BRITISH STANDARD

BS EN
12329:2000

Corrosion protection of metals — Electrodeposited coatings of zinc with supplementary treatment on iron or steel

The European Standard EN 12329:2000 has the status of a British Standard

ICS 25.220.40

National foreword

This British Standard is the official English language version of EN 12329:2000. It supersedes BS 1706:1990 which is withdrawn.

CAUTION EN 12329 was approved as a European Standard as it received the requisite support amongst the 19 member bodies of the European Committee for Standardization (CEN). The UK therefore has an obligation to implement EN 12329 as its national standard and to withdraw BS 1706 with which it conflicts. However, attention is drawn to the fact that the UK did not support this standard on the basis of possible safety implications, these being related to the commencement of heat treatment as described in clause 6. The UK concern is that once a sub-microscopic crack forms in the coated article, at present there is no means for its detection and it cannot be "removed". Following the initiation of a sub-microscopic crack no subsequent heat treatment can repair the damage already sustained. It is essential therefore that the delay in applying heat treament is as short as practicable. The UK recommendation therefore was to amend the requirement in clause 6 to "heat treatment shall commence as soon as possible, preferably within 1 h, but not later than 3 h after plating" in accordance with those conditions given in ISO 9588. The recommendation was not accepted by the CEN Technical Committee responisble for the development of EN 12329.

The UK participation in its preparation was entrusted to Technical Committee STI/33, Electrodeposited and related coatings, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 16, an inside back cover and a back cover.

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English version

Corrosion protection of metals – Electrodeposited coatings of zinc with supplementary treatment on iron or steel

Protection contre la corrosion des métaux – Revêtements électrolytiques de zinc avec traitement complémentaire sur fer ou acier

Korrosionsschutz von Metallen – Galvanische Zinküberzüge auf Eisenwerkstoffen mit zusätzlicher Behandlung

This European Standard was approved by CEN on 3 February 2000.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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EUROPÄISCHES KOMITEE FÜR NORMUNG

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 262, Metallic and other inorganic coatings, the Secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2000, and conflicting national standards shall be withdrawn at the latest by September 2000.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

Electrodeposited coatings of zinc can be chromate treated in order to retard the formation of corrosion products on surfaces of coatings exposed to corrosive atmospheres. When corrosion protection is the main purpose of the coating, the usual practice is to apply a chromate or other conversion coating on top of the electrodeposited zinc coating. This is particularly effective in retarding the formation of white corrosion products which form on zinc coatings under certain conditions (see annex A).

Certain types of chromate conversion coating can be coloured in order to facilitate identification of the treated articles.

1 Scope

This European Standard specifies requirements for electrodeposited coatings of zinc on iron or steel with supplementary treatment.

This European Standard does not specify chromate finishes which are required only for improving the adhesion of paints or varnishes.

NOTE This European Standard is not intended to be used alone, but is the complement of EN 1403. It is necessary for the purchaser to specify the zinc electrodeposited coating in accordance with the designation as specified in EN 1403.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

prEN ISO 3497, *Metallic coatings — Measurement of coating thickness — X-ray spectrometric methods (ISO/DIS 3497:1998).*

prEN ISO 3543, *Metallic and non-metallic coatings — Measurement of thickness — Beta backscatter method (ISO/DIS 3548:1998).*

EN 1403:1998, *Corrosion protection of metals — Electrodeposited coatings — Method of specifying general requirements.*

EN ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods (ISO 1461:1999).*

EN ISO 1463, *Metallic and oxide coatings — Measurement of coating thickness — Microscopical method (ISO 1463:1982).*

EN ISO 2177, *Metallic coatings — Measurement of coating thickness — Coulometric method by anodic dissolution (ISO 2177:1985).*

EN ISO 2178, *Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method (ISO 2178:1982).*

EN ISO 2360, *Non-conductive coatings on non-magnetic basis metals — Measurement of coating thickness — Eddy current method (ISO 2360:1982).*

EN ISO 2819, *Metallic coatings on metallic substrates — Electrodeposited and chemically deposited coatings — Review of methods available for testing adhesion (ISO 2819:1980).*

EN ISO 3613:1994, *Chromate conversion coatings on zinc and cadmium — Test methods (ISO 3613:1980).*

EN ISO 3892, *Conversion coatings on metallic materials — Determination of coating mass per unit area — Gravimetric methods (ISO 3892:1980).*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests.*

3 Terms and definitions

For the purposes of this standard the terms and definitions given in EN 1403 apply.

4 Information to be supplied by the purchaser

The information to be supplied by the purchaser shall be as specified in EN 1403. In addition, the purchaser shall use the designation specified in clause 5.

5 Designation

5.1 General

The appropriate designation according to the severity of service conditions which the coating has to withstand (see annex B) shall be used.

NOTE Examples of designations are given in annex C.

5.2 Heat treatment

The heat treatment designation as described in EN 1403 shall be used (see clause 6).

5.3 Supplementary treatments

5.3.1 Chromate conversion coatings

The codes for chromate conversion coatings given in annex B shall be used.

NOTE See annex A for more information on chromate conversion coatings.

5.3.2 Other supplementary treatments

Treatments carried out after chromating to enhance corrosion resistance (sealants) or provide colour (dyes) shall be specified in the designation using the symbols given in EN 1403.

NOTE See the introduction, A.2 and A.5 for more information on sealing and dyeing.

6 Heat treatment

Any heat treatment for the relief of hydrogen embrittlement shall be carried out before a chromate conversion coating is applied. Heat treatment shall be carried out as soon as possible after coating and in any case within 4 h.

NOTE 1 Heat treatment procedures and classes are specified in ISO 9587 for stress relieving before processing and in ISO 9588 for embrittlement relief after processing, but other conditions may be specified by the purchaser.

NOTE 2 Heat treatment in accordance with the recommended conditions can never guarantee complete freedom from hydrogen embrittlement.

7 Requirements

7.1 General

All tests (including corrosion resistance tests) shall be deferred until the expiry of a period of 24 h after the chromating process has ended.

NOTE Chromate conversion coatings harden with age by gradual dehydration. They should therefore be handled carefully for the first 24 h after the treatment.

7.2 Appearance

Over the significant surface, the electroplated articles shall be free from clearly visible plating defects such as blisters, pits, roughness, cracks or unplated areas. See also 4.1 d) of EN 1403:1998.

Parts which have been given supplementary treatment shall be free from untreated areas on the significant surface.

7.3 Thickness

7.3.1 Minimum local thickness

When tested in accordance with one of the following standards the minimum local thickness of the zinc coating on articles having a significant surface area of greater than 1 cm^2 shall conform to that specified in its designation: EN ISO 1463, EN ISO 2177, EN ISO 2178, EN ISO 2360, prEN ISO 3497, prEN ISO 3543.

NOTE Before using the method specified in EN ISO 2177, it is necessary to remove the chromate or other supplementary treatment using a very mild abrasive, for example a paste of levigated alumina or magnesium oxide. In the case of heavy conversion coatings, the results will, therefore, be slightly low.

7.3.2 Average thickness

For articles having a significant surface area of less than 100 mm^2, the minimum local thickness shall be deemed to be the minimum value of the average determined by the method specified in annex D.

7.4 Adhesion

7.4.1 Adhesion of zinc coating

When tested by the burnishing test in accordance with EN ISO 2819 the zinc coating shall have good adhesion.

7.4.2 Adhesion of coloured chromate coating

Coloured chromate coatings shall be tested in accordance with 3.6 of EN ISO 3613:1994.

7.5 Corrosion resistance

When tested in accordance with the neutral salt spray (NSS) test described in ISO 9227 for the times given in Tables 1 and 2, the test surface shall remain free from red corrosion product (see Table 1) or white corrosion product (see Table 2) when examined by the unaided eye or corrected vision. Slight staining of the test surface shall not be a cause of rejection. The test surface shall comprise those parts of the significant surfaces of the test specimens that can be touched by a ball 20 mm in diameter or as otherwise specified by the purchaser (see clause 4).

NOTE Red corrosion indicates corrosion of the basis metal and white corrosion indicates corrosion of the zinc coating.

Table 1 — Corrosion resistance of the combined coating (zinc coating plus chromate conversion coating)

(Partial) designation	Service condition number	Neutral salt spray test time (h)
Zn5/A Zn5/B Zn5/F	0	48
Zn5/C Zn5/D Zn8/A Zn8/B Zn8/F	1	72
Zn8/C Zn8/D Zn12/A Zn12/F	2	120
Zn12/C Zn12/D Zn25/A Zn25/F	3	192
Zn25/C Zn25/D	4	360

Table 2 — Corrosion resistance of the chromate conversion coating before corrosion of the underlying zinc coating

Chromate conversion coating code	Neutral salt spray test time (h)	
	Barrel plated parts	Rack plated parts
A	8	16
B	8	16
C	72	96
D	72	96
F	24	48

Annex A
(informative)

Chromate conversion coatings

A.1 General

Chromating solutions are usually acidic and contain hexavalent chromium salts together with other salts which can be varied to affect the appearance and hardness of the film. Clear, bleached, iridescent, olive-green and black films on zinc coating can be obtained by processing in appropriate solutions. Transparent films can also be obtained by bleaching iridescent films in alkaline solutions or in phosphoric acid. Table A.1 gives the approximate mass per unit area for each type of chromate conversion coating when measured in accordance with EN ISO 3892.

Table A.1 — Chromate conversion coating type, appearance and mass per unit area

Type		Coating mass per unit area
Code	Name	g/m^2
A[a]	Clear	$\leq 0,5$
B[b]	Bleached	$\leq 1,0$
C	Iridescent	$> 0,5$ to $\leq 1,5$
D	Opaque	$> 1,5$
F	Black	$> 0,5$ to $\leq 1,0$

[a] A need not contain chromium in hexavalent form.

[b] B is a two-stage process.

A.2 Sealing

In order to give better protection against corrosion, chromate conversion coatings can be post-treated with sealing agents, by introducing organic products into the chromate film. This operation also enhances the resistance of the chromate conversion coating to higher temperatures.

Sealing can be carried out by dipping or spraying the conversion coating with polymers in aqueous solutions. A similar process is based on the addition of suitable organic products to the chromating solution.

A.3 Rinsing and drying

If hot water is used as the final rinse after the chromating process, the time of rinsing should be kept as short as possible in order to prevent the dissolution of the hexavalent chromium. The drying of the article should be carried out at a temperature compatible with the type of chromating used in order to prevent cracking due to dehydration of the chromate coating (in general, the maximum drying temperature is 60 °C).

A.4 Processing of parts in bulk

If parts are processed in bulk by electroplating and chromating in barrels, the corrosion resistance of the chromate coating is reduced by a degree which is reflected in the salt spray test requirements given in Table 2.

A.5 Dyeing

If required, chromate conversion coatings of types A or B can be dyed with organic dyes to produce coloured finishes suitable for identification purposes. The process is carried out by dipping in or spraying with aqueous solutions of the appropriate organic dye (see the introduction).

Annex B
(normative)

Choice of designation

B.1 Selection

The appropriate designation shall be selected according to the severity of service conditions which the coating has to withstand (see Table B.1).

Table B.1 — (Partial) designation, service condition numbers and service conditions

(Partial) designation	Service condition number	Service conditions
Zn5/A Zn5/B Zn5/F	0	Purely cosmetic applications
Zn5/C Zn5/D Zn8/A Zn8/B Zn8/F	1	Service indoors in warm dry atmospheres
Zn8/C Zn8/D Zn12/A Zn12/F	2	Service indoors in places where condensation may occur
Zn12/C Zn12/D Zn25/A Zn25/F	3	Service outdoors in temperate conditions
Zn25/C Zn25/D	4	Service outdoors in severe corrosive conditions, e.g. marine or industrial

NOTE 1 In any particular environment, the protective value of a zinc coating increases with the coating thickness, but for any particular coating thickness, the corrosion resistance can be enhanced by the use of appropriate chromate treatments.

NOTE 2 When very long service life is required, as for example on structural steel components, the thicker zinc coatings required can be applied by hot-dip zinc coating in accordance with EN ISO 1461, for example.

B.2 Chromate conversion coatings

The code of the chromate conversion coating shall conform to Table B.2.

Table B.2 — Chromate conversion coating types and typical appearance

Type		Typical appearance
Code	**Name**	
A[a]	Clear	Transparent, clear to bluish
B[b]	Bleached	Transparent with slight iridescence
C	Iridescent	Yellow iridescent
D	Opaque	Olive-green
F	Black	Black

[a] A need not contain chromium in hexavalent form.

[b] B is a two-stage process.

Annex C
(informative)

Examples of designations

EXAMPLE 1 Designation of an electrodeposited coating of 12 μm zinc (Zn12) on iron or steel (Fe) which has had an iridescent chromate conversion coating (C) applied:

Electrodeposited coating EN 12329 - Fe//Zn12//C

EXAMPLE 2 Designation of an electrodeposited coating of 25 μm zinc (Zn25) on iron or steel (Fe) which has been heat treated for hydrogen embrittlement relief for 2 h at 190 °C (HT(190)2) and has been given a supplementary opaque chromate conversion coating (D) followed by a sealing treatment consisting of the application of organic sealant (T2):

Electrodeposited coating EN 12329 - Fe//Zn25/HT(190)2/D/T2

NOTE These examples do not include the standard designation of the basis metal as recommended in 5.2 of EN 1403:1998.

Annex D
(normative)

Measurement of average thickness of coating on small articles

D.1 Materials

Suitable stripping solutions are listed below [items a) to e)].

WARNING Antimony trioxide (Sb_2O_3) dissolved in hydrochloric acid and antimony trichloride ($SbCl_3$) are toxic. Avoid contact with the skin.

Stibine (SbH_3), which is a very toxic gas, may be released during the stripping process when using either solution A or B, and stringent precautions should be taken to avoid breathing it. Carry out the stripping process in a fume cupboard.

Formaldehyde solution is toxic, irritant and causes burns. Avoid breathing the vapour. Avoid contact with the skin and eyes.

a) Solution A comprises 2,0 g antimony trioxide (Sb_2O_3) dissolved in 800 ml hydrochloric acid (ρ = 1,16 g/ml to 1,19 g/ml) and diluted with 200 ml distilled or de-ionized water.

b) Solution B comprises 3,2 g antimony trichloride ($SbCl_3$) dissolved in 800 ml hydrochloric acid (ρ = 1,16 g/ml to 1,19 g/ml) and diluted with 200 ml distilled or de-ionized water.

c) Solution C comprises 10 ml formaldehyde (solution of mass fraction 30 %) dissolved in 500 ml hydrochloric acid (ρ = 1,16 g/ml to 1,19 g/ml) and diluted with 500 ml distilled or de-ionized water.

d) Solution D comprises 300 g/l ammonium nitrate (NH_4NO_3).

e) Solution E comprises 1 g propan-2-ol-1 (C_3H_3OH) dissolved in 500 ml hydrochloric acid (ρ = 1,16g/ml to 1,19 g/ml) and diluted with 500 ml distilled or de-ionized water.

WARNING Do not re-use parts stripped in accordance with annex D.

D.2 Procedure

For articles having a significant surface area of less than 1 cm^2, take a sufficient number of articles to give a mass of coating not less than 100 mg. Weigh the articles, to the nearest milligram, and strip off the zinc coating at room temperature using a suitable stripping solution. When solution A or solution B is used, the articles shall be removed from the solution as soon as the zinc coating has completely dissolved, i.e. as soon as the vigorous chemical reaction has ceased.

WARNING The stripping solutions have hazards associated with them and the precautions given in D.1 should be carefully observed.

Rinse the articles in running water, if necessary brushing to remove any loose dark deposit (of antimony when using solution A or solution B) from the surface, dry carefully and reweigh, noting the loss in mass. Calculate the thickness of the zinc coating, d, in micrometres, from the following equation:

$$d = \frac{m \times 10^3}{A\rho}$$

where

m is the loss in mass, in milligrams;

A is the area of the surface under examination, in square millimetres;

ρ is the density of the zinc coating, in grams per cubic centimetre, normally 7,1 g/cm^3.

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