INTERNATIONAL STANDARD

ISO 8502-8

First edition
2001-08-01

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

Part 8:
Field method for the refractometric determination of moisture

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

Partie 8: Méthode in situ pour la détermination réfractométrique de l'humidité

Reference number
ISO 8502-8:2001(E)

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Printed in Switzerland

Contents

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 3.

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 part of ISO 8502 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 8502-8 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 12, *Preparation of steel substrates before application of paints and related products*.

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*
- *Part 5: Measurement of chloride on steel surfaces prepared for painting (ion detection tube method)*
- *Part 6: Extraction of soluble contaminants for analysis — The Bresle method*
- *Part 8: Field method for the refractometric determination of moisture*
- *Part 9: Field method for the conductometric determination of water-soluble salts*
- *Part 10: Field method for the titrimetric determination of water-soluble chloride*
- *Part 12: Field method for the titrimetric determination of water-soluble ferrous ions*

The following parts are in the process of preparation:

- *Part 7: Field method for determination of oil and grease*
- *Part 11: Field method for the turbidimetric determination of water-soluble sulfate*
- *Part 13: Field method for the determination of soluble salts by conductometric measurement*

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 system 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 below deal with the stated 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.

The protective properties of paints and related products depend on the type of coating system that is used and on the amount of moisture (often in microscopic layers of water) on the steel surface when the coating is applied.

In sub-clause 5.2 of ISO 12944-7:1998, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 7: Execution and supervision of paint work*, it is specified that coating materials shall not be applied at temperatures below 3 °C above the dew point, determined in accordance with ISO 8502-4. Wet surfaces shall only be painted with those coating materials which are permitted in the technical data sheet or approved by the paint manufacturer.

In many cases, however, application of paint must take place even if there is an obvious risk that the steel surface will not be perfectly dry. This happens not only in hot and humid areas (e.g. Singapore), where the temperature of the steel is often less than 1 °C above the dew point for long periods of time, but also in less extreme environments.

Under these circumstances, a field method for direct measurement of the surface density of moisture (water) can be most helpful and even a must when it comes to the decision “to paint, or not to paint”. This part of ISO 8502 describes such a method.

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

Part 8:

Field method for the refractometric determination of moisture

1 Scope

This part of ISO 8502 describes a field method for the assessment of moisture, usually caused by condensation of water, on steel surfaces prior to application of paint.

The method can be used on flat and slightly curved horizontal and vertical surfaces. The assessment should not be done on surfaces that are exposed to any falling water, e.g. rain, or condensation.

The lowest surface moisture (water) level that can be detected by the method is 4 g/m^2. Refinements for considerably lowering this level are indicated in clause 8.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 8502. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 8502 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

ISO 8502-6:1995, *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 6: Extraction of soluble contaminants for analysis — The Bresle method*

3 Principle

Over a certain part of the steel surface, moisture (usually caused by condensation of water from the atmosphere) is removed from the surface by the Bresle method (see ISO 8502-6), using a mixture of monoethylene glycol and water as solvent. Before and after the removal operation, the mass fraction of the glycol in the glycol-water mixture is measured in a refractometer. From these measurements, the surface density of moisture (water) is then calculated.

4 Reagents

4.1 Water, of at least grade 3 purity as defined in ISO 3696.

4.2 Monoethylene glycol, analytical grade.

5 Apparatus

5.1 Glass bottle (50 ml), with ground-glass stopper.

5.2 Adhesive patch, as specified in subclause 4.1 of ISO 8502-6:1995, size A-1250 unless another standard size is more appropriate.

5.3 Magnetic panel, of the same shape as the compartment in the patch (5.2).

5.4 Plastic brush, of the nail brush, or similar, type.

5.5 Graduated syringe, volume 1 ml unless another size is more appropriate.

5.6 Handheld refractometer, for measurement of the mass fraction of a specific component in a solution, and with a scale covering the relevant range.

The procedure described in this part of ISO 8502 uses a commonly available instrument, called the Brix-meter, designed to measure the concentration of sucrose in aqueous solutions. The smallest scale interval shall correspond to a sucrose concentration of not more than 0,2 %. The scale shall cover at least the range 30 % to 50 %.

When used with solutions other than sucrose in water, as in this case, the Brix-meter gives a reading which is directly proportional to the solute concentration, in this case that of monoethylene glycol in water.

Often, the scale of this type of refractometer is in Brix units. 1 Brix unit is equal to a sucrose concentration in an aqueous solution of 1 %. The Brix unit is not a recognized SI unit.

6 Procedure

6.1 Preparation of sampling area

6.1.1 A zone on the steel surface shall first be selected by the parties interested in the test.

If the steel surface is already clean enough to ensure a tight seal with the patch, the part of the procedure given in 6.1.2 to 6.1.4 need not be carried out.

6.1.2 Place the magnetic panel (5.3) on the steel surface over the test area within the selected zone.

NOTE To avoid the magnetic strip from picking up moisture from the surface, it is possible to use a magnetic strip with a rim (approximately of the same size as the area to be tested). The rim will cover a small part (approximately 20 %) of this area. Due to the precision of the method, this coverage is believed to have a minor effect on the result of the assessment.

6.1.3 Clean an area approximately 12 mm wide around the magnetic panel with the plastic brush (5.4) to remove loose contaminants (dust, rust, etc.).

6.1.4 Remove the magnetic panel.

6.1.5 Remove the protective cover and the central punch-out from the patch.

6.1.6 Press the adhesive patch against the steel surface so that the compartment in the patch covers exactly the test area previously covered by the magnetic panel, with the adhesive rim of the patch over the cleaned area, ensuring that it adheres firmly.

6.2 Preparation of solvent

Prepare the solvent by pouring a suitable volume of water (e.g. 10 ml) and a suitable volume of monoethylene glycol (4.2) (e.g. 20 ml) into the glass bottle (5.1). Stopper the bottle and shake it to mix.

NOTE These suggested proportions represent a compromise; more monoethylene glycol will increase the viscosity, more water will decrease the sensitivity.

6.3 Preparation of refractometer

Before each measurement, check that the prism of the refractometer is clean and dry.

Transfer about 3 drops of the solvent from the bottle (see 6.2) to the refractometer (5.6) and record the reading, n_0 (in %), which is proportional to the initial concentration of monoethylene glycol in the solvent.

6.4 Removal of moisture (water) from the steel surface

Fill the syringe (5.5) with solvent (see 6.2) and empty it back into the glass bottle. Repeat this operation twice, for a total of 3 times.

Fill the syringe with 1 ml of solvent unless another volume is more appropriate.

Insert the needle of the syringe into the compartment between the elastomer film and the steel surface, taking care that the needle passes through the adhesive foam body only and is inserted at the top edge of the patch. Inject the solvent into the compartment using the technique described in ISO 8502-6.

Leave the syringe with its needle inserted for 5 min, pumping the solvent back and forth at least twice a minute.

Finally, suck the solvent including the removed moisture back into the syringe.

6.5 Refractometric measurements

Transfer about 3 drops of the solvent sucked back into the syringe to the refractometer and record the reading, n_1 (in %), which is proportional to the final concentration of monoethylene glycol in the solvent.

7 Expression of results

From the measurements made in 6.5, the surface density of moisture (water), ρ_A, expressed in grams per square metre, is calculated using the following equations.

NOTE The equations imply that the quantity values put into them be complete, i.e. that each quantity be expressed as a numerical value multiplied by the relevant unit, SI or other, and that units other than SI units, if any, then be replaced by the corresponding value expressed in SI units.

$$\rho_\mathrm{A} = \frac{m}{A} \qquad (1)$$

where

m is the mass of moisture (water) removed from that part of the surface which is covered by the patch compartment;

A is the area of that part of the surface.

In this case m is given by

$$m = \rho_{\mathrm{H_2O}} \times \Delta V \tag{2}$$

where

$\rho_{\mathrm{H_2O}}$ is the density of moisture (water) (equal to 1 000 kg/m^3);

ΔV is the volume of moisture (water) removed from the surface in 6.4.

From what is said in 6.3 about proportionality, it follows that

$$\frac{n_0}{n_1} = \frac{V + \Delta V}{V}$$

i.e.

$$\Delta V = V \times \frac{n_0 - n_1}{n_1} \tag{3}$$

where

V is the volume of solvent used in 6.4;

n_0 is the refractometer reading in 6.3;

n_1 is the refractometer reading in 6.5.

From (1), (2) and (3), it follows that ρ_{A}, expressed in kilograms per square metre, is given by the equation

$$\rho_{\mathrm{A}} = \frac{1\,000\,V}{A} \times \frac{n_0 - n_1}{n_1} \tag{4}$$

EXAMPLE If V is equal to 1 ml (see 6.4) and A is equal to 1 250 mm^2 (see 5.2), it follows that

$$\rho_{\mathrm{A}} = 0{,}8 \times \frac{n_0 - n_1}{n_1} \tag{5}$$

where ρ_{A} is expressed in kilograms per square metre (SI units).

Multiplying the numerical value obtained from equation (5) by 10^3 gives ρ_{A} expressed in grams per square metre.

Multiplying the numerical value obtained from equation (5) by 10^2 gives ρ_{A} expressed in milligrams per square centimetre.

Inserting different values of V in equation (4) for other volumes of solvent gives equations similar to equation (5). Three straight lines corresponding to three different equations are plotted in Figure 1.

8 Precision

The accuracy of the determination depends on several factors, such as variations in temperature or the presence of contaminants that are soluble in the solvent used. The presence of insoluble contaminants does not noticeably affect the refractive index. Very little, if anything, has been published on this subject. Practical experience has shown, however, that the variation of most parameters except that of the resolution of the refractometer has a negligible influence on the overall accuracy[1].

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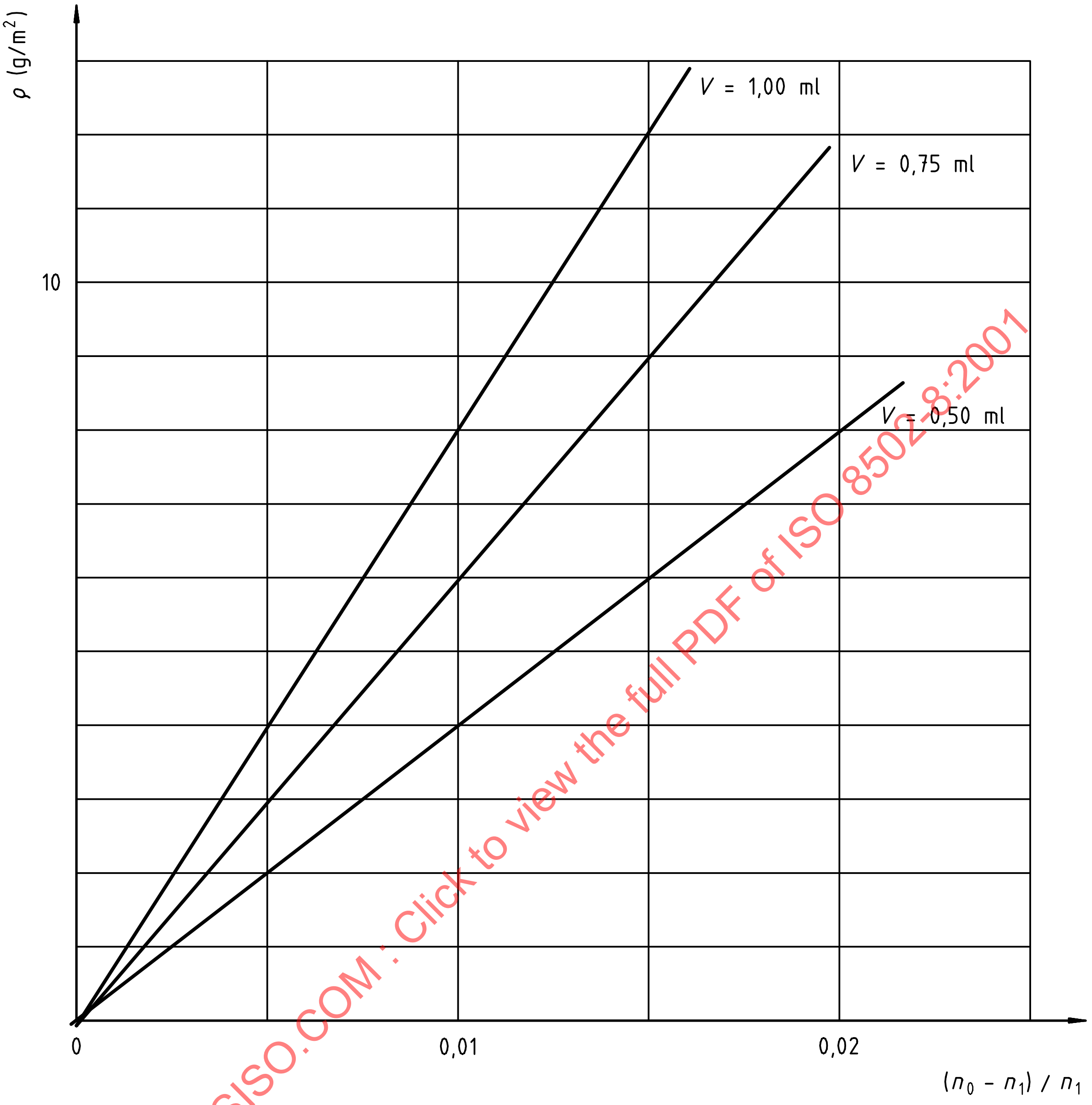
[1] BRESLE, A., Field determination of moisture on metal surfaces, *Industrial Corrosion*, February/March 1994, **2**, pp. 20-21.



NOTE Each straight line corresponds to a different volume of solvent in the syringe. In each case the patch size is A-1250 as defined in ISO 8502-6.

Figure 1 — Surface density of moisture (water), ρ_A, plotted as a function of the ratio $(n_0 - n_1)/n_1$ for patch size A-1250

Obviously, the resolution of the Brix-meter (5.6) is equal to its scale interval or better which means that n_0 and n_1 can each be read to within $\pm$ 0,1 % or less, and consequently that the difference between them, $n_0 - n_1$, can be determined to within an error of $\pm$ 0,2 % or less.

With the solvent as specified (see 6.2) and the commonly encountered amounts of moisture on the surface, i.e. $\rho_\text{A} \leqslant 60$ g/m^2, experience has shown that $n_1 \approx 40$. From equation (4), it follows that ρ_A can be calculated to within $\pm$ 4 g/m^2.

This accuracy implies that the lowest surface density of moisture (water) that can be determined with certainty is 4 g/m^2 when 1 ml of solvent and patch size A-1250 are used.