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Zinc coatings for steel wire

Dépôts de zinc sur fils d'acier

Reference number
ISO 7989 : 1988 (E)

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 7989 was prepared by Technical Committee ISO/TC 17, *Steel.*

Annexes A and B form an integral part of this International Standard.

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Zinc coatings for steel wire

1 Scope

This International Standard specifies requirements for the mass, quality and testing of zinc coatings on steel wire of circular cross-section.

2 Definitions

2.1 zinc-coated wire: Wire to which a coating of zinc has been applied as a protection against corrosion. This can be performed either by dipping in a bath of molten zinc or by electrodeposition of the zinc coat from an aqueous solution of a zinc salt.

2.2 coating mass: Mass of the zinc coating per unit area, expressed in grams per square metre.

3 Coating requirements

3.1 Coating mass

The minimum mass of zinc per unit area of surface shall comply with the requirements of table 1 for the appropriate quality of the coating.

3.2 Coating appearance

The coating shall be continuous and as smooth and evenly distributed as practicable.

NOTE — The coating on hot dip zinc coated wire is not perfectly smooth or devoid of irregularities. Therefore, when measuring the diameter, the smooth parts of the wire should be used.

Table 1 — Coating mass

Diameter of zinc-coated wire[1)] mm from	up to but excl.	Minimum mass of zinc coating, g/m² — Coating[2)] quality: A — AS[3)]	A — AH[3)]	AB	B[4)]	C	D
0,20	0,25	—	—	—	20	20	—
0,25	0,40	—	—	—	30	25	—
0,40	0,50	90	75	60	40	30	—
0,50	0,60	110	90	70	50	35	20
0,60	0,80	120	110	75	60	40	20
0,80	1,00	150	130	90	70	50	20
1,00	1,20	180	150	105	80	60	25
1,20	1,50	200	165	105	90	60	25
1,50	1,90	230	180	120	100	70	30
1,90	2,50	240	205	155	110	80	40
2,50	3,20	260	230	185	125	90	45
3,20	3,60	270	250	230	135	100	50
3,60	4,00	280	250	230	135	100	60
4,00	4,40	290	260	245	135	110	60
4,40	5,20	290	270	245	150	110	70
5,20	8,20	290	290	275	—	110	80
8,20	10,00	300	300	—	—	110	80

1) Before removing the zinc coating.

2) The coating process is not prescribed.

3) Quality AS applies to "soft" wires (tensile strength 660 N/mm² and below).
Quality AH applies to "hard" wires (tensile strength over 660 N/mm²).

4) Quality B is normally produced by drawing after zinc-coating.

3.3 Special finishes

If the purchaser requires a special finish or an exceptionally smooth and/or bright finish, this is to be agreed at the time of enquiry and order.

3.4 Adhesion of coating

When tested in accordance with 4.3, the coating shall remain firmly adherent to the steel base and shall not crack or flake to such an extent that any flakes of coating can be removed by rubbing with the bare fingers. Loosening or detachment during the test of superficial, small particles of zinc formed by mechanical polishing of the surface of the zinc-coated wire shall not be considered cause for rejection.

4 Test requirements

4.1 Selection of samples

4.1.1 The number of coils of wire to be tested shall be agreed at the time of enquiry and order.

4.1.2 A suitable length of wire for performing the required tests shall be cut from one or both ends of each coil selected for sampling. If the ends of the wire are obviously damaged, a sufficient length of wire shall be discarded before taking the test length.

4.2 Determination of coating mass

4.2.1 The determination of the coating mass shall be carried out in accordance with one of the following methods, to be agreed at the time of enquiry and order:

a) the volumetric method described in Annex A;

b) the gravimetric method described in Annex B.

In cases of dispute, the gravimetric method shall be used as the referee test method.

4.2.2 For gravimetric tests on wires 3 mm diameter or larger, the length of the test specimens shall be not less than 200 mm.

NOTE — As a guide to the length for smaller sizes of wire, this should be such that the mass in grams is numerically not less than four times the diameter in millimetres.

4.3 Adhesion test

4.3.1 For wires of nominal diameter 7,5 mm and smaller, the adhesion of the coating shall be tested by wrapping the wire at least six close turns around a cylindrical mandrel. The ratio of mandrel diameter to wire diameter shall be in accordance with table 2.

Table 2

Wire diameter, d mm		Mandrel diameter mm
over	up to and incl.	
—	3,8	$4d$
3,8	10,0	$5d$

4.3.2 For wires over 7,5 mm nominal diameter, the wire shall be bent through an angle of at least 90° around the mandrel. The ratio of mandrel diameter to wire diameter shall be in accordance with table 2.

Annex A
(normative)

Determination of mass of zinc deposited per unit surface area (volumetric method)

A.1 Principle

The zinc coating of a test specimen of wire of given dimensions is dissolved in hydrochloric acid solution. The mass of zinc so dissolved is determined by measuring the volume of hydrogen released during dissolution of the coating (gas volumetric method). By relating the mass of zinc determined in this way to the surface area of the test specimen, measured after dissolving the coating, the mass of zinc deposited per unit surface area is obtained.

A.2 Reagents

A.2.1 Hydrochloric acid, solution of suitable concentration.

A.2.2 Inhibitor, for example, hexamethylene tetramine ($C_6H_{12}N_4$), antimony(III) chloride ($SbCl_3$) or antimony(III) oxide (Sb_2O_3).

A.3 Apparatus

The apparatus used consists of the following elements (see figure A.1):

A.3.1 Tube, graduated in millimetres at least, with a tap at each end.

A.3.2 Flask, with a nozzle near the bottom connected by a rubber tube to a nozzle near the bottom of the graduated tube as shown in figure A.1.

A.3.3 Beaker, for holding the test specimen after removal of the zinc coating.

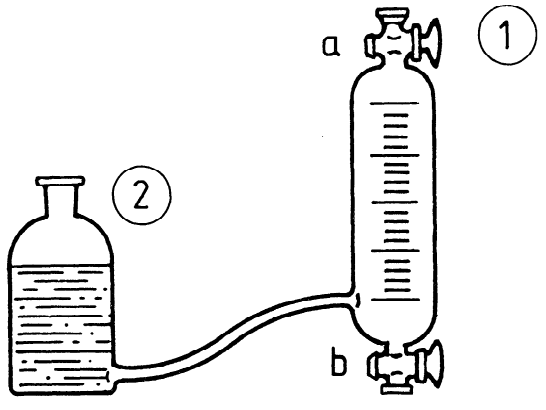

Figure A.1 — Apparatus for determination of coating mass (volumetric method)

A.4 Preparation of test specimens

After carefully straightening the samples of wire, test specimens shall be cut to a length of

300 mm for wires less than 1,00 mm in diameter;

150 mm for wires 1,00 to 1,49 mm in diameter;

100 mm for wires 1,5 to 3 mm in diameter;

50 mm for wires more than 3 mm in diameter.

Care shall be taken that these lengths are measured accurately.

A.5 Procedure

With tap "b" closed, the graduated tube and part of the flask are filled with hydrochloric acid solution (A.2.1) containing a suitable inhibitor (A.2.2).

The level of the liquid in the graduated tube (A.3.1) is raised to just under tap "a" by raising the acid reservoir flask (A.3.2). The level in the tube and flask should be the same.

After introducing the test specimen into the graduated tube through tap "a", tap "a" is closed and the hydrogen released by the action of the acid on the zinc coating is accumulated in the upper part of the graduated tube.

When hydrogen is no longer released, the flask is lowered in relation to the graduated tube so as to bring the levels of the solution in the tube and in the flask into the same plane. The position of the meniscus of the liquid in the tube then indicates the volume of hydrogen released.

The remaining part of the solution contained in the graduated tube is collected in the flask by placing the flask on a table and opening tap "a".

Tap "b" is then opened so that the test specimen can be extracted into the beaker (A.3.3). The test specimen is washed and carefully wiped before measuring its length and diameter.

The test is carried out on one test specimen at a time, the temperature in the tube being held at 20 °C ± 2 °C.

A.6 Expression of results

The result is determined after testing of all test specimens

The mass m, in grams per square metre, of zinc deposited per unit of surface area, is given by the equation

$$m = \frac{2\,720\ V}{\pi\ d.l}$$

where

d is the diameter, in millimetres, of the uncoated wire;

l is the length, in millimetres, of the test specimen;

V is the mean volume, in millilitres, of hydrogen released during each of the tests.

Where the barometric pressure is known to be outside the range 740 to 780 mmHg[1)], the right-hand side of the equation above shall be multiplied by the factor $p/760$, where p is the barometric pressure, in conventional millimetres of mercury.

In practice, tables allow the mass of zinc per square metre of the surface of the uncoated wire to be read directly as a function of the diameter of the wire and the volume of hydrogen released.

1) 1 mmHg = 133,322 Pa

Annex B
(normative)

Determination of mass of zinc deposited per unit surface area (gravimetric method)

B.1 Principle

The zinc coating on a surface of known area is dissolved in inhibited acid and the resultant loss in mass is determined by weighing the test specimen before and after the coating is dissolved.

B.2 Stripping solution

WARNING — Care must be exercised in handling the stripping solution in view of the toxicity of antimony compounds.

Dissolve about 3,2 g of antimonous chloride ($SbCl_3$) or 2 g of antimony(III) oxide (Sb_2O_3) in 500 ml of concentrated hydrochloric acid (ϱ = 1,190 g/ml). Dilute this solution with distilled water to 1 litre.

B.3 Procedure

Where necessary, the test specimen shall be degreased with an organic solvent that does not attack the coating, and then dried.

Before stripping, the test specimen shall be weighed to an accuracy better than 1 % of the presumed coating mass.

The quantity of stripping solution taken shall be measured so that at least 10 ml of solution is available for each square centimetre of the surface of the test specimen. The test specimen shall be completely immersed in the solution at room temperature and left until the coating has completely dissolved. The end of the dissolution process can be recognized by the cessation of the originally brisk evolution of hydrogen. The test specimen shall then be rinsed in running water and, if necessary, brushed to remove any loose substances which may be adhering to the surface, dipped in alcohol, quickly dried and again weighed to the previously stated accuracy.

The surface area A of the exposed surface shall then be determined, to an accuracy of 1 %, by measuring the dimensions of the test specimen.

B.4 Calculation of coating mass

The loss in mass Δm, in grams, is obtained from the equation

$$\Delta m = m_1 - m_2$$

where

m_1 is the mass, in grams, of the test specimen before stripping;

m_2 is the mass, in grams, of the test specimen after stripping.

The mass per unit area, m_A, in grams per square metre, of the coating is obtained, from the equation

$$m_A = \frac{\Delta m}{A} \times 10^6 \qquad \text{(see note)}$$

where Δm is expressed in grams and A in square millimetres.

NOTE — With steel wire, it is often advantageous to calculate the mass per unit area m_A of the zinc coating in grams per square metre using the equation

$$m_A = 1\,960 \times D \times \frac{\Delta m}{m_2}$$

where D is the diameter, in millimetres, of the wire after stripping, and the density of the steel is taken as 7 850 kg/m^3.

In this way, it is not necessary to know the length of the wire.

The reproducibility (different observers, different apparatus and different operating conditions) is about ± 5 % of the mean value.

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