INTERNATIONAL STANDARD

ISO 10683

Second edition
2014-05-15

Fasteners — Non-electrolytically applied zinc flake coatings

Fixations — Revêtements non électrolytiques de zinc lamellaire

Reference number
ISO 10683:2014(E)

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Published in Switzerland

Contents

Page

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 2, *Fasteners*, SC 14, *Surface coatings*.

This second edition cancels and replaces the first edition (ISO 10683:2000). The main technical changes are the following:

— wider application to all types of fasteners and all parties involved, see Introduction, Clause 1, 4.1, 4.3, Clause 7 and Annex A;

— full description of zinc flake coating systems, see 4.1, 4.2 and A.1.2;

— definitions related to coatings for fasteners moved to the new standard ISO 1891-2;

— detailed specification in relation with hexavalent chromium;

— detailed specification concerning pre-treatment in relation with internal hydrogen embrittlement, see 4.4;

— precedence of corrosion resistance over thickness, see 5.2 and 5.3;

— extended range of properties for coatings and related test methods (including Kesternich test, thickness and weight determination, torque/tension relationship, determination of hexavalent chromium), see 5.3, 7.3, 7.7, 7.8 and A.2;

— consideration related to bulk handling, automatic processes, storage and transport, see 5.4 and A.4;

— alternatives for gaugeability and assemblability/mountability, see 6.2.2;

— revised arrangement of tests to be carried out for each lot, for in-process control or when specified, see Clause 8;

— revised designation for coating systems and addition of labelling, see Clause 9;

— consideration related to design aspects and assembly of coated fasteners, see new Annex A;

— detailed specification for coating thickness and thread clearance for ISO metric threads, moved to new Annex B;

— precise control of corrosivity for the salt spray cabinet for coated fasteners, see new Annex C.

Introduction

The revision of ISO 10683:2000 was made in order to define the relevant requirements on zinc flake coated fasteners (coating systems with and without hexavalent chromium) for all parties involved in the fastener field, i.e. chemical suppliers, coaters, fastener manufacturers, distributors and end users. It covers all types of fasteners, i.e. fasteners with ISO metric thread, fasteners with non-ISO metric thread (including thread forming, ASME inch 60° screw thread, etc.) and non-threaded fasteners (including washers, pins, clips, etc.). It also provides basic advice for the design and use of coated fasteners in assembly.

Fasteners — Non-electrolytically applied zinc flake coatings

1 Scope

This International Standard specifies requirements for non-electrolytically applied zinc flake coatings for steel fasteners. It applies to coatings:

— with or without hexavalent chromium;

— with or without top coat;

— with or without lubricant (integral lubricant and/or subsequently added lubricant).

National regulations for the restriction or prohibition of certain chemical elements should be taken into account in the countries or regions concerned.

It applies to bolts, screws, studs and nuts with ISO metric thread, to fasteners with non-ISO metric thread, and to non-threaded fasteners such as washers, pins, clips, etc.

NOTE Coatings in accordance with this International Standard are especially used for high strength fasteners (≥1 000 MPa) to avoid risk of internal hydrogen embrittlement (see 4.4).

Information for design and assembly of coated fasteners is given in Annex A.

This International Standard does not specify requirements for such fastener properties as weldability or paintability. It does not apply to mechanically applied zinc coatings.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1463, *Metallic and oxide coatings — Measurement of coating thickness — Microscopical method*

ISO 1502, *ISO general-purpose metric screw threads — Gauges and gauging*

ISO 1891-2, *Fasteners — Terminology — Part 2: Vocabulary and definitions for coatings*[1)]

ISO 3269, *Fasteners — Acceptance inspection*

ISO 3613:2010, *Metallic and other inorganic coatings — Chromate conversion coatings on zinc, cadmium, aluminium-zinc alloys and zinc-aluminium alloys — Test methods*

ISO 6988, *Metallic and other non organic coatings — Sulfur dioxide test with general condensation of moisture*

ISO 8991, *Designation system for fasteners*

ISO 9227:2012, *Corrosion tests in artificial atmospheres — Salt spray tests*

ISO 16047, *Fasteners — Torque/clamp force testing*

1) To be published.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1891-2 apply.

4 General characteristics of the coating

4.1 Zinc flake coating systems

Zinc flake coating systems are produced by applying a zinc flake dispersion to the surface of a steel fastener, usually with the addition of aluminium flakes, in a suitable medium. Under the influence of heat (curing), a bonding amongst flakes and also between flakes and substrate is generated, thus forming an inorganic surface coating sufficiently electrically conducting to ensure cathodic protection. The coating may or may not contain hexavalent chromium, Cr(VI).

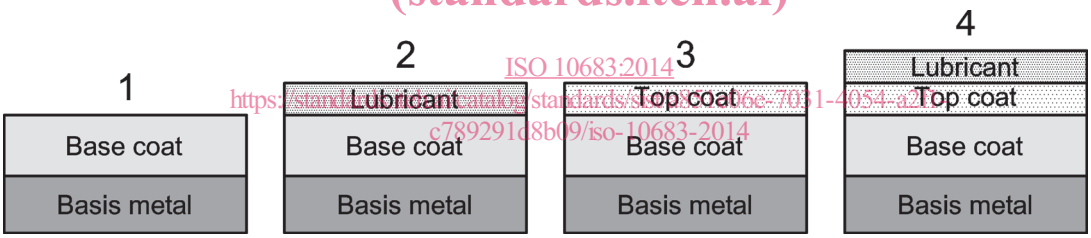
Special techniques may be necessary to avoid excessive or insufficient coating thickness.

Special techniques may be necessary to prevent lightweight and/or flat fasteners from sticking together (e.g. washers, clips, fasteners with captive washer, flanged nuts).

An additional top coat can be applied to increase corrosion resistance and/or to achieve specific properties (e.g. torque/tension properties, chemical resistance, aspect, colour, electrical insulation/conductivity – see A.2).

4.2 Composition of the systems

There are four basic zinc flake coating systems as shown in Figure 1.



Key

1 only base coat
2 base coat + lubricant
3 base coat + top coat
4 base coat + top coat + lubricant

Figure 1 — Basic zinc flake coating systems

Base coat and top coat can be with integral lubricant, see detailed possible combinations in A.1.2.

4.3 Mechanical and physical properties and curing

The coating process shall not adversely influence the mechanical and physical properties of the fasteners.

NOTE Distributors who coat non-coated fasteners are considered as alteration coating distributors in accordance with ISO 16426.[9]

Depending on the zinc flake coating system, the curing temperatures can be up to 320 °C. The curing temperature shall not be above the tempering temperature of quenched and tempered fasteners.

WARNING — The curing process (especially with higher temperature and/or longer duration) may affect the fatigue limit of fasteners with thread rolled after heat treatment. See also A.1.3 for other possible effects of curing.

4.4 Avoidance of internal hydrogen embrittlement

A characteristic of zinc flake coating systems is that hydrogen is not generated during the deposition process.

Pre-treatment processes using alkaline/solvent cleaner followed by mechanical cleaning do not generate hydrogen, thus eliminating all risk of internal hydrogen embrittlement (IHE).

When mechanical cleaning is not suitable for functional reasons (e.g. for fasteners with captive washers, fasteners with internal threads, fasteners to be rack coated), chemical cleaning (pickling) may be applied, provided that acid with suitable inhibitor and minimum cleaning cycle time are used to minimize the risk of internal hydrogen embrittlement. Fasteners with hardness greater than 385 HV or property class 12.9 and above shall not be subjected to acid cleaning. The duration between cleaning and coating shall be as short as possible.

A phosphating process is permitted as an alternative to mechanical cleaning (hydrogen may be generated during this pre-treatment process, however the curing process allows outward diffusion). The duration between phosphating and coating shall be as short as possible.

Cathodic cleaning processes are not permitted.

NOTE Zinc flake coatings have a high permeability for hydrogen which, during the curing process, allows outward diffusion of hydrogen which may have been absorbed during the pre-treatment process as specified in this subclause.

4.5 Coating systems and coating processes

The type and geometry of the fasteners shall be considered when selecting a coating system and the related coating process, see A.2.

5 Corrosion protection and testing

5.1 General

Corrosion resistance in accelerated corrosion tests cannot be directly related to corrosion protection behaviour in particular service environments. However, accelerated tests are used to evaluate the corrosion resistance of the coating.

5.2 Neutral salt spray test

The neutral salt spray test (NSS) in accordance with ISO 9227:2012, 5.2, is used to evaluate the corrosion resistance of the coating systems. For coated fasteners, the salt spray cabinet shall be controlled in accordance with Annex C.

The neutral salt spray test shall be carried out on fasteners alone, not sooner than 24 h after coating in the "as-coated" condition, i.e. before sorting, packaging and/or assembling.

After the neutral salt spray test using test duration of Table 1 there shall be no visible basis metal corrosion (red rust).

Table 1 — Standard categories for neutral salt spray test

Neutral salt spray test duration (without red rust)	Reference thickness of the coating system[a]
240 h	4 µm
480 h	5 µm
600 h	6 µm
720 h	8 µm
960 h	10 µm

[a] The reference thickness includes base coat(s) and top coat(s) if any, with or without Cr(VI). The corrosion resistance shall be decisive for acceptance, the reference thickness is given for guidance only.

The composition of the system (base coat only, base coat + top coat, etc.) shall be specified at the time of the order.

NOTE Guidance for the selection of coating thickness in relation to corrosion protection is given in Annex B.

5.3 Sulfur dioxide test (Kesternich test)

This test is only intended for outdoor building fasteners.

The sulfur dioxide test with general condensation of moisture in accordance with ISO 6988 is used to evaluate the corrosion resistance of the coating systems; for outdoor building fasteners, the test shall be carried out with two litres of SO_2.

The sulfur dioxide test shall be carried out on fasteners alone, no sooner than 24 h after coating in the "as-coated" condition, i.e. before sorting, packaging and/or assembling.

The minimum number of cycles shall be agreed between the supplier and the purchaser at the time of the order, i.e. 2 cycles, 3, 5, 8, 10, 12, 15 cycles, etc.

5.4 Bulk handling, automatic processes such as feeding and/or sorting, storage and transport

Bulk handling, automatic processes such as feeding and/or sorting, storage and transport can cause a significant reduction of corrosion protection depending on the coating system and type and geometry of the fasteners. This may especially occur for Cr(VI)-free coating systems where less self-healing effect takes place and/or where top coats are sensitive to impact damage and/or abrasion.

When necessary, an agreement should be reached between the supplier and the purchaser, e.g. by reducing the minimum duration to neutral salt spray test and/or by increasing the thickness of the coating system.

6 Dimensional requirements and testing

6.1 General

Before coating, fasteners shall be within the specified dimensions. For ISO metric threads special requirements may apply, see 6.2.2, B.4 and B.5.

6.2 Bolts, screws, studs and nuts with ISO metric threads

6.2.1 Coating thickness

When considering the coating thickness related to the desired corrosion resistance, the dispersion of the thickness of the coating system shall be taken into account, see B.3.

Coating thickness has a significant influence on gaugeability, therefore thread tolerance and clearance in the thread shall be taken into account. The coating shall not cause the zero line (basic size) to be exceeded in the case of external threads; nor shall it fall below in the case of internal threads, see B.4.

NOTE For standard bolts, screws, studs and nuts not specifically manufactured to accommodate zinc flake coatings, see B.4 and B.5.

6.2.2 Gaugeability and assemblability

Coated ISO metric screw threads shall be gauged in accordance with ISO 1502 with a GO-gauge of tolerance position h for external threads and H for internal threads.

When gauging a coated external thread, a maximum torque of 0,001 d^3 (Nm) is acceptable, where d is the nominal thread diameter in millimetres, see Table 2.

Table 2 — Maximum torque for gauging of coated ISO metric screw threads

Nominal thread diameter, d	Maximum torque for gauging[a]
mm	Nm
4	0,06
5	0,13
6	0,22
8	0,51
10	1,0
12	1,7
14	2,7
16	4,1
18	5,8
20	8,0
22	11
24	14
27	20
30	27
33	36
36	47
39	59

[a] For other diameters, the torque shall be calculated in accordance with 0,001 d^3 (Nm) and rounded to 2 digits.

Other acceptance procedures may be applied by agreement between supplier and purchaser:

— for external thread, use of a suitable nut or the original mating fastener;

— for internal thread, use of a suitable mandrel or the original mating fastener.

6.3 Other fasteners

There is no standard dimensional requirement for non-ISO metric threaded coated fasteners and non-threaded coated fasteners. For additional information, see A.3.

7 Mechanical and physical properties and testing

7.1 Appearance

The colour of zinc flake coating is originally silver-grey. Other colours can be obtained by using a top coat. Variation in colour shall not be cause of rejection unless otherwise agreed, see Clause 10 h).

The coated fastener shall be free from blisters and uncoated areas which may adversely affect the corrosion protection. Local excess of coating shall not impair functional properties (see Clause 6 and A.2).

7.2 Corrosion resistance related to temperature

Elevated temperature can affect the corrosion protection of the coated fasteners. This test is specified for in-process control, it is not intended to check the behaviour of the coated fasteners together with the assembled parts.

After heating the coated fasteners for 3 h at 150 °C (fastener temperature) the corrosion resistance requirements as specified in Clause 5 shall still be met.

Other specifications may be agreed at the time of the order.

7.3 Test methods for thickness or coating weight determination

Coating thickness or coating weight shall be determined using one of the following test methods:

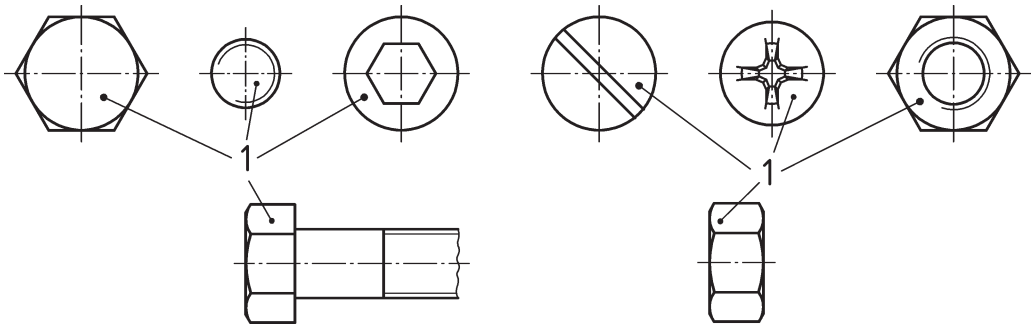
— magnetic inductive techniques (determination of the total local thickness, on measuring areas);

— X-ray techniques (this method is only capable to determine the local thickness of the base coat, on measuring areas);

— chemical or mechanical removal of the coating system (determination of the average total coating weight of the fastener);

— microscopic method in accordance with ISO 1463 (determination of the total local thickness, on any area(s) of the fastener).

In case of dispute, the microscopic method in accordance with ISO 1463 shall be used. The thickness shall be measured on the reference areas specified in Figure 2, unless otherwise agreed.



a) Reference areas for threaded fasteners