INTERNATIONAL STANDARD

ISO 15711

First edition
2003-05-15

Paints and varnishes — Determination of resistance to cathodic disbonding of coatings exposed to sea water

Peintures et vernis — Détermination de la résistance au décollement cathodique des revêtements exposés à l'eau de mer

Reference number
ISO 15711:2003(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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 15711 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

Introduction

This International Standard describes two methods for determining the ability of paint or other organic coatings applied to metallic substrates to withstand cathodic disbonding. These methods may also afford a basis for the comparison of particular coatings. The conditions of test are more severe than those likely to be encountered normally and so coating failure may be accelerated. It is recommended that the test be carried out for a period of at least 26 weeks and hence these methods are not suitable as a means of achieving quality control.

The methods are suitable for coatings used for the protection of ships and structures exposed to sea water. Method A is based on the procedure developed and evaluated by COIPM (Comité International Permanent pour la Protection des Matériaux en Milieu Marin).

The test result may be influenced not only by the properties of the coating system under test, but also by the nature and preparation of the substrate, the method of application of the coating system and other factors.

Paints and varnishes — Determination of resistance to cathodic disbonding of coatings exposed to sea water

1 Scope

This International Standard describes two methods for determining the ability of paint, or other organic coatings, applied to metallic substrates to withstand cathodic disbonding when the surface coating may contain or develop discontinuities. The methods are applicable to coatings that are exposed to sea water, such as those applied to ships or marine structures. They are not suitable for the assessment of the ability of coatings to withstand cathodic disbonding on land-based structures.

Method A involves the use of a cathodic protection circuit, whereby the electrode potential of the test substrates is controlled potentiostatically.

Method B involves the use of sacrificial anodes attached to the test substrates. This reflects the practical method of cathodic protection commonly used on ships.

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 554, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 1513, *Paints and varnishes — Examination and preparation of samples for testing*

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

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

ISO 3270, *Paints and varnishes and their raw materials — Temperatures and humidities for conditioning and testing*

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

ISO 4624, *Paints and varnishes — Pull-off test for adhesion*

ISO 4628-2, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 2: Assessment of degree of blistering*

ISO 8501-1, *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 12944-6, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 6: Laboratory performance test methods*

ISO 15528, *Paints, varnishes and raw materials for paints and varnishes — Sampling*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
cathodic disbonding
failure of adhesion between a coating and a metallic surface that is directly attributable to cathodic protection conditions and that is often initiated by a defect in the coating system, such as accidental damage, imperfect application or excessive permeability of the coating

4 Principle

4.1 Method A (impressed current)

A coated test panel is damaged in a defined way. The panel is then exposed in a test tank and connected to a cathodic protection circuit. The effects of exposure are evaluated against criteria which correspond to ISO 12944-6 (e.g. ISO 4628-2 or ISO 4624).

4.2 Method B (sacrificial anode)

A sacrificial metal anode is attached electrically to a metal substrate which has been coated with the test coating/system. The inherent electrochemical nature of the two metals coupled in this manner establishes the test potential.

The coating under test is applied to four panels in total. Two of these panels are protected by the sacrificial metal anodes and the other two, unprotected, panels act as controls. Artificial defects are introduced on all four test panels which are then immersed for six months in sea water.

After the immersion period, the test panels are removed from the sea water and immediately examined for blister formation and creep from the defect. An assessment of the coating's performance under cathodic protection conditions is made by comparing the results from the protected and unprotected panels.

5 Required supplementary information

For any particular application, the test method specified in this International Standard needs to be completed by supplementary information. The items of supplementary information are given in Annex A.

6 Test solutions

6.1 Artificial sea water, conforming to the requirements given in Table 1, shall be used unless otherwise agreed (see 6.2).

Table 1 — Artificial sea water composition

Compound	Concentration g/l
Sodium chloride	23,0
Magnesium chloride hexahydrate	9,8
Sodium sulfate decahydrate	8,9
Calcium chloride	1,2

The formulation shall contain no other additives, e.g. EDTA.

Use water conforming as a minimum to the requirements of grade 2 of ISO 3696, and chemical reagents of analytical grade, for all solutions.

6.2 Natural sea water may be used if specified. If necessary, suspended solids may be removed by filtering through a suitable filter paper.

7 Apparatus

Ordinary laboratory apparatus and glassware, together with the following:

7.1 Method A (impressed current)

7.1.1 Test tank, of glass or other inert material that will not affect the pH of the electrolyte (6.1 or 6.2). The tank, either round of diameter not less than 700 mm or rectangular of minimum side 700 mm, shall have a depth of not less then 200 mm. A system for aerating the electrolyte shall be provided.

7.1.2 Anode, of graphite, with a minimum length of 200 mm and a minimum diameter of 10 mm, or of platinum wire, platinum gauze, platinized titanium or other materials which show sufficient resistance to anodic polarization in sea water.

7.1.3 Reference electrode, such as a saturated calomel or Ag/AgCl electrode, constructed from either glass or plastic, with a porous plug. If an Ag/AgCl or other reference electrode is used, it shall be checked against the saturated calomel electrode and measured potentials corrected in accordance with Table 2.

Table 2 — Potentials of reference electrodes with respect to the standard hydrogen electrode (at 25 °C)

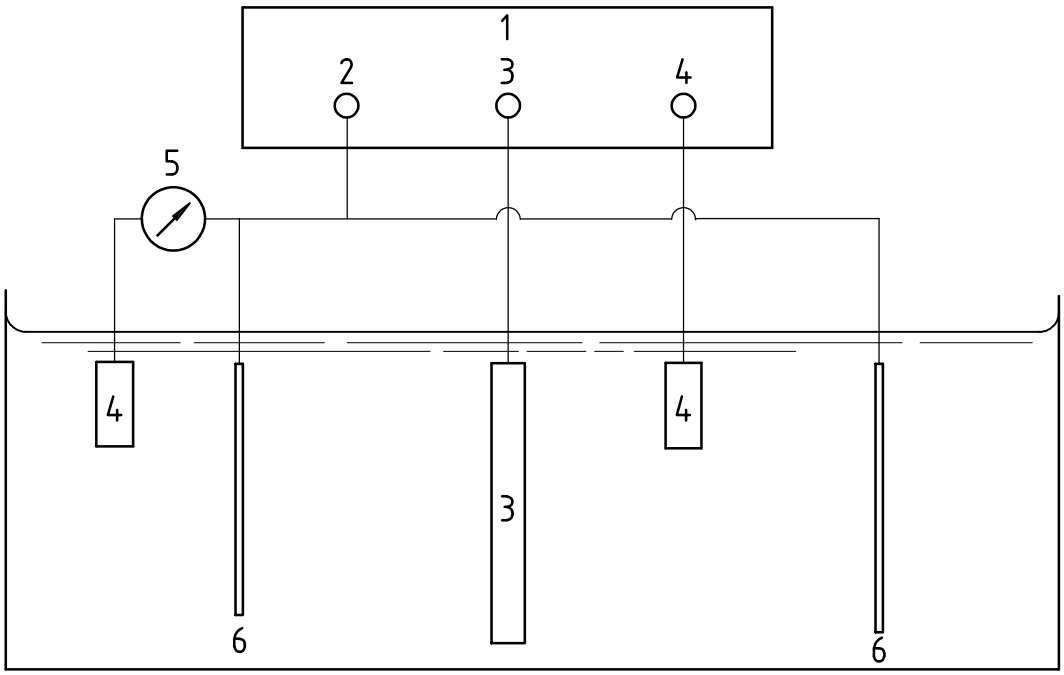
Electrode	Potential V
Copper/copper sulfate	+ 0,32
Silver/silver chloride/saturated KCl	+ 0,20
Silver/silver chloride/sea water	+ 0,25 (approx.)
Calomel (normal KCl)	+ 0,28
Calomel (saturated KCl)	+ 0,25

7.1.4 Voltmeter, with a minimum resistance of 10 MΩ and capable of measuring in the range 0 V to 2 V to the nearest 1 mV.

7.1.5 Cathodic protection circuit, operating from a d.c. supply and capable of maintaining the electrode potential of the test substrate at (– 1 050 ± 5) mV relative to the saturated calomel reference electrode.

The potential should preferably be controlled potentiostatically, but if a potentiostat is not available then a galvanostat may be used. The potential shall be frequently checked and adjusted to ensure that the electrode potential is within the specified limits (see 10.3.1).

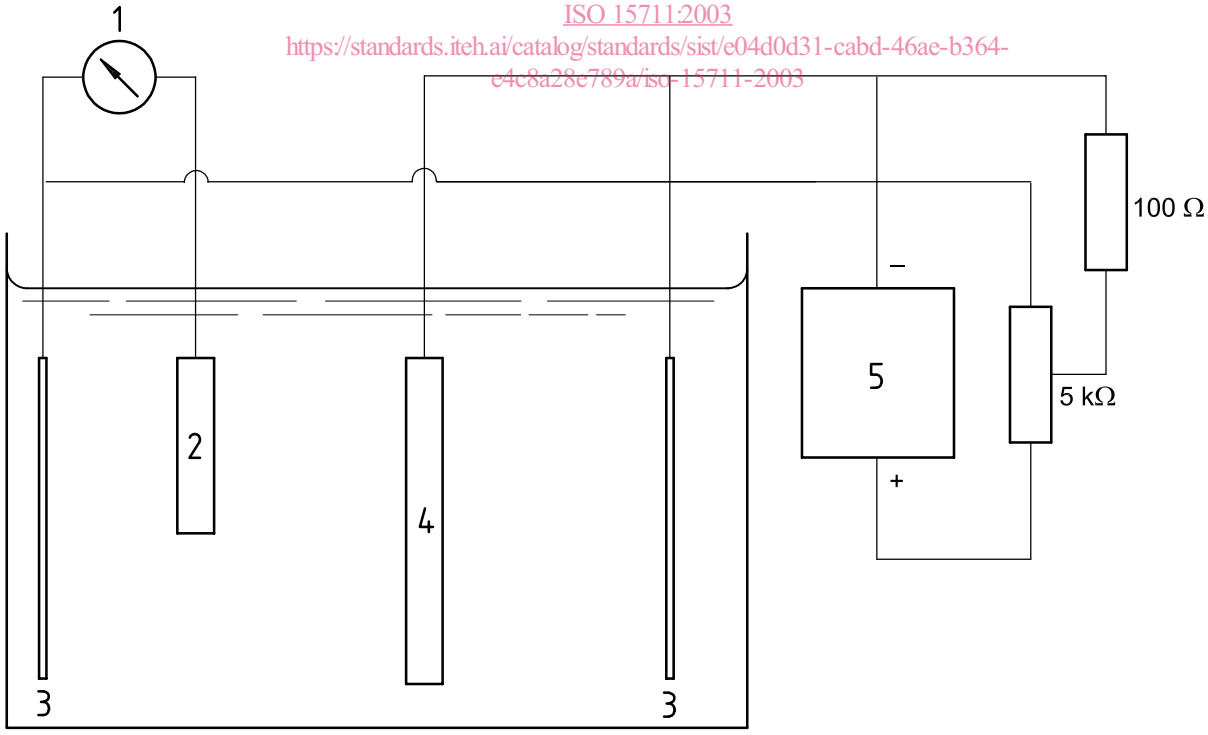
Typical cathodic protection circuits are shown in Figures 1 and 2.



Key

1	potentiostat	4	reference electrode(s)
2	working electrode	5	voltmeter
3	anode	6	test panel

Figure 1 — Potentiostatically controlled cathodic protection circuit



Key

1	voltmeter	4	anode
2	reference electrode	5	d.c. source
3	test panel		

Figure 2 — Galvanostatically controlled cathodic protection circuit

7.2 Method B (sacrificial anode)

7.2.1 Test tanks, made of glass or reinforced plastic, with means for thermostatic temperature control and water circulation/aeration. The capacity of the tanks shall be such that they contain not less than 7,5 l of water per 1 m^2 of panel surface exposed (if the panel spacing specified in 7.2.2 is adopted, the water:panel-area ratio well exceeds this figure). The tanks shall be of a depth such that panels 300 mm in height can be fully immersed with 50 mm of water above the top of the panel.

7.2.2 Test panel racks, non-electrically conductive, to hold panels at no more than 20° to the vertical, at a minimum panel separation of 30 mm, with 50 mm minimum clearance from the tank walls and insulated from the tank bottom. Spacing shall be such that the panels do not come into contact with each other.

7.2.3 Standard drill press and milling cutter/slot drill bit, of 3 mm diameter, for introduction of artificial defects (see 9.5.2).

7.2.4 Electromagnetic dry film thickness meter.

7.2.5 Penknife, for adhesion testing. A knife with a 5 cm to 6 cm blade has been found to be suitable.

7.2.6 Panel edging "tray", of such dimensions as to enable the panel edges to be dipped in along their full length.

7.2.7 Zinc anodes, having a composition as described in Annex B, to provide a potential of ($-$ 1 040 $\pm$ 10) mV relative to a saturated calomel reference electrode. Each anode shall have a hole drilled through the centre (of such diameter as to enable attachment to the steel bolt which has been previously welded to the test panel) and be of approximate dimensions 50 mm $\times$ 40 mm $\times$ 10 mm, to give a mass of (125 $\pm$ 5) g.

If pre-used anodes are to be used, in order to ensure that they are active they shall be cleaned by wire brushing or by immersion in dilute acid to remove corrosion products.

7.2.8 Serrated galvanized mild-steel locking washers and galvanized mild-steel nuts.

7.2.9 pH-monitoring equipment: a pH-meter or pH-papers.

7.2.10 Temperature-monitoring equipment: a thermometer or data-logging device.

8 Sampling

Take a representative sample of the product to be tested (or of each product in the case of a multi-coat system), as specified in ISO 15528.

Examine and prepare each sample for testing, as specified in ISO 1513.

9 Test panels

9.1 Material and dimensions

9.1.1 Method A (impressed current)

Unless otherwise specified, the test panels shall be of the same material and prepared to the same standard as the substrate to which the coating will be applied.

If such test panels are not available, steel test panels conforming to the requirements of ISO 1514 shall be used, prepared in the same manner as the representative substrate.