INTERNATIONAL STANDARD

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Paints and varnishes — Evaluation of defects on coated surfaces using optical imaging —

Part 4: Evaluation of filiform corrosion

Peintures et vernis — Évaluation par imagerie optique des défauts des surfaces revêtues —

Partie 4: Évaluation de la corrosion filiforme

Reference number
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 21227-4 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*, in collaboration with Technical Committee CEN/TC 139, *Paints and varnishes*.

ISO 21227 consists of the following parts, under the general title *Paints and varnishes — Evaluation of defects on coated surfaces using optical imaging*:

— *Part 1: General guidance*

— *Part 2: Evaluation procedure for multi-impact stone-chipping test*

— *Part 3: Evaluation of delamination and corrosion around a scribe*

— *Part 4: Evaluation of filiform corrosion*

Introduction

Conventional ISO test methods used for evaluating surface defects and appearance changes often utilize pictorial standards which depict particular types of surface deterioration and require human visual evaluation. The technology described in the various parts of this International Standard can yield more objective, accurate, quantitative and reproducible results when compared to the human visual evaluation techniques.

Paints and varnishes — Evaluation of defects on coated surfaces using optical imaging —

Part 4:
Evaluation of filiform corrosion

1 Scope

This part of ISO 21227 describes a method for evaluating filiform corrosion by means of digital optical imaging. The filiform corrosion can be produced in accordance with ISO 4623-1, ISO 4623-2 or EN 3665.

2 Normative references

The following referenced documents are indispensable for the application 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 4623-1, *Paints and varnishes — Determination of resistance to filiform corrosion — Part 1: Steel substrates*

ISO 4623-2, *Paints and varnishes — Determination of resistance to filiform corrosion — Part 2: Aluminium substrates*

ISO 21227-1, *Paints and varnishes — Evaluation of defects on coated surfaces using optical imaging — Part 1: General guidance*

EN 3665, *Aerospace series — Test methods for paints and varnishes — Filiform corrosion resistance test on aluminium alloys*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21227-1 and the following apply.

3.1
filiform corrosion
type of corrosion proceeding under a coat of paint, varnish or related product, in the form of filaments, generally starting from bare edges or from local damage to the coating

NOTE 1 Usually, the filaments are irregular in length and direction of growth, but they may also be nearly parallel and of approximately equal length.

NOTE 2 Filiform corrosion can also occur under other protective coatings.

[ISO 4623-1]

4 Principle

A grey-scale or colour image is produced from the original image of the surface showing filiform corrosion. In the simplest case, this image is converted into a binary image (thresholding). The damaged area and the maximum filament length are measured, and the mean width of the filiform corrosion is calculated.

5 Requirements

5.1 General

The requirements laid down in ISO 21227-1 also apply for this part of ISO 21227.

5.2 Illumination

The illumination shall be such that the damaged area can be clearly distinguished from the undamaged area. Bright-field or dark-field illumination can be used.

NOTE 1 In the case of glossy specimens, directional illumination is suitable. For matt specimens, dark-field illumination is recommended.

NOTE 2 When detecting filiform corrosion without previously removing the coating, directional reflection illumination can be of advantage because of the low contrast. After stripping the coating, filiform corrosion can be readily recognized when using diffuse reflection illumination, provided the contrast is sufficiently high.

5.3 Resolution

The minimum resolution shall be 6 pixels per millimetre.

NOTE Different resolutions, in particular in the case of damage involving a large number of filaments, can lead to different values for the damaged area.

6 Calibration

By calibrating the scale in both the x and y directions (e.g. with an object micrometer or a photographic picture graduated in millimetres), the digitized image can be measured with sufficient accuracy.

7 Procedure

Prepare the test panels in accordance with ISO 4623-1, ISO 4623-2 or EN 3665.

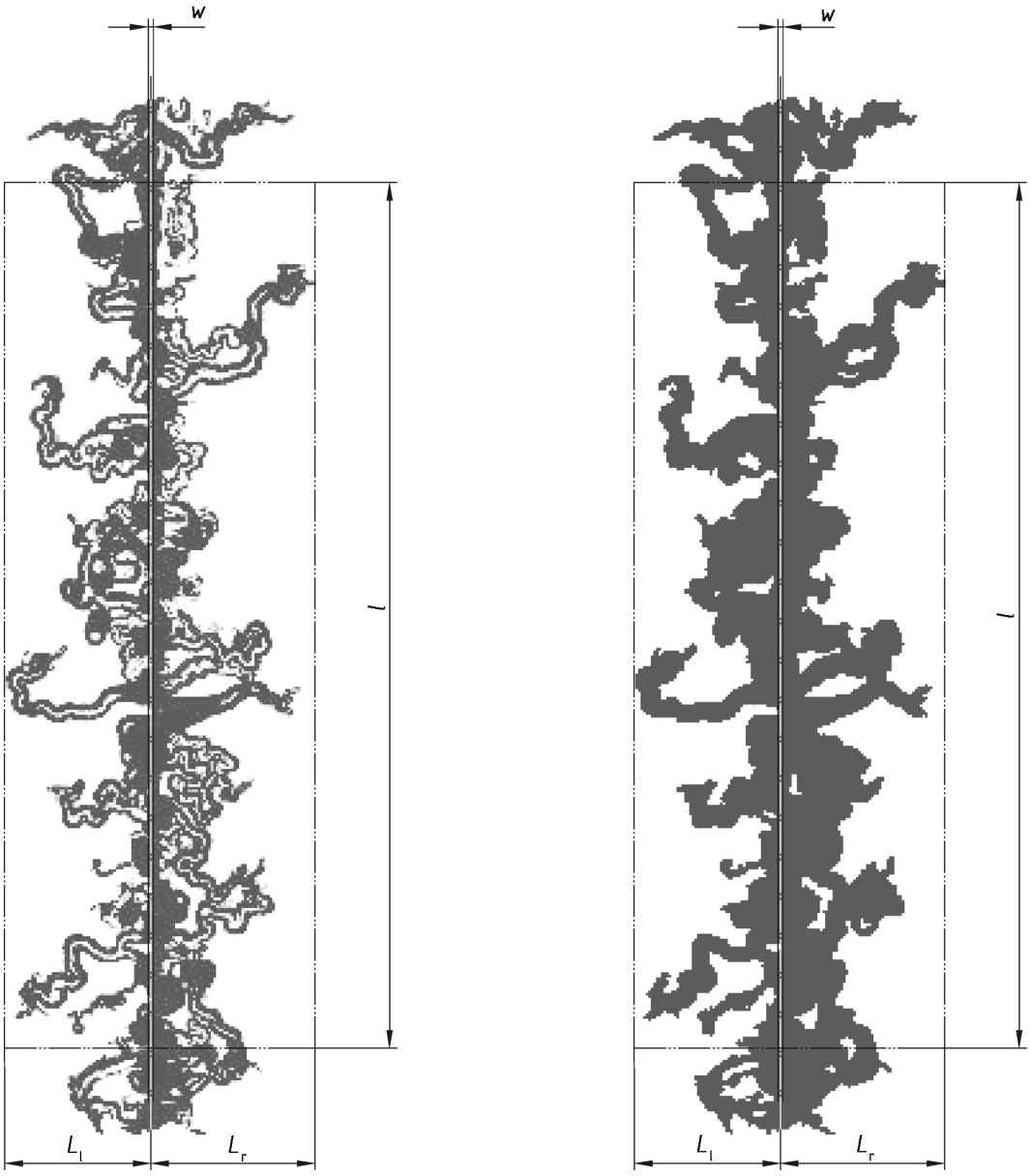
Using the previously calibrated digital optical-imaging system, take a picture of the test panel area containing the scribe and the adjacent damaged area. After suitable threshold setting and damage detection, the digital image provides a value for the damaged area including the area of the scribe. The length of the scribe in the area assessed shall also be determined and indicated in the test report. If the damaged areas at the ends of the scribe differ from the remaining damaged area, these areas are not assessed.

If the test panel contains several scribes (e.g. two intersecting scribes), these can be considered as sections of a single scribe, and the relevant areas and scribe lengths can be added to one another. The area of intersection is not assessed. In the case of scribes perpendicular to each other, indicate the result for both scribes separately, as the scribe running perpendicular to the direction of rolling will show considerably more and longer filiform corrosion than that running parallel to it.

If the scribe width is not known, it shall be measured. If it cannot be measured, the same value (preferably zero) shall be used for all assessments intended to be comparative, and this value shall be quoted in the test report.

8 Image evaluation

In contrast to the manual assessment of filiform corrosion, digital optical imaging can determine directly the size of an area of any shape (see Figure 1). The assessment will thus be more accurate and more reproducible.



a) Original image **b) Binary image**

Key

w width of scribe

l scribe length evaluated

L_l maximum filament length on left-hand side of scribe

L_r maximum filament length on right-hand side of scribe

Figure 1 — Images showing parameters required for assessment

Assuming the scribe width w is known, calculate the area A of the scribe using Equation (1):

$$A = w \times l \tag{1}$$

Calculate the mean width of the filiform corrosion f_A, in millimetres, using Equation (2):

$$f_A = \frac{A_1 - A}{2} \times \frac{1}{l} \tag{2}$$

where

A is the area of the scribe, in square millimetres;

A_1 is the area of the filiform corrosion, including the scribe area, in square millimetres;

l is the scribe length evaluated, in millimetres.

In the case of corrosion involving filaments of irregular length, an extended evaluation in accordance with Annex A is recommended in addition to the above.

9 Precision

Information on the precision of this method is currently not available.

10 Test report

The test report shall contain at least the following information:

a) all information necessary for identification of the coating tested (manufacturer, trade name, batch number, etc.);

b) a reference to this part of ISO 21227 (ISO 21227-4:2008);

c) the type of illumination used (light source, arrangement of lamps);

d) the image acquisition set-up used, including details of the

   1) original image,

   2) optical components used,

   3) resolution,

   4) image size,

   5) grey level/colour depth,

   6) gamma correction;

e) details of the image processing and image analysis, including all processing procedures (filters) used;

f) the scribe length evaluated;

g) the result of the assessment, as indicated in Clause 8;

h) any deviations from the procedure specified;

i) any unusual features (anomalies) observed during the test;

j) the date of the test;

k) the name of the person who carried out the test.

Annex A
(informative)

Extended evaluation

In the case of irregular corrosion, the degree of corrosion can be characterized more closely by reporting the following additional parameters:

a) The so-called g-value, which is a measure of the irregularity of the corrosion and is given by Equation (A.1):

$$g = \frac{A_1 - A}{(L_l + L_r) \times l} \tag{A.1}$$

where

A is the area of the scribe, in square millimetres;

A_1 is the area of filiform corrosion, including the scribe area, in square millimetres;

L_l is the maximum length of the filaments on the left-hand side of the scribe, in millimetres;

L_r is the maximum length of the filaments on the right-hand side of the scribe, in millimetres;

l is the scribe length, in millimetres.

A large g-value is obtained when there are many uniform filaments (as in the case of infiltration of a protective coating by water), the maximum value being 1.

A low g-value is obtained when there is a high degree of irregularity, the minimum value being 0.

b) The maximum filament length on each side of the scribe (see Figure 1).

c) The most frequent filament length (see ISO 4628-10).

Bibliography

[1] ISO 4628-10, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 10: Assessment of degree of filiform corrosion*

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