protect one face of the reference specimens with a removable coating, for example an adhesive plastic film.

B.2 Arrangement of the reference specimens

At least four reference specimens are positioned in four different quadrants (if six specimens are used, these are placed in six different positions including the four quadrants) in the test cabinet, with the unprotected face upward and at an angle of 20° ± 5° from the vertical.

The support for the reference specimens should be made of, or coated with, inert materials such as plastic, and should be placed at the same level as the test specimens.

The recommended test duration for the NSS test is 48 h, for the AASS test 24 h. and for the CASS test 24 h.

The cabinet should be verified during the testing of test specimens. If this is the case, great care should be taken that the specimens do not affect each other. Otherwise, the cabinet is filled with substitute specimens to maintain the homogeneity of the cabinet. The verification procedure is performed using the same settings as for the test runs.

B.3 Determination of mass loss

Immediately after the end of the test, the protective coating is removed. The corrosion products are then removed by repetitive cleaning as described in ISO 8407. For chemical cleaning of the zinc reference specimens, use a solution of saturated glycine, 250 g ± 5 g of glycine, $C_2H_5NO_2$ (p.a.), per litre of deionized water.

The chemical cleaning procedure is preferably performed in repetitive immersions of 5 min. After each immersion step, thoroughly clean the reference specimen at ambient temperature by rinsing with water and by light brushing, then by rinsing with acetone or ethanol, followed by drying. Weigh the reference specimen to the nearest 1 mg and plot the mass versus the actual cleaning cycle as described in ISO 8407.

From the plot of mass versus number of cleaning cycles, determine the true mass of the specimen after removal of the corrosion products as described in ISO 8407. Subtract this number from the initial mass of the reference specimen prior to testing, and divide the resulting number by the area of the exposed surface of the reference specimen to assess the metal mass loss per square metre of the reference specimen.⌀

B.4 Satisfactory performance of cabinet

The cabinet has performed satisfactorily if the loss in mass of each zinc reference specimen is within the allowed ranges given in Table B.1.

Table B.1 — Allowed range of mass loss of the zinc reference specimens during verification of the corrosivity of the cabinet

Test method	Test duration h	Allowed range of mass loss of the zinc reference specimens g/m^2
NSS	48	50 ± 25
AASS	24	30 ± 15
CASS	24	50 ± 20