SLOVENSKI STANDARD

oSIST prEN ISO 14713-2:2019

01-maj-2019

Cinkove prevleke - Smernice in priporočila za zaščito železnih in jeklenih konstrukcij proti koroziji - 2. del: Vroče pocinkavanje (ISO/DIS 14713-2:2019)

Zinc coatings - Guidelines and recommendations for the protection against corrosion of iron and steel in structures - Part 2: Hot dip galvanizing (ISO/DIS 14713-2:2019)

Zinküberzüge - Leitfäden und Empfehlungen zum Schutz von Eisen- und Stahlkonstruktionen vor Korrosion - Teil 2: Feuerverzinken (ISO/DIS 14713-2:2019)

Revêtements de zinc - Lignes directrices et recommandations pour la protection contre la corrosion du fer et de l'acier dans les constructions - Partie 2: Galvanisation à chaud (ISO/DIS 14713-2:2019)

Ta slovenski standard je istoveten z: **prEN ISO 14713-2**

ICS:

25.220.40	Kovinske prevleke	Metallic coatings
91.080.10	Kovinske konstrukcije	Metal structures
91.080.13	Jeklene konstrukcije	Steel structures

oSIST prEN ISO 14713-2:2019 **en**

DRAFT INTERNATIONAL STANDARD
ISO/DIS 14713-2

ISO/TC **107**/SC **4** | Secretariat: **BSI**

Voting begins on: **2019-03-08** | Voting terminates on: **2019-05-31**

Zinc coatings — Guidelines and recommendations for the protection against corrosion of iron and steel in structures —

Part 2: **Hot dip galvanizing**

Revêtements de zinc — Lignes directrices et recommandations pour la protection contre la corrosion du fer et de l'acier dans les constructions —

Partie 2: Galvanisation à chaud

ICS: 25.220.40

This document is circulated as received from the committee secretariat.

ISO/CEN PARALLEL PROCESSING

Reference number
ISO/DIS 14713-2:2019(E)

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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 14713-2 was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*, Subcommittee SC 4, *Hot dip coatings (galvanized, etc.)*.

This second edition cancels and replaces ISO 14713-2:2009, which has been technically revised

ISO 14713 consists of the following parts, under the general title *Zinc coatings — Guidelines and recommendations for the protection against corrosion of iron and steel in structures:*

— *Part 1: General principles of design and corrosion resistance*

— *Part 2: Hot dip galvanizing*

— *Part 3: Sherardizing*

The principal changes in this revised edition compared to ISO 14713-2:2009 are the following:

— Minor technical changes to Table 1 and addition of two new notes to Table 1.

— Improvements to the clarity of recommendations throughout Clause 6.

— Extensive revisions to the Figures contained in Annex A.

— Addition of Tables A.1, A.2 and A.3 in Annex A.

— Other minor technical and editorial changes.

Zinc coatings — Guidelines and recommendations for the protection against corrosion of iron and steel in structures —

Part 2:
Hot dip galvanizing

1 Scope

This part of ISO 14713 provides guidelines and recommendations regarding the general principles of design which are appropriate for articles to be hot dip galvanized after fabrication (e.g., to ISO 1461) for corrosion protection, for example, articles manufactured in accordance with EN 1090-2.

The protection afforded by the hot dip galvanized coating to the article will depend upon the method of application of the coating, the design of the article and the specific environment to which the article is exposed. The hot dip galvanized article can be further protected by application of additional coatings (outside the scope of this part of ISO 14713), such as organic coatings (paints or powder coatings). When applied to hot dip galvanized articles, this combination of coatings is often known as a “duplex system”.

Specific product-related requirements (e.g. for hot dip galvanized coatings on tubes or fasteners, etc.) will take precedence over these general recommendations.

This standard does not apply to hot dip galvanized coatings applied to continuous sheet (e.g. to EN 10346).

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 1461, *Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods*

ISO 8044, *Corrosion of metals and alloys — Basic terms and definitions*

ISO 2080, *Metallic and other inorganic coatings — Surface treatment, metallic and other inorganic coatings — Vocabulary*

ISO 10684, *Fasteners — Hot dip galvanized coatings*

ISO 12944-5, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 5: Protective paint systems*

EN 10210-1, *Hot finished structural hollow sections of non-alloy and fine grain steels — Part 1: Technical delivery requirements*

EN 10219-1, *Cold formed welded structural hollow sections of non-alloy and fine grain steels — Part 1: Technical delivery requirements*

EN 10240, *Internal and/or external protective coatings for steel tubes — Specification for hot dip galvanized coatings applied in automatic plants*

EN 1090-2:2018, *Execution of steel structures and aluminium structures — Part 2: Technical requirements for steel structures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8044 and the following apply.

3.1
hot dip galvanizing
formation of a coating of zinc and/or zinc/iron alloys on iron and steel products by dipping prepared steel or cast irons in the zinc melt

3.2
hot dip galvanized coating
coating obtained by hot dip galvanizing

Note 1 to entry: The term “hot dip galvanized coating” is subsequently referred to as the “coating”.

4 Design for hot dip galvanizing

4.1 General

It is essential that the design of any article required to be finished should take into account not only the function of the article and its method of manufacture but also the limitations imposed by the finish. Annex A illustrates some of the important design features, some of which are specific to hot dip galvanizing.

Some internal stresses in the articles to be galvanized will be relieved during the hot dip galvanizing process and this may cause deformation or damage of the coated article. These internal stresses arise from the finishing operations at the fabrication stage, such as cold forming, welding, oxy-cutting or drilling, and from the residual stresses inherited from the rolling mill. The purchaser should seek the advice of the hot dip galvanizer before designing or making a product that is subsequently to be hot dip galvanized, as it may be necessary to adapt the construction of the article for the hot dip galvanizing process.

4.2 Surface preparation

The design and the materials used should permit good surface preparation. This is essential for the production of a high-quality coating (see 6.2).

Graphite exposed at the surface of iron castings interferes with wetting by molten metal and those castings that have been annealed may have silica particles in the surface layers which have to be removed in order to obtain a good-quality hot dipped coating. Grit blasting is recommended both before and after annealing.

4.3 Procedures related to design considerations

The hot dip bath and associated plant should be of adequate capacity to process the articles to be hot dip coated with zinc. Preferably, articles should be designed to enable coating in a single dipping operation. Articles that are too large for the available baths may be partially immersed and then reversed for length or depth, so that a complete coating is obtained. Partial immersion (and then dipping for a second time to complete the coating) is less common than the single, complete immersion operation.

All work has to be secured during immersion in the baths. Arrangements for lifting and handling should be made before articles are delivered to the galvanizer. When necessary, the customer should consult the galvanizer and advise any limitations (e.g. on the use of existing holes). Lifting lugs are often incorporated to assist general handling.

Articles may be held in racks or jigs. Some contact marks may be visible after hot dip galvanizing in such cases. The dipping operation involves vertical movement out of the bath, but the parts being withdrawn may be inclined at an angle. The processing sequence requires circulation of air, pretreatment liquids and zinc to all surfaces of the article. Air pockets prevent local surface preparation and give uncoated surfaces; liquids in enclosed air vaporize at the hot dip galvanizing temperature of about 450 °C and the force generated can cause buckling or explosions; excess zinc may adhere poorly, may look unattractive and is wasteful.

Suitable articles, e.g. heat exchangers and gas cylinders, may be hot dip galvanized on the outside only. This involves special techniques and equipment (e.g. to push the article into the bath against the buoyancy of the molten zinc) and a specialist galvanizer should be consulted in advance.

Hot dip galvanizing of hollow sections ensures protection of both internal and external surfaces. Small amounts of trapped zinc ash may be unavoidable within hollow sections and, for certain shapes and designs cannot be removed.

4.4 Design features

Preferred design features for articles to be hot dip galvanized are shown in Annex A.

WARNING — It is essential that sealed compartments be avoided or be vented, otherwise there is a serious risk of explosion that may cause serious injury to operators. This aspect of design shall be given careful consideration and is essential in order to maintain satisfactory standards of health and safety for operators.

The provision of holes for venting and draining tubular fabrications also allows a coating to be formed on the inside surfaces and therefore ensures better protection for the article. Occasionally, at sufficiently high levels of residual stress in the article, stress relief may occur at the hot dip galvanizing temperature. This is one of the main causes of unexpected distortion or cracking of the steel article. Symmetrical sections are preferred and, as far as possible, large variations in thickness or cross-section, e.g. thin sheet welded to thick angles, should be avoided, welding and fabrication techniques should be chosen to minimize the introduction of unbalanced stresses and differential thermal expansion should be minimized during welding and processing. Heat treatment may be desirable before hot dip galvanizing. The purchaser should discuss with the galvanizer the requirements for coating and assembly of fabricated articles. Compact sub-assemblies (which occupy minimum bath space) are most economical to galvanize. Welding is preferable before hot dip galvanizing, to ensure a continuous hot dip galvanized coating over the weld.

Articles should be designed so as to assist the access and drainage of molten metal and so that air locks are avoided. A smooth profile, avoiding unnecessary edges and corners, assists hot dip galvanizing. This, combined with bolting after galvanizing, improves long-term corrosion resistance.

Holes which are necessary in structures for the hot dip galvanizing process are preferably made before assembly and by cutting or grinding off corners of sections; this facilitates the absence of “pockets” in which excess molten zinc can solidify. When already assembled, burning may be the optimum method of producing holes, as the space available for drilling may not allow the hole to be close enough to the edge or corners.

Internal venting of hollow sections should be avoided. If internal venting is unavoidable, it shall be agreed in advance with the galvanizer and the customer shall ensure that:

(1) the holes are of maximum possible size;

(2) provision for internal venting is adequately documented (e.g., by photography) before assembly.

4.5 Tolerances

The thickness of the hot dip coating is determined mainly by the nature and thickness of the steel. On mating surfaces and at holes, extra tolerance should be provided to allow for the thickness of the coating metal. For hot dip galvanized coatings on flat surfaces, an allowance of at least 1 mm has been found satisfactory. See ISO 1461 for definitions of significant surfaces and acceptance criteria for the coating. For threaded work, for example, for hot dip galvanized and centrifuged nuts and bolts, current practices differ according to the country. See 7.1.

5 Design for storage and transport

Hot dip galvanized articles should be stacked securely so that the articles can be handled, stored and transported safely.

Where there is a specific need to minimize the development of wet-storage staining (primarily basic zinc oxide and zinc hydroxide, formed on the surface of the galvanized coating during storage of articles in humid conditions), this should be communicated by the purchaser to the galvanizer at the time of ordering and any relevant control measures should be agreed upon.

Such measures might include, for example: storage of articles such that free movement of air across the surfaces of the article is allowed; the use of spacers to minimize contact areas on the work; chemical post-treatment, or avoidance of close nesting of work (where the design allows this). Shrink wrapping may lead to water retention within the articles and subsequent wet-storage staining.

In accordance with ISO 1461, the presence of wet-storage staining shall not be a cause for rejection, provided the coating thickness remains above the specified minimum requirements at the time of acceptance inspection.

6 Effect of article condition on quality of hot dip galvanizing

6.1 General

Most steels can be hot dip galvanized according to ISO 1461. This includes unalloyed carbon steels (see e.g. EN 10025-2), fine-grained steels (see e.g. EN 10025-3 and EN 10025-4), quenched and tempered steels, hollow sections that are hot finished (see e.g. EN 10210-1), hollow sections that are cold finished (see e.g. EN 10219-1), reinforcement steels (see e.g. EN 10080), fastener grade steels (see e.g. ISO 898), grey cast iron (see e.g. EN 1561) and malleable cast iron (see e.g. EN 1562). Where other ferrous metals are to be galvanized, adequate information or samples should be provided by the purchaser for the galvanizer to decide whether these steels can be satisfactorily galvanized. Sulfur-containing free-cutting steels are normally unsuitable.

6.1.1 Material composition

Certain elements, in particular silicon (Si) and phosphorus (P), in the steel surface can affect hot dip galvanizing by prolonging the reaction between iron and molten zinc. Therefore, certain steel compositions can achieve more consistent coatings with regard to appearance, thickness and smoothness. The prior history of the steel (e.g. whether hot rolled or cold rolled) can also affect its reaction with molten zinc. Where aesthetics are important or where particular coating thickness or surface smoothness criteria exist, specialist advice on steel selection should be sought prior to fabrication of the article or hot dip galvanizing.

Table 1 gives simplified guidance on steel compositions that are associated with certain typical coating characteristics when galvanizing is carried out at temperatures of 440 °C to 460 °C.

6.1.2 Castings

Castings should be as free as possible from surface porosity and shrinkage holes and should be cleaned by grit blasting, electrolytic pickling or by other methods especially suitable for castings. Conventional hydrochloric acid pickling does not remove mould-sand deposits, graphite or temper carbon from the surface of cast iron. Grit blasting is necessary to remove these contaminants. Surface cleaning of complex shapes can be undertaken by specialist galvanizing companies using hydrofluoric acid. Care needs to be exercised in the design of cast-iron sections. Small castings of simple shape and solid cross-section do not present problems for galvanizing, provided that the material and surface condition are suitable. Larger castings should have a balanced design with uniform section thicknesses to avoid distortion and cracking due to thermal stress. Large fillet radii and pattern numbers should be used and sharp corners and deep recesses avoided.

The rough surface finish which castings tend to possess may result in thicker galvanized coatings than on rolled articles.

NOTE Castings can take several forms:

— grey iron castings: grey iron has a carbon content of greater than 2 %, the majority of which is graphite in flake form;

— spheroidal graphite (SG) castings: similar to grey iron in many aspects of composition but with carbon present primarily as graphite in spheroidal form, initiated by additions of magnesium or cerium;

— malleable iron castings: black-heart, white-heart and pearlitic. The toughness and workability are derived from annealing processes and no primary graphite is permissible.

Table 1 — Coating characteristics related to steel composition

Category	Typical levels of reactive elements	Additional information	Typical coating characteristics
A	≤ 0,03 % Si and < 0,02 % P	See Note 1 and Note 4	Coating has a shiny appearance with a finer texture. Coating structure includes outer zinc layer.
B	≥ 0,14 % Si to 0,25 % Si	Other elements may also affect steel reactivity. In particular, phosphorus levels greater than 0,035 % will give increased reactivity.	Coating can have shiny or matt appearance. Coating structure can include outer zinc layer or iron-zinc alloy can extend through to the coating surface depending on steel composition.
C	> 0,03 % Si to < 0,14 % Si	Excessively thick coatings may be formed.	Coating has a darker appearance with a coarser texture. Iron/zinc alloys dominate coating structure and often extend to the coating surface, with reduced resistance to handling damage.
D	> 0,25 % Si	Coating thickness increases with increasing silicon content.	

NOTE 1 Steels with compositions satisfying the formula Si ≤ 0,03% and Si + 2,5P ≤ 0,09 % are also expected to exhibit these characteristics. For cold rolled steels, these characteristics are expected to be observed when the steel composition satisfies the formula Si + 2,5P ≤ 0,04 %.

NOTE 2 The presence of alloying elements (e.g. nickel or aluminium) in the zinc melt can have a significant effect on the coating characteristics indicated in this table. This table does not provide relevant guidance for high-temperature galvanizing (i.e., immersion in molten zinc at 530 °C to 560 °C).

NOTE 3 The steel compositions indicated in this table will vary under the influence of other factors (e.g., hot rolling) and the boundaries of each range will vary accordingly.

NOTE 4 Steels with compositions < 0,01 % silicon that also have aluminium contents > 0,035 % can exhibit lower reactivity that could result in a lower than expected coating thickness. These steels might exhibit reduced levels of coating cohesion.

NOTE 5 The design of the article to be galvanized may also influence coating characteristics.

6.2 Surface condition

The surface of the basis metal should be clean before dipping into the molten zinc. Degreasing and pickling in acid are the recommended methods of cleaning the surface. Excessive pickling should be avoided. Surface contamination that cannot be removed by pickling, e.g. carbon films (such as rolling oil residues), oil, grease, paint, some weld anti-spatter sprays, welding slag, labels, glues, marking materials, fabrication oils and similar impurities, should be removed prior to pickling as this may otherwise lead to uncoated areas after galvanizing. Weld anti-spatter sprays that are not removed during degreasing and pickling should be avoided. Silicone-free sprays are preferred and the excessive use of welding spray should be avoided. Burnt-on suds- type cutting fluids and burnt-on weld anti-spatter sprays

