TECHNICAL
REPORT

ISO
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Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness —

Part 1:
Field test for soluble iron corrosion products

Préparation des subjectiles d'acier avant application de peintures et de produits assimilés — Essais pour apprécier la propreté d'une surface —

Partie 1: Essai in situ pour déterminer les produits de corrosion du fer

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.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 8502-1, which is a Technical Report of type 2, was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*.

The reasons which led to the decision to publish this document in the form of a type 2 Technical Report are explained in the Introduction.

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ISO 8502 consists of the following parts, under the general title *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness*:

- *Part 1: Field test for soluble iron corrosion products* [Technical Report]
- *Part 2: Laboratory determination of chloride on cleaned surfaces*
- *Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)*
- *Part 4: Guidance on the estimation of the probability of condensation prior to paint application*

Annex A of this part of ISO 8502 is for information only.

Introduction

The performance of protective coatings of paint and related products applied to steel is significantly affected by the state of the steel surface immediately prior to painting. The principal factors that are known to influence this performance are:

a) the presence of rust and mill scale;

b) the presence of surface contaminants, including salts, dust, oils and greases;

c) the surface profile.

International Standards ISO 8501, ISO 8502 and ISO 8503 have been prepared to provide methods of assessing these factors, while ISO 8504 provides guidance on the preparation methods that are available for cleaning steel substrates, indicating the capabilities of each in attaining specified levels of cleanliness.

These International Standards do not contain recommendations for the protective coating systems to be applied to the steel surface. Neither do they contain recommendations for the surface quality requirements for specific situations even though surface quality can have a direct influence on the choice of protective coating to be applied and on its performance. Such recommendations are found in other documents such as national standards and codes of practice. It will be necessary for the users of these International Standards to ensure that the qualities specified are:

- compatible and appropriate both for the environmental conditions to which the steel will be exposed and for the protective coating system to be used;

- within the capability of the cleaning procedure specified.

The four International Standards referred to above deal with the following aspects of preparation of steel substrates:

ISO 8501 — Visual assessment of surface cleanliness;

ISO 8502 — Tests for the assessment of surface cleanliness;

ISO 8503 — Surface roughness characteristics of blast-cleaned steel substrates;

ISO 8504 — Surface preparation methods.

Each of these International Standards is in turn divided into separate parts.

Rusted steel substrates, particularly of rust grades C or D (see ISO 8501-1), even when blast-cleaned to preparation grade Sa 3 (see ISO 8501-1 and ISO 8501-2), may still be contaminated by soluble iron corrosion products. These compounds are almost colourless and are localized at the lowest point of the rust pits. If they are not removed prior to painting, chemical reactions can result in large accumulations of rust which destroy the adhesion between the substrate and the applied protective coating.

In surfaces cleaned to preparation grades lower than Sa 2½, it is likely that soluble iron corrosion products will be concealed under layers of iron oxide and will not be detectable until further cleaning is carried out.

In the field, it is difficult to determine accurately the concentration of soluble salts on the substrate present after blast-cleaning. Nevertheless, because a procedure is required for detecting and estimating soluble iron salts, one is described in this type 2 Technical Report. It is given as an aid and is not, at this stage, to be considered as an International Standard, as further experience needs to be gained with the method.

In addition to the procedure described in this Technical Report, other methods of detecting soluble salts are in use, and some of these are described briefly in annex A with a commentary on their advantages and limitations.

Using the swabbing procedures described in clause 5, it has been estimated that the surface concentration detectable is of the order of 10 mg/m^2 of iron(II) ions. In practical use, there are indications that results obtained in the field of less than 15 mg/m^2 are probably insignificant for most coating purposes, but that results of the order of 250 mg/m^2 indicate that it would be undesirable to paint the surface, except if the coated structure is to be maintained in the very driest exposure conditions. Surfaces indicating this latter level of contamination will also generally rapidly re-rust after blast-cleaning in relative humidities above 50 %.

NOTE 1 After carrying out the test, it is advisable to further clean the test area to remove flash rusting before application of a paint system.

It is important, when specifying the maximum permissible amount of surface contamination by soluble iron corrosion products, to avoid imposing unnecessarily strict limits. Lower limits are appropriate only to marine or similar aggressive environments. A requirement for excessively low contamination levels can be very costly and, in many rural and non-industrial inland areas, would be disproportionate to the benefits to be obtained.

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Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness —

Part 1:
Field test for soluble iron corrosion products

1 Scope

This Technical Report describes a field test for the assessment of soluble iron corrosion products on surfaces abrasively blast-cleaned to Sa 2½ or better (see ISO 8501-1 or ISO 8501-2). The test uses indicator test strips that are sensitive to ferrous ions.

This field test is not applicable to manually cleaned steel surfaces.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Technical Report. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Technical Report are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3696:1987, *Water for analytical laboratory use — Specification and test methods.*

ISO 8501-1:1988, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.*

ISO 8501-2:—[1], *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 2: Preparation grades of previously coated steel substrates after localized removal of previous coatings.*

3 Principle

A proportion of the soluble salts on the test substrate is removed by controlled washing of the surface with water. The collected washings are tested for iron(II) ions by the colorimetric reaction with 2,2′-bipyridyl indicator paper.

4 Reagents, apparatus and materials

Use only reagents of recognized analytical reagent grade, and water of at least grade 3 purity in accordance with ISO 3696.

4.1 Indicator test strips for iron(II) ions, prepared by impregnating small paper test strips with 2,2′-bipyridyl. The test strips shall be sensitive within the range 5 mg/l to 250 mg/l. The test strips shall be kept in dry, tightly closed containers when not being used.

Commercial indicator test strips are widely available. If these are used, they shall be calibrated (see 5.1) by immersion in solutions of known iron(II) ion concentration before use.

4.2 Soluble iron(II) salt, e.g. ammonium iron(II) sulfate.

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[1] To be published.

4.3 Sulfuric acid, dilute.

4.4 Three absorbent pads of pure cotton, of mass approximately 2 g to 3 g.

4.5 Two containers (a and b), approximately 400 ml capacity each, one of them (4.5a) containing 50 ml of water and the other (4.5b) empty.

NOTE 2 Plastic bags have been found suitable for site work.

4.6 Small glass rod.

4.7 Ruler and chalk, or other suitable means for marking the test area.

5 Procedure

5.1 Preparation of reference indicator test strips

Calibrate indicator test strips (4.1) for reference use immediately before each series of tests, using the following procedure.

Prepare fresh solutions of soluble iron(II) salt (4.2) with iron(II) concentrations of 5 mg/l, 10 mg/l, 100 mg/l and 250 mg/l and stabilize with dilute sulfuric acid (4.3). If the stability of the soluble iron(II) salt is questionable, determine its iron(II) content by any standard redox method prior to making up the solutions. Into each solution, dip an indicator test strip (4.1), and withdraw and retain for comparison with strips obtained during the test.

5.2 Preparation of the test solution

Carry out the washing procedure described below and the subsequent assessment of the resulting test solution (see 5.3) in duplicate. Minimize contamination with iron salts by wearing clean plastic gloves or by using plastic tweezers, as appropriate.

Following blast-cleaning, mark out a test area measuring approximately 25 000 mm^2 (e.g. 250 mm × 100 mm) using a suitable means (4.7). Soak an absorbent cotton pad (4.4) with the water in the first container (4.5a) and then thoroughly swab the test area with the soaked pad. Take care to avoid water running freely from the pad, especially if the test area is not horizontal. Place the absorbent cotton swab into the second container (4.5b) and repeat the swabbing procedure with a fresh cotton pad. Add any remaining water in the first container to the second container.

Complete the whole swabbing operation in approximately 4 min.

Dry the surface with a dry absorbent cotton pad and place the pad in the second container. Thoroughly mix the three absorbent cotton pads and water, using the glass rod (4.6), to prepare the test solution.

5.3 Assessment of the test solution

Dip an indicator test strip (4.1) into the test solution prepared in 5.2 in the second container (4.5b) and assess the colour against the reference indicator strips (see 5.1).

6 Expression of results

Using 50 ml of water and a test area of 25 000 mm^2 as described in 5.2, twice the iron(II) concentration, in milligrams per litre, indicated by the indicator strip is equal to the concentration of dissolved iron(II) corrosion products in milligrams per square metre.

7 Test report

The test report shall contain at least the following information:

a) a reference to this Technical Report (ISO/TR 8502-1);

b) identification and attitude (e.g. horizontal, vertical, angled) of the area tested;

c) the rust grade and preparation grade of the surface under test;

d) any deviation from the test method specified;

e) the result of the test as indicated in clause 6;

f) the date(s) of the test.

Annex A
(informative)

Other methods of determining soluble iron corrosion products

A.1 General

Recent work in the UK has indicated that the semi-quantitative method of test for ferrous ions, using a swab test for sampling and using test strips that are specific to iron(II) ions (as given in this Technical Report), remains the most suitable for a field test. In addition, soluble-salt contamination on a steel surface is unlikely to be uniformly distributed but largely concentrated in individual pits. The analytical technique requires sampling of a substantial surface area, about 25 000 mm², which could give an assessment of the average contamination of the surface but fail to reveal the presence of pits containing a high concentration of aggressive material.

A number of other field tests for the detection of these salts have been investigated over the past years. These are described in A.2 to A.5.

A.2 Conductivity measurement

This method measures the conductivity of water washings from the blast-cleaned surface. An increase in conductivity could be correlated with the soluble-salt content. This method has the advantage of measuring all soluble salts, e.g. ammonium as well as ferrous. It has the disadvantage of requiring special apparatus for field use.

A.3 Potassium hexacyanoferrate(III) test papers

This method uses test papers impregnated with potassium hexacyanoferrate(III) to indicate the presence of soluble iron salts. The test, described in appendix G of BS 5493:1977, *Code of Practice for protective coating of iron and steel structures against corrosion*, is as follows:

a) Spray a fine mist of water droplets on to a small area of blast-cleaned surface using a hand spray (a scent-spray type of bottle is satisfactory).

b) Allow the water droplets to evaporate and at the moment when they have disappeared but the surface is just perceptibly wet apply a small piece of the test paper and press with the thumb for 2 s to 5 s.

If soluble salts remain, these will be drawn by capillary action into the test paper and will react with the potassium hexacyanoferrate(III) to give "a characteristic prussian blue complex as blue dots on the paper, corresponding to the contaminated pits on the blast-cleaned steel".

The method is simple to use and has the advantage of indicating the exact location of pits containing soluble iron corrosion products. It has the disadvantage that it relies on wetting the surface to the right degree in order to dissolve the salts. Too little water and this will not be achieved, too much water and there is an overall blue coloration over the test paper. Also, the intensity of the blue spots varies according to the sampling procedure and the intensity may remain consistently high even when the actual soluble salt contamination has dropped to a low level. In addition, the test papers deteriorate rapidly during storage and have to be freshly made for each test.

A.4 Corrosion-product indicators in emulsion-type formulations

This method incorporates soluble iron corrosion product indicators, such as potassium hexacyanoferrate(III) or 2,2′-bipyridyl, in a white emulsion-type formulation. This has the possible advantage over the potassium hexacyanoferrate(III) test papers in that the sampling technique may be more efficient. However, the method has the other disadvantages of the potassium hexacyanoferrate(III) method. It can give an overall blue coloration unrelated to the degree of contamination, and it has been found that the indicator deteriorates in storage.

Similarly, if a thick film of a specially formulated white emulsion paint is applied over a contaminated surface, the presence of soluble iron salts is demonstrated by a pattern of flash-rusting developing in the film. As far as is known, no repeatability or reproducibility tests have been carried out on this method but it is understood that it is used by some coating applicators as a "pass/fail" test for critical applications.