ICS 24. 220.40

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NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

中华人民共和国国家标准

GB/T 13912–2002

Replace GB/T 13912–1992

Metallic coatings—Hot dip galvanized coatings on fabricated iron and steel articles—Specifications and test methods

金属覆盖层 钢铁制件热浸镀锌层 技术要求及试验方法

(ISO 1461: 1999, Hot dip galvanized coatings on fabricated iron and steel articles-Specifications and test methods, MOD)

Issued on April 10, 2002 **Implemented on December 01, 2002**

Issued by General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China

Content

Foreword

This national standard is modified in relation to ISO1461: 1999, Hot dip galvanized coatings on fabricated iron and steel articles-Specifications and test methods, MOD.

This national standard was re-drafted in accordance with ISO1461: 1999, while chapter and clause comparison table between this standard and ISO 1461 is listed in Annex A.

There have been some significant changes in this national standard over ISO1461: 1999 in the following technical aspects, while technical differences between this standard and ISO 1461: 1999 and reasons are listed in Annex B.

-In accordance with current domestic standards, the name of this standard is revised as Metallic Coatings-Hot Dip Galvanized Coatings on Fabricated Iron and Steel Articles-Specifications and Test Methods.

-Foreword in ISO 1461 is canceled.

-"This standard" is used instead of "this international standard".

-Some domestic standard in which international standards are partly adopted are referred.

4.2 clause and Annex A of ISO1461: 1999 are combined into 4.1 clause of this standard.

-The 6^{th} chapter in ISO1461: 1999 is divided into the 6^{th} and 7^{th} chapters of this standard.

-Requirement on galvanized coating thickness of hot dip galvanized fabricated articles which are treated with zinc-explosion instead of centrifuge, or with zinc-explosion and centrifuge at meanwhile, is proposed in this standard.

-Safety requirement is proposed in this standard on un-completely dried hot dip galvanized fabricated articles.

This standard will replace GB/T 13912-1992 Metallic Coatings-Hot Dip Galvanized Coatings on Fabricated Iron and Steel Articles-Specifications

The major difference between this national standard and GB/T 13912-1992 are as following:

-If galvanized coating thickness is larger than specified value, dark or light grey uneven color is allowable on galvanized fabricated articles;

- Safety requirement is proposed for hot dip galvanized process;

-It is required that each uncoated area shall not be larger than 10 cm^2;

-The thickness of repairing layer shall be 30 μm thicker than the minimum required thickness of galvanized coating.

Annex D of this standard is a normative annex, while Annex A, Annex B, Annex C and Annex E are informative annexes.

This standard was proposed by China Mechanical Industry Administration.

This standard is under the jurisdiction of National Metallic and non-metallic coatings Standardization Technology Committee.

This national standard was drafted by Wuhan Material Protection Facility.

This national standard was jointly drafted by Haerbin Iron Tower Factory.

The main drafters of this national standard are Wu Yong and Li Chunyan.

Metallic coatings-Hot dip galvanized coatings on Fabricated iron and steel articles-Specifications and test methods

1 Scope

This national standard specifies specifications and test methods for hot dip galvanized coatings on fabricated iron and steel articles (total content of other alloy elements is no more than 2%).

This national standard is not applicable to following conditions:

a) Plate, belt, wire, pipe and bar which are manufactured by means of continuous hot dip galvanized coating;

b) Hot dip galvanized products that special standard is adopted;

c) Hot dip galvanized products that additional requirement or requirement different with those in this standard is adopted.

Note: Standard for some products can be formed through reference of this standard number or revising part clauses of this standard to specify hot dip galvanized coatings of products,

2 Normative references

The following normative documents contain provision which, through reference in this text, constitute provisions of this national standard. For dated reference, subsequent amendments to, or revisions of (not include content for corrigenda), any of these publications do not apply. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. For undated references, the latest edition of the normative document referred to applies.

GB/T 470 Zinc ingots (eqv ISO 752)

GB/T 4955 Metallic coatings-Measuring of coating thickness-Anode solving Method (eqv ISO 2177)

GB/T 4956 Measuring of non-magnetic coating thickness on magnetic metal base-Magnetic method (eqv ISO 2178)

GB/T 6462 Metal and oxide coatings-Measuring method for cross sectional surface with microscope (eqv ISO 1463)

GB/T 9793 Metal and other inorganic coatings-Hot spraying-Zinc, aluminum and other alloys (eqv ISO 2063)

GB/T 12334 Metal and other inorganic coatings-Definitions and generic regulations on thickness measurement (eqv ISO 2064)

GB/T 13825 Metallic coatings-Mass determination of hot dip galvanized coatings on black metallic materials-Weighing method (eqv ISO 1460)

GB/T 18253 Steel and steel products Types of inspections files (eqv ISO 10747)

GB/T 2859-1 Sampling procedure of characteristic inspection-Part 1: Inspection and sampling plan which is confirmed in accordance with acceptable quality level as per lot (eqv ISO)

GB/T 2859-3 Sampling procedure of characteristic inspection-Part 3: Sampling procedure of un-continuous lot (eqv ISO)

3 Terms and definitions

The following terms and definitions are confirmed in GB/T 12334 and applicable in this standard.

3.1 Hot dip galvanizing

A process and method with which pre-treated steel or cast iron fabricated articles are immersed into melt zinc bath to form a zinc or zinc-iron alloy coatings on their

surfaces.

3.2 Hot dip galvanizing coating

A zinc or zinc-iron alloy coating achieved on steel or iron article surface with hot dip galvanizing method.

Note: It is briefly called as coating in this standard.

3.3 Coating mass

Total mass of zinc and (or) zinc-iron alloy coating on unit area of steel or iron surface in unit of g/cm^2.

3.4 Coating thickness

Total thickness of zinc and (or) zinc-iron coating on steel or iron surface in unit of μm.

3.5 Significant surface

Part of surface which is or is going to be hot dip galvanized on fabricated article. The coating on part of surface is very important to its appearance and (or) using performance.

3.6 Control sample

Hot dip galvanizing fabricated article or article group which is sampled in random from inspection lot for test.

3.7 Reference area

Area for inspection and test in accordance with specified times.

3.8 Local coating thickness

The mean value of coating thicknesses which are determined with magnetic method in accordance with specified times in a certain reference area, or thickness conversion value of coating mass which is determined with weighing method at one time.

3.9 Mean coating thickness

Mean value of local coating thicknesses determined with samples of a large article or a certain lot of galvanized articles.

Note: Large article in this standard mainly means article that surface is larger than 2 m^2 (refer to 6.2.7.2).

3.10 Local coating mass

Coating mass which is determined with weighing method in a certain local coating area.

3.11 Mean coating mass

Sampling shall be performed in accordance with specifications in 5^{th} chapter. The mean value of local coating mass determined with weighing method, or conversion value of mean coating thickness.

3.12 Minimum value

The minimum value of conversion thickness values of coating mass determined with weighing method on reference area, or the minimum value of mean values of coating thickness determined with magnetic method in accordance with times.

3.13 Inspection lot

Briefly called as lot. Hot dip galvanized fabricated articles which are ordered or delivered at one time.

3.14 Acceptance inspection

If it were not otherwise specified, inspection which shall be performed in hot dip galvanizing manufacturer on certain inspection lot of hot dip galvanized articles.

3.15 Uncoated area

Area in which steel or iron article surface has not reacted with melt zinc.

4 Generic requirements

4.1 Files that user shall provide to supplier

4.1.1 Necessary files

Standard number of this standard.

4.1.2 Additional files

If it is with special requirements from user, the following information shall be provided:

a) The chemical composition and performance which have effect on hot dip galvanizing (refer to Annex C);

b) Scaling of main surface, sample marked in accordance with drawings or proper marking is provided;

c) The area in which performance of galvanized article will be affected by surface smoothness shall be marked in drawing or with other methods. These unevenness are generally caused by factors such as zinc knob formed during galvanizing, or trace which is formed by contacting between articles during galvanizing. These problems shall be solved through discussion between both sides;

d) Surface smooth degree which is required for product shall be specified with sample or other method;

e) If it is required for special pre-treatment;

f) If it is specially required on galvanized coating thickness (refer to note in 6.2 clause and Annex C);

g) If it is allowable that requirements in Table 3, instead of those in Table 2, are met for galvanized coating thickness after centrifuge or zinc-explosion treatment;

h) If post-treatment or painting shall be required after hot dip galvanizing (refer to 6.2.3 sub-clause, C.4 and C.5 clauses in Annex C);

i) Sampling methods (refer to the 5th chapter);

j) If certificate is required to be conform with specifications in GB/T 18253.

Related files, including repairing methods (refer to 6.2.3 sub-clause, C.5 clause in Annex C), shall be provided by supplier in accordance with requirements from user.

4.2 Base metal

The appearance, thickness, organization structure and physical/mechanical performances of coating shall be affected by chemical composition, surface status, weight of article and galvanizing conditions of base metal. Detail requirements on these factors are unavailable in this standard. Selection of base metal and galvanizing conditions can be discussed between both sides refer to Annex C.

4.3 Hot dip galvanizing bath

Zinc bath for hot dip galvanizing is mainly composed with melt zinc liquid. The total content of impurity in melt zinc shall not be larger than 1.5% of total mass. Refer to GB/T for specification on impurity.

4.4 Safety

Provisions for safety shall be adopted in accordance with requirements in Annex D during hot dip galvanizing.

Note: Guide for choosing of hot dip galvanized coating for steel or iron has be given in ISO 14713. Information about painting on hot dip galvanized coating are inclusive in ISO 12944-5 (refer to Annex F).

5 Sampling

Samples for galvanizing coating thickness shall be sampled from each inspection lot (refer to 3.6 clause). Articles which are not less than the minimum quantity shall be sampled from each inspection lot in accordance with requirements in Table 1 to form control sample.

Table 1 Quantity of control samples which are confirmed in accordance with quantity of lot

Article quantity of inspection lot	The minimum quantity of articles required for control sample
1—3	All
4—500	3
501—1200	5
1201—3200	8
3201—10000	13
＞10000	20

Unless it is required by user during ordering, acceptance inspection shall be performed prior to ex-factory of product from galvanizing factory.

6 Requirements on hot dip galvanized coatings

6.1 Appearance

All of articles shall be inspected visually. Their main surfaces (refer to 3.5 clause) shall be smooth without dripped knob, coarse, zinc burr (if these zinc burr can cause damage), peeling, uncoated area and remained solvent slag. There shall not be zinc knob and zinc dust at position at which performance or anti-corrosion performance of hot dip galvanized articles can be affected.

Note 1: Coarse and smooth are two relative concepts. The coarse degree of coating on article is different with that of galvanized product (such as galvanized steel plate and galvanized steel wire) which experienced mechanical rolling or (and) blowing and beveling.

Once if coating thickness is larger than specified value, dark or light gray uneven color area is allowable on galvanized article surface. About galvanized articles which are stored under humid condition, white rust (white or grey corrosion product are mainly basic zinc oxide) is allowable on surface.

Note: It is impossible to establish a definition on appearance and finishing which can cover all of practical requirements.

Appearance shall be visually inspected. Unacceptable articles shall be repaired or re-galvanized for re-inspection in accordance 6.3.2 sub-clause.

If with special requirement (such as painting after galvanizing), samples shall be provided in accordance with requirements (refer to 4.1.2 sub-clause and C.1.4 sub-clause in Annex C).

6.2 Thickness

Sampling in accordance quantity specified in the 5th chapter shall be performed for galvanizing coating thickness test, while test methods specified in 7.2 clause shall be followed for test. In accordance with area of main surface (refer to 3.5 clause) of hot dip galvanized articles, the following requirements shall be met for galvanizing coating thickness determined in the test:

a) About article that main surface (refer to 3.5 clause) area is larger than 2 m^2, i.e. large article, the mean coating thicknesses determined in all of reference areas (refer to 3.7 clause) of each article in control samples shall not be less than the minimum value of respective mean coating thicknesses in Table 2 or Table 3;

b) About article that main surface (refer to 3.5 clause) area is less than or equal to 2 m^2, the coating thicknesses determined in each reference area (refer to 3.7 clause) of each article in control samples shall not be less than the minimum value of respective mean coating thicknesses in Table 2 or Table 3, and the mean coating thicknesses determined in all of reference areas (refer to 3.7 clause) of each article in control samples shall not be less than the minimum value of respective mean coating

thicknesses in Table 2 or Table 3.

Note: The length of anti-corrosion period of hot dip galvanizing coating is approximately in direct ratio with coating thickness. About article which is servicing under serious corrosive conditions and (or) longer service life is required, its coating thickness can be larger than required specified in this standard. However, coating thickness shall be limited by factors such as chemical composition of base metal, surface conditions of article, dimension of article and hot dip galvanizing process parameter etc. If thicker coating is required, the technical possibility of hot dip galvanizing shall be discussed by both sides, while related technical conditions shall be noted (refer to Annex C).

Table 2 Minimum thickness of coating without centrifuge treatment

Article and its thickness/mm	Local coating thickness/μm min	Mean coating thickness/μm min
Steel thickness≥6	70	85
3≤Steel thickness<6	55	70
1.5≤Steel thickness<3	45	55
Steel thickness<1.5	35	45
Cast iron thickness≥6	70	80
Cast iron thickness<6	60	70
Note: Those listed in this table are general requirement. Practical product standard can include each kind of requirement on different thickness grades and sorting. If it is not conflict with this standard, requirement on thicker coating and other requirements can be added.		

Table 3 Minimum thickness of coating with centrifuge treatment

Article and its thickness/mm		Local coating thickness/μm min	Mean coating thickness/μm min
Thread article	Diameter≥20	45	55
	6≤Diameter<20	35	45
	Diameter<6	20	25
Other articles (include cast iron article)	Thickness≥3	45	55
	Thickness<3	35	45
Note: 1 Those listed in this table are general requirement. There can be different requirements (refer to 4.1.2.g) on fixture article and detail standard. Note 2: Refer to C.4 in Annex C for galvanized article with centrifuge treatment, or with centrifuge and zinc-explosion treatment at meanwhile.			

6.3 Uncoated areas and repairing

6.3.1 The total area of uncoated areas of hot dip galvanized article shall not be larger than 0.5% of total area of article. The area of each uncoated area shall not be larger than 10 cm^2.

6.3.2 If there uncoated areas on hot dip galvanized article surface, uncoated areas shall be repaired (refer to C.5) with methods such as hot zinc spraying, coating with zinc rich coat or zinc alloy melting. Unless it is specially required by user, for example, after hot dip galvanizing, the thickness of coating treatment or repairing coating shall be the same with that of original galvanizing coating. The coating thickness in repairing area generally shall be 30 μm thicker than respective coating thickness listed in Table 2 or Table 3. Coating repairing shall be such that sacrificial

anode protection to steel shall be required for steel during its using.

Prior to repairing, any oxides and other dirt shall be removed from uncoated area, or other pre-treating methods shall be required to assure adhesion between repairing coating and base. If hot zinc spraying is adopted for repairing, requirement in GB/T shall be met for it.

Repairing methods shall be informed to user by supplier. If it is specially required by user, repairing methods shall be informed to supplier by user prior to repairing is started.

Refer to C.5 for suggestion on repairing method for damaged surface.

6.4 Adhesive power

Under normal working conditions, faking and peeling shall not be allowed for hot dip galvanized articles of general thickness. Faking and peeling caused by bending and deforming fabrication after galvanizing does not mean poor adhesive power.

If it is specially required by user and adhesive power should be tested, discussion between both sides shall be required.

6.5 Acceptance regulations

Several reference areas shall be selected in accordance with requirements in 7.2.2, Test shall be performed on there reference areas in accordance with methods specified in 7.2.3. Tested coating thickness shall not be less the value specified in Table 2 and Table 3. Unless it is disputed, or cutting article for weighing test is allowed by supplier, un-destructive test shall always be adopted. If steel article is in different thicknesses, each thickness of article shall be deemed as an independent treatment lot, while the respective values in Table 2 and Table 3 shall be reached for coating thickness.

If the coating thickness of control sample can not meet these requirements, double quantity of samples shall be sampled from samples of the lot (if the quantity of articles is less than the minimum sampling quantity, all of articles shall be tested). If samples of larger quantity can pass test, the lot of article is acceptable. If not, un acceptable articles shall be discarded or re-galvanized with agreement from user.

7 Test methods

7.1 Appearance test

Visually inspected in normal reading environment with corrected vision shall be performed.

7.2 Coating thickness test

7.2.1 General test conditions

If it is allowable for size of article, coating thickness shall not be measured at place that distance to edge is less than 10 cm, flare cutting surface, edge or corner (refer to C.1.2).

7.2.2 Reference area (refer to 3.7)

To achieve the most possible representative mean coating thickness (refer to 3.9) or coating mass (refer to 3.1.1), if coating thickness is measured with magnetic method or weighing method, the quantity, position and size of reference area shall be confirmed in accordance with shape and size of article. About long fabricated article in control samples, its reference area shall be about 100 mm away from each end of it, and approximately nearer to center line, while the whole cross sectional area of article shall be included.

The quantity of reference areas shall be based on size of each fabricated article in control samples, and confirmed with following specifications:

a) If main surface (refer to 3.5) area is larger than 2 m^2, i.e. large article, at least 3 reference areas shall be sampled for each fabricated article in control samples;

b) If main surface (refer to 3.5) area is larger than 10,000 mm^2-2 m^2 (include 2 m^2), at least 1 reference areas shall be sampled for each fabricated article in control samples;

c) If main surface (refer to 3.5) area is within 1,000 mm^2-10,000 mm^2 (include 10,000 mm^2), at least 1 reference areas shall be sampled for each article fabricated in control samples;

d) If main surface (refer to 3.5) area is less than 1,000 mm^2, there shall be sufficient articles to provide at least 1,000 mm^2 area as a independent reference area. The last column in Table shall be followed for total quantity of reference areas. Therefore, the total quantity of articles for measuring is equal to that articles quantity which is required to provide an independent reference area timed with quantity listed in the last column in Table 1. This is related with the quantity (if the lot is not large, all of fabricated articles shall be tested) of total quantity of articles used for measuring and inspection lot (refer to 3.13). If above specification is not adopted, sampling procedure specified in ISO 2859-1 or ISO 2859-3 shall be followed.

Note: 10,000 mm^2=100 cm^2;

1,000 mm^2=10 cm^2;

The typical expression of 2 m^2 is 200 cm×100 cm;

The typical expression of 10,000 mm^2 is 10 cm×10 cm;

The typical expression of 1,000 mm^2 is 10 cm×1 cm.

7.2.3 Thickness measuring method (refer to Annex E)

Coating thickness shall be measured with following method:

a) Weighing method. This method is applied for arbitration and requirement in GB/T 13825 shall be followed. The coating mass of galvanizing coating measured with this method shall be conversed into coating thickness in accordance with coating density (7.2g/ cm^3) (refer to E.2). This method is a destructive method. If fabricated articles is less than 10, damage of fabricated articles caused by weighing method and cost for repairing are unacceptable to user, the user shall not be forced to accept weighing method.

b) Magnetic method. This is an un-destructive test method, and requirement in GB/T 4956 shall be followed. During measuring, its reference area shall be in a typical area which can be selected as reference area for weighing method. If thickness is measured with magnetic method in each at least 1,000 mm^2 reference area, at least 5 points shall be measured. Their mean value is local coating thickness (refer to 3.9) of the reference area. If the mean value is not less than local thickness value specified in Table 2 or Table 3, it is allowable that measured values of some points are less than value specified in Table 2 or Table 3. Magnetic method is suitable to on-line quality control in factory. Because each area for measuring with this method is quite small, individual measured value can possibly be less than local thickness or mean thickness of coating. If sufficient measuring times have been performed in a reference area with magnetic method, measured local thickness value shall approach to value measured with weighing method.

c) Cross sectional area microscope method. This method is a destructive method and can represent only one certain point. Therefore, it is inapplicable to general inspection on large article or expansive article. However, the metallographic of certain point can be observed. Specification in GB/T 6462 shall be followed.

d) Anode solving coulomb method. This method is a destructive method. Specification in GB/T 4955 shall be followed.

In above measuring methods, destructive test method can cause damage to hot dip galvanized fabricated article. If fabricated article is quite small, the sum of main

surfaces of at least 5 fabricated can reach 1,000 mm^2, and reference area which is suitable for magnetic method is available on each fabricated article, magnetic method can be adopted. Otherwise weighing method shall be applied. Refer to Annex for conversion between coating thickness and coating mass.

7.3 Adhesive power test

If the requirement of using and operating under normal conditions can be met for adhesion between galvanized coating and base, generally, special test on adhesion between galvanized coating and base shall not be required.

If it is specially required by user, test method (refer to C.6) for adhesion shall be confirmed by both sides through discussion. Adhesion test shall be performed in main surface and the area in which adhesion is specially required in certain degree.

8 Certificates

In accordance with need, hot dip galvanizing factory shall provide certificate that requirement in this standard shall be met.

Annex A (Informative annex) Chapter and clause comparison between this standard and ISO 1461: 1999

Chapter and clause comparison between this standard and ISO 1461: 1999 is given in Table A.1

Table A.1 Chapter and clause comparison between this standard and ISO 1461: 1999

Chapter and clause number in this standard	Respective chapter and clause number in ISO 1461
4.1	4.2 and Annex A
4.2	Note 1 in the 4th chapter
4.3	4.1
4.4	4.3
Note in the 4th chapter	Note 2 in the 4th chapter
6.7	6
8	7
Annex C	Annex C
D.1 and D.2	Annex B
Annex E	Annex D
Reference	Annex E
Note: Except chapters and clauses listed in this table, all of other chapters and clauses in this standard are the same and correspond to those ISO 1461:1999.	

Annex B (Informative annex) Technical differences between this standard and ISO 1461: 1999 and reasons

Technical differences between this standard and ISO 1461: 1999 and reasons is given in Table B1.

Table B.1 Technical differences between this standard and ISO 1461: 1999 and reasons

Chapter and clause number in this standard	Technical difference	Reason
6.2	About galvanized article (refer to C.4) with zinc-explosion instead of centrifuge or with zinc-explosion and centrifuge treatment at meanwhile, its coating thickness can be referred to requirements in Table 3.	Zinc-explosion or with zinc-explosion and centrifuge treatment at meanwhile is adopted in many hot dip galvanizing factories in China.
D.3	It is required to take provision against burning hurt on human body from escaped zinc fluid.	In many factories in China, there is no drying procedure prior to galvanizing, or hot dip galvanizing is performed prior to complete drying of article.

Annex C (Informative annex) Effective factors of hot dip galvanizing

C.1 Base metal

C.1.1 Composition

Carbon steel, low alloy steel, grey cast iron and mottled cast iron are generally suitable for hot dip galvanizing. If other iron-based metals are required for hot dip galvanizing, files or samples shall be provided to supplier by user to decide whether satisfied result can be achieved after hot dip galvanizing on these steels. Free cutting steel that contains sulfur are unsuitable for hot dip galvanizing.

C.1.2 Surface conditions

Base metal surface shall be clean prior to entering hot dip galvanizing bath. Pickling is suggested method for surface cleaning. However, over pickling shall be avoided. About surface dirt which can not be removed with pickling, such as carbon film (such as remains of rolled oil), oil failure, paint, weld slag and similar pollutions, shall be removed prior to pickling. The responsibility for removing these impurities shall be discussed and confirmed by both sides.

There shall be as less void and shrinkage void as possible on cast iron article. Sandblasting, ball blasting, electrolytic pickling and other methods which are suitable for cast iron article shall be applied for cleaning.

C.1.3 Effect of steel surface coarse degree on galvanizing coating thickness

Coarse degree of steel surface has effect on coating thickness and coating structure. Unevenness of base metal surface generally shall maintain after hot dip galvanizing.

By treatment prior to pickling such as sandblasting or coarse milling etc, coarse surface can be achieved on steel. After hot dip galvanizing, coating on such treated steel will be thicker than that on steel which experienced pickling only. On the contrary, it is difficult to achieve thicker coating on smooth surface of article.

Cutting with flare can vary structure and composition of steel in flare cutting area. Therefore, coatings specified in 6.2, Table 2 and Table 3 are difficult to achieve in this

area. To reach specified coating thickness, mill off flare cutting surface and then perform hot dip galvanizing.

C.1.4 Effect of active elements in base metal on coating thickness and appearance

Most of steel can be satisfactorily hot dip galvanized. However, some of active elements in steel, such as Silicon and phosphorus can affect hot dip galvanizing. Surface composition of steel can affect coating thickness and appearance. In certain range of composition, Silicon and phosphorus can cause uneven light and (or) dark grey coating. Coating on these parts may be brittle and thicker. Guidance on steel which is suitable for galvanizing and its performance has been given in France standard NF A35-503:1994 (refer to Reference). However, research on effect of special elements in steel is still going on [refer to ISO 14713 (reference to Reference)].

C.1.5 Internal stress in base metal

Part of internal stress in base metal shall be released during hot dip galvanizing. Therefore, deforming of galvanized fabricated article may be caused at meanwhile.

After certain degree of cold fabrication (such as bending), steel fabricated article will tend to brittle. This depends on sort of steel and cold fabrication degree. Hot dip galvanizing is a heat treatment process. If steel which will be coated is sensitive to deforming ageing, deforming ageing will be accelerated so that steel and iron fabricated article become brittle. To avoid embrittlement, steel which is insensitive to deforming ageing-hardening can be used. If a certain kind of steel which is thought to be sensitive to deforming ageing, deep cold fabrication shall be avoided if possible. If impossible, heat treatment shall be performed prior to pickling and galvanizing.

Note: Deforming ageing hardening and brittleness increasing caused by it are mainly caused by ammonia contained in steel, and more exactly depending on manufacturing procedure of steel. In modern industry producing, this kind of problem generally will not happen. Aluminum killed steel has the lowest degree of deforming ageing.

Steel which experienced heat treatment and cold fabrication hardening will experience heating and tempering during galvanizing. Therefore, strength achieved with heat treatment and cold fabrication will be decreased.

Internal stress shall exist in quenched and (or) deep tensile steel. Internal stress is so great that the possibility of cracking of article in zinc bath during pickling and hot dip galvanizing will be increased. Prior to pickling and hot dip galvanizing, stress releasing treatment shall be required for fabricated article to reduce risk of this kind of cracking. However, consulting to expert shall be required prior to hot dip galvanizing treatment of this kind of steel.

Structural steel generally will not be brittle broken because of hydrogen absorption during pickling. Remained hydrogen (if has) generally will not affect structural steel. As for structural steel, absorbed hydrogen shall be released during hot dip galvanizing. If steel hardness is higher than 34HRC, 340HV or 325HB (refer to ISO 4964), hydrogen absorbing amount shall be the lowest degree as possible during pre-treatment.

As for preventing brittle failure, if experiences from a certain location can prove that special steel, pre-treatment, heat treatment, mechanical treatment, pickling and hot dip galvanizing can achieve satisfied result, these experiences can guide the same steel, pre-treatment, heat treatment, mechanical treatment, pickling and hot dip galvanizing at other locations.

C.1.6 Effect of article dimension

Two factors, large size and metallurgy property of thick steel article fabricated with

normal fabrication method, will require that article need to stay in hot dip galvanizing bath for longer period. Therefore, thicker coating will be caused.

C.1.7 Hot dip galvanizing process

As one part of hot dip galvanizing treatment technologies, less amount of alloy elements can be added in hot dip galvanizing bath (requirement in 4.3 shall be met) to remarkably decrease unfavorable effect of Silicon and phosphorus (refer to C.1.4) or improve coating appearance. General quality and anti-corrosion life hot galvanizing coating and mechanical performances of product will not be affected by these possibly added elements. Standardization on these added elements is not required.

C.2 Design

C.2.1 Generic Principles

The design of hot dip galvanizing article shall be suit for hot dip galvanizing process. Prior to design and fabrication of galvanizing product, user shall consult hot dip galvanizing factory because it may be necessary to make the structure suitable for hot dip galvanizing process.

C.2.2 Size tolerance of matching thread article

There are two different kinds of methods for preserved fabrication tolerance: the first is down-cut external thread, the second is up-cut internal thread. Refer to related specification and standard for fastener. Under general conditions, fabrication tolerance shall be preserved on thread article which is required on matching to permit coating thickness. It is not required on coating on which internal thread is fabricated after hot dip galvanizing or re-fabricated.

Coating thickness of thread article means coating thickness achieved with centrifuge and zinc-explosion immediately after hot dip galvanizing. The purpose of this kind of post-treatment is for assuring thread cleanness.

Note 1: If an internal article and an external thread article are matched together, coating on external one can form electrolytic protection to internal one. Therefore, galvanizing coating on internal thread will not be required.

Note 2: Sufficient strength shall be available for hot galvanized thread article to meet designed requirement.

C.2.3 Effect of process heating

Hot dip galvanizing is not suit for material which will bear unfavorable effect in hot dip galvanizing bath.

C.3 Hot dip galvanizing bath

If it is specially required, the contents of added elements or impurity in galvanizing bath or galvanizing coating can be specified by user.

Especially for boiler (i.e. heat water storage duct and tank) which will be treated with hot dip galvanizing and used for portable water system together with hot dip galvanized steel pipe, user can put forward on composition of pipe coating that EN 10240 (refer to Reference) shall be followed for coating composition.

C.4 Post-treatment

Generally, if articles are hot and humid, they shall not be put together. Small articles can be separately put in material basket or frame. Extra zinc shall be removed by centrifuge or explosion immediately after out of hot dip galvanizing.

To prevent white rust on articles during storing in humid environment, fabricated article surface without further painting shall be properly treated after galvanizing.

If painting or powder painting shall be performed after galvanizing of article, supplier shall be informed by user prior to hot dip galvanizing.

C.5 Repairing of uncoated area and damaged area

If painting is required after galvanizing of article, supplier shall be informed by

user that repairing to damaged areas is allowable. Suggested methods and materials for repairing uncoated or damaged areas shall be informed also. User and contractor for next painting shall assure the compatibility between next painting system and repairing method/material adopted.

Acceptance requirements on repaired coating thickness are specified in 6.3. The same method can be used for site repairing of damaged area. The area of repaired area shall be the same with that of uncoated area. If uncoated area of certain size is acceptable, repaired area of the same size is also acceptable.

C.6 Adhesive power test

Strong bonding between coating and base is a characteristic of hot dip galvanizing process. Therefore, test on bonding force between coating and base is generally not required. However, flaking or peeling on hot dip galvanized article of general thickness and used in normal operation conditions shall not be allowed. If bonding force should be tested, for example, article will bear large mechanical stress during its using or assembling, proper test method shall be selected discussed by both sides in accordance with servicing conditions of galvanizing article. Cross scaling has certain reference for assessing mechanical performance of coating. However, under certain conditions, requirements for test are stricter than that for using. Additionally, harming method and filing method can be applied also.

Any suggested adhesive power test shall be agreed by both sides, while practical operation conditions shall be concerned.

Annex D (Normative annex) Requirements on safety

D.1 Any related national code and standard on safety, environment protection and human health shall be followed for hot dip galvanizing procedure.

D.2 Unless a hole is properly opened on enclosed void, hot dip galvanizing of article with enclosed internal void should be strictly prohibited to prevent explosion caused by heated air. Additional, properly opened hole can assure that zinc contained in internal void can smoothly flow out after hot dip galvanizing. In case that air discharging and flow leading of internal void are not involved in national code on safety and health, opening method or other treatment provision shall be user. Otherwise, it shall be treated by supplier. Refer to ISO 14713 (refer to Reference) for opening, air discharging and leading method.

D.3 About incompletely dried article, water solution of solvent or other water shall remain on surface, and explosion can be caused after entering zinc bath. Provisions shall be taken against burn hurt on human body by escaped zinc liquid.

Annex E (Informative annex) Thickness determination

E.1 Generic principles

Measuring methods of coating thickness can be divided into destructive and un-destructive method (NDT).

The most popular un-destructive method is magnetic method (refer to 6.2 and GB/T 4956). Electromagnetic method is also a kind of un-destructive test method (refer to ISO 2808).

Destructive method includes weighing method (refer to GB/T 13825), anode solving Coulumb method (refer to GB/T 4955) and cross sectional area microscope

method (refer to GB/T 6462).

The 3rd chapter shall be carefully studied, especially while the relationship between local thickness and mean thickness which are determined with magnetic method is disputed. Measuring result with weighing method shall be followed.

E.2 Conversion between unit area coating mass and coating thickness (method for reference)

Unit area coating mass can be determined with weighing method specified in GB/T 13825 in unit of $g.m^2$. Divided by coating density (7.2 $g.m^3$), it can be conversed into coating thickness. Refer to Table E.1 and Table E.2 for coating thickness in Table 2 and Table 3 respective to approximate coating mass.

Table E.1 Relationship between coating mass without centrifuge treatment and thickness

Article and its thickness/mm	Local value (min)		Mean value (min)	
	Coating mass/($g.m^2$)	Thickness/ μ m	Coating mass/($g.m^2$)	Thickness/ μ m
Steel thickness ≥6	505	70	610	85
3 ≤ Steel thickness<6	395	55	505	70
1.5 ≤ Steel thickness<3	325	45	395	55
Steel thickness<1.5	250	35	325	45
Cast iron thickness≥6	505	70	575	80
Cast iron thickness<6	430	60	505	70

Table E.2 Relationship between coating mass with centrifuge treatment and thickness

Article and its thickness/mm		Local value (min)		Mean value (min)	
		Coating mass/($g.m^2$)	Thickness/ μ m	Coating mass/($g.m^2$)	Thickness/ μ m
Thread article	Diameter≥20	325	45	395	55
	6 ≤ Diameter<20	250	35	325	45
	Diameter<6	145	20	180	25
Other articles (include cast iron article)	Thickness≥3	325	45	395	55
	Thickness<3	250	35	325	45

Reference

1 ISO 2808:1997 Color paint and varnish-Determination of paint film thickness

2 ISO 4964:1984 Steel-Hardness conversion calculation

3 ISO 14713:1999 Corrosion protection of steel and iron structural article-Zinc and aluminum coating-Guidance

4 ISO 12944-4:1998 Color paint and varnish-Corrosion protection of coating system of steel structure-Part 4: Sorts of surface and surface preparation
5 ISO 12944-5:1998 Color paint and varnish-Corrosion protection of coating system of steel structure-Part 5: Protective coating system
6 EN 10240 Internal and (or) external protective coating-Specification on hot dip galvanized steel pipe coated with automatic equipment
7 ISO NF A35-503:1994 Iron and steel-Steel for hot dip galvanizing

ICS 25.220.40
A 29

中华人民共和国国家标准

GB/T 13912—2002
代替 GB/T 13912—1992

金属覆盖层　钢铁制件热浸镀锌层 技术要求及试验方法

Metallic coatings—Hot dip galvanized coatings on fabricated iron and steel articles—Specifications and test methods

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

2002-04-10 发布　　2002-12-01 实施

中华人民共和国
国家质量监督检验检疫总局　发布

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前　言

本标准修改采用 ISO 1461:1999《钢铁制件热浸镀锌层　技术条件及试验方法》。

本标准根据 ISO 1461:1999 重新起草，在附录 A 中列出了本标准与 ISO 1461 章条编号的对照一览表。

本标准对 ISO 1461:1999 作了下列修改，在附录 B 中列出了本标准与 ISO 1461 的技术性差异及其原因的一览表。

——按国内现有的系列标准，标准名称改为“金属覆盖层　钢铁制件热浸镀锌层　技术要求及试验方法”；

——取消了 ISO 1461 的前言；

——用“本标准”代替“本国际标准”；

——引用了部分采用国际标准的我国标准；

——将 ISO 1461:1999 中的 4.2 和附录 A 的内容合并为本标准的 4.1；

——将 ISO 1461:1999 中第 6 章的内容分解为本标准的第 6 章和第 7 章；

——对采用爆锌代替离心处理或同时采用爆锌和离心处理的热浸镀锌制件的镀层厚度提出了要求；

——对未经完全烘干的制件热浸镀锌提出了安全要求。

本标准代替 GB/T 13912—1992《金属覆盖层　钢铁制品热镀锌层　技术要求》。

本标准与 GB/T 13912—1992 相比主要变化如下：

——在镀层的厚度大于规定值的条件下，允许被镀制件表面存在发暗或浅灰色的色彩不均匀；

——对热浸镀锌生产过程提出了安全要求；

——要求每个漏镀面的面积不应超过 10 cm^2；

——修复层的厚度应比镀锌层要求的最小厚度厚 30 μm 以上。

本标准的附录 D 是规范性附录，附录 A、附录 B、附录 C 和附录 E 是资料性附录。

本标准由中国机械工业联合会提出。

本标准由全国金属与非金属覆盖层标准化技术委员会归口。

本标准负责起草单位：武汉材料保护研究所。

本标准参加起草单位：哈尔滨铁塔厂。

本标准主要起草人：吴勇、李春燕。

金属覆盖层　钢铁制件热浸镀锌层　技术要求及试验方法

1　范围

本标准规定了钢铁制件热浸镀锌层(其他合金元素总含量不超过2%)的技术要求和试验方法。

本标准不适用于下列情况：

a)　连续式热浸镀生产的板材、带材、线材、管材和棒材；

b)　采用特殊标准的热浸镀锌产品：

c)　有附加要求或有与本标准要求不一致的热浸镀锌产品。

注：某些产品标准可以通过引用本标准号或修改本标准的部分条款来规定产品的热浸镀锌层。

本标准对热浸镀锌产品的后处理和附加保护涂层未做规定。

2　规范性引用文件

下列文件中的条款通过本标准的引用而成为本标准的条款。凡是注日期的引用文件，其随后所有的修改单(不包括勘误的内容)或修订版均不适用于本标准，然而，鼓励根据本标准达成协议的各方研究是否可使用这些文件的最新版本。凡是不注日期的引用文件，其最新版本适用于本标准。

GB/T 470　锌锭(eqv ISO 752)

GB/T 4955　金属覆盖层　覆盖层厚度测量　阳极溶解库仑法(eqv ISO 2177)

GB/T 4956　磁性金属基体上非磁性覆盖层厚度测量　磁性法(eqv ISO 2178)

GB/T 6462　金属和氧化物覆盖层　横断面厚度显微镜测量方法(eqv ISO 1463)

GB/T 9793　金属和其他无机覆盖层　热喷涂　锌、铝及其合金(eqv ISO 2063)

GB/T 12334　金属和其他无机覆盖层　关于厚度测量的定义和一般规则(eqv ISO 2064)

GB/T 13825　金属覆盖层　黑色金属材料热镀锌层的质量测定　称量法(nqv ISO 1460)

GB/T 18253　钢及钢产品　检验文件的类型(eqv ISO 10747)

ISO 2859-1　特性检查的抽样程序　第1部分：按可接受的质量水平(AQL)确定的逐批检查抽样方案

ISO 2859-3　特性检查的抽样程序　第3部分：不连续批的抽样程序

3　术语和定义

GB/T 12334中确立的以及下列术语和定义适用于本标准。

3.1

热浸镀锌　hot dip galvanizing

将经过前处理的钢或铸铁制件浸入熔融的锌浴中，在其表面形成锌和(或)锌-铁合金镀层的工艺过程和方法。

3.2

热浸镀锌层　hot dip galvanized coating

采用热浸镀锌方法在钢铁件表面上获得的锌和(或)锌-铁合金镀层。

注：在本标准中简称为镀层。

3.3

镀层的镀覆量 coating mass

钢铁表面上单位面积锌和(或)锌-铁合金镀层的总质量,以 g/m^2 表示。

3.4

镀层厚度 coating thickness

钢铁表面上锌和(或)锌-铁合金镀层的总厚度,以 μm 表示。

3.5

主要表面 significant surface

制件上被热浸镀锌或将被热浸镀锌的部分表面,该部分表面上的镀层对于制件的外观和(或)使用性能是极为重要的。

3.6

样本 control sample

从检查批中随机抽取用于试验的热浸镀锌制件或制件组。

3.7

基本测量面 reference area

按规定次数进行检测试验的区域。

3.8

镀层局部厚度 local coating thickness

在某一基本测量面按规定次数用磁性法所测得的镀层厚度的算术平均值或用称量法进行一次测量所测得的镀层镀覆量的厚度换算值。

3.9

镀层平均厚度 mean coating thickness

对某一大件或某一批镀锌件抽样后测得镀层局部厚度的算术平均值。

注:本标准中大件是指主要表面的表面积大于 2 m^2 的制件(见 6.2,7.2)。

3.10

镀层的局部镀覆量 local coating mass

采用称量法进行一次测量所测得的某一区域镀层的镀覆量。

3.11

镀层的平均镀覆量 mean coating mass

按第 5 章规定抽样,用称量法测得的镀层局部镀覆量的算术平均值,或镀层平均厚度的换算值。

3.12

最小值 minimum value

在基本测量面上用称量法测得的镀层镀覆量厚度换算值中的最小值,或按规定次数用磁性法所测得的镀层厚度的算术平均值中的最小值。

3.13

检查批 inspection lot

简称批。指一次订货或一次交货的热浸镀锌制件。

3.14

验收检查 acceptance inspection

在没有其他规定的情况下,应在热浸镀锌生产厂家内对某检查批的热浸镀锌制件进行的检查。

3.15

漏镀面 uncoated areas

钢铁制件表面未与熔融锌发生反应的区域。

4 一般要求

4.1 需方应向供方提供的资料

4.1.1 必要资料

本标准的标准号。

4.1.2 附加资料

需方若有特殊要求，则应提供下列资料：

a) 对热浸镀锌会产生影响的基体金属的化学成分和性能(参见附录C)；

b) 主要表面的标定，可利用图纸标明或提供标有适当标记的样品；

c) 表面平整与否将影响镀锌制件使用性能的区域用图纸或其他方法标明，这些不平整往往由镀锌过程中形成的锌瘤、镀锌时制件相互接触形成的痕迹等因素造成；供需双方应协商解决这些问题；

d) 用样品或其他方法说明产品要求的表面光滑程度；

e) 是否有特殊预处理要求；

f) 是否有特殊的镀层厚度要求(见6.2中注和附录C)；

g) 是否允许经离心或爆锌处理的镀层厚度达到表3而不是表2要求；

h) 热浸镀锌后是否还要进行后处理或涂装(见6.2.3，附录C.4和附录C.5)；

i) 抽样方法(见第5章)；

j) 合格证书是否要求与GB/T 18253的规定一致。

供方应根据需方要求提供包括修复方法(见6.3.2和附录C.5)在内的有关资料。

4.2 基体金属

基体金属的化学成分、表面状况、制件的重量及镀锌条件都将影响镀层的外观、厚度、组织结构及物理/力学性能。本标准没有对这些提出具体的要求，供需双方可参照附录C对基体金属的选择及镀锌条件进行协商。

4.3 热浸镀锌浴

用于热浸镀锌的锌浴主要应由熔融锌液构成。熔融锌中的杂质总含量(铁，锡除外)不应超过总质量的1.5%。所指杂质见GB/T 470规定。

4.4 安全

在热浸镀锌的生产过程中应按附录D的要求采取安全措施。

注：ISO 14713给出了钢铁热浸镀锌层的选用指南。ISO 12944-5包含有关钢铁热浸镀锌层上涂装的信息(参见附录F)。

5 抽样

用于镀层厚度试验的样本应从每一检查批(见3.6)中随机抽取，应按表1要求从每一检查批中抽取不少于最小数量的制件组成样本。

表1 按批的大小确定样本大小

检查批的制件数量	样本所需制件的最小数量
1～3	全部
4～500	3
501～1 200	5
1 201～3 200	8
3 201～10 000	13
>10 000	20

除非订货时需方提出其他要求，验收检查应在产品离开镀锌厂家之前进行。

6 镀层的要求

6.1 外观

目测所有热浸镀锌制件，其主要表面（见 3.5）应平滑，无滴瘤、粗糙和锌刺（如果这些锌刺会造成伤害），无起皮，无漏镀，无残留的溶剂渣，在可能影响热浸镀锌工件的使用或耐腐蚀性能的部位不应有锌瘤和锌灰。

注 1："粗糙"和"平滑"是相对概念，制件镀层的粗糙度不同于经机械辊挤或（和）吹、抹的镀锌制品（如镀锌钢板和镀锌钢丝）的粗糙度。

只要镀层的厚度大于规定值，被镀制件表面允许存在发暗或浅灰色的色彩不均匀区域。潮湿条件下储存的镀锌工件，表面允许有白锈（以碱式氧化锌为主的白色或灰色腐蚀产物）存在。

注 2：不可能确立一个能覆盖所有实际要求的关于外观和精饰的定义。

目查外观，检查不合格的制件应按 6.3.2 进行修复或重镀后再交送重新检查。

若有特殊要求（例如镀锌后需要涂装），应按要求提供样品（见 4.1.2 和附录 C.1.4）。

6.2 厚度

镀层的厚度试验应按第 5 章规定数量抽样，并按 7.2 规定的试验方法进行试验。根据热浸镀锌制件主要表面（见 3.5）面积的大小，试验测得的镀层厚度应分别达到以下要求：

a） 对于主要表面（见 3.5）面积大于 2 m^2 的制件（即大件），样本中每个制件的所有基本测量面（见 3.7）内测得的镀层平均厚度应不低于表 2 或表 3 中相应的平均镀层厚度的最小值；

b） 对于主要表面（见 3.5）面积小于或等于 2 m^2 的制件，在每个基本测量面（见 3.7）内测得的局部镀层厚度应不小于表 2 或表 3 中局部厚度最小值，在样品的所有基本测量面（见 3.7）测得的镀层平均厚度应不低于表 2 或表 3 相应平均厚度最小值。

注：热浸镀锌层防腐蚀时间的长短大致与镀层厚度成正比。在极严酷的腐蚀条件下服役和（或）要求更长的服役时间的制件，其镀层厚度要求可以高于本标准的规定要求。但是镀锌层的厚度要受基材的化学成分、制件的表面状况、制件的几何尺寸、热浸镀工艺参数等因素的限制。当需要较厚镀层时，供需双方应探讨热浸镀技术上的可能性并注明相关技术条件（参见附录 C）。

表 2 未经离心处理的镀层厚度最小值

制件及其厚度/mm	镀层局部厚度/μm min	镀层平均厚度/μm min
钢厚度 ≥6	70	85
3≤钢厚度<6	55	70
1.5≤钢厚度<3	45	55
钢厚度<1.5	35	45
铸铁厚度≥6	70	80
铸铁厚度<6	60	70

注：本表为一般的要求，具体产品标准可包含不同的厚度等级及分类在内的各种要求，在和本标准不冲突情况下，可以增加更厚的镀层要求和其他要求。

表 3 经离心处理的镀层厚度最小值

制件及其厚度/mm		镀层局部厚度/μm min	镀层平均厚度/μm min
螺纹件	直径≥20	45	55
	6≤直径<20	35	45
	直径<6	20	25
其他制件（包括铸铁件）	厚度≥3	45	55
	厚度<3	35	45
注 1：本表为一般的要求，紧固件和具体产品标准可以有不同要求（见 4.1.2.g）。 注 2：采用爆锌代替离心处理或同时采用爆锌和离心处理的镀锌制件见附录 C.4。			

6.3 漏镀和修复

6.3.1 漏镀

热浸镀锌制件漏镀面的总面积不应超过制件总表面积的 0.5%。每个漏镀面的面积不应超过 10 cm^2。当供需双方没有其他协议时，若漏镀面积大于上述规定值，这些制件应予重镀。

6.3.2 修复

热浸镀锌制件表面若存在漏镀面，应采用热喷涂锌、涂敷富锌涂料或融敷锌合金等方法对漏镀面进行修复（见附录 C.5）。除非需方另有特殊要求，如：热浸镀锌以后还要进行涂装处理或修复层的厚度必须与原镀锌层的厚度相同，修复区域内锌的涂（覆）层厚度一般应比表 2 或表 3 中要求的相应的镀层局部厚度厚 30 μm 以上。修复涂层应能在钢的使用过程中给予钢材以牺牲性阳极保护。

修复前，应去除漏镀区域内的氧化皮和其他污物，或采用其他前处理方法，以保证修复层与基体间的附着力。若采用热喷涂锌修复，则应按 GB/T 9793 要求进行。

供方应将修复方法告之需方。若需方有特殊要求，则应在修复前要求供方告知修复方法。

破损面的修复方法建议参见附录 C.5。

6.4 附着力

一般厚度的热浸镀锌工件在正常工作条件下应没有剥落和起皮现象。镀锌后再进行弯曲和变形加工产生的镀层剥落和起皮现象不表示镀层的附着力不好。

若需方有特殊要求，必须测试附着力，则由供需双方协商。

6.5 验收准则

按 7.2.2 的要求选取若干基本测量面，在这些基本测量面上按 7.2.3 规定的试验方法进行试验，所测的镀层厚度不应小于表 2 和表 3 所规定的值。除非在有争议的情况下，或供方许可切割其制件做称量法试验，否则都应采用非破坏性试验方法。当制件的钢材厚度不同时，则每一厚度范围的制件都应视为单独的处理批次，其镀层厚度都应分别达到表 2 和表 3 中的相应的值。

如果样本的镀层厚度不符合这些要求，则应在该批制件中双倍取样（制件数少于最低取样数则取全部制件进行试验）。若这一较大的样本通过了试验则视该批制件合格；若通不过，则不符合要求的制件应报废，或经需方允许重镀。

7 试验方法

7.1 外观试验

采用校正视力在正常的阅读环境下目查。

7.2 镀层厚度试验

7.2.1 一般试验条件

在制件的尺寸允许的情况下镀层的厚度测量不应在离边缘少于 10 mm 的区域、火焰切割面或边角进行(见附录 C.1.2)。

7.2.2 **基本测量面**(见 3.7)

为了获得尽可能具有代表性的镀层平均厚度(见 3.9)或镀覆量(见 3.11),采用磁性法或称量法测量镀层的厚度时,基本测量面的数量、位置及尺寸应根据制件形状和大小确定。对样本中较长制件,其基本测量面应在离其每端大约 100 mm,大致接近中心线的位置获取,并应包括制件的整个横截面。

基本测量面的数量取决于样本中各制件的尺寸,应按以下规定确定:

a) 主要表面(见 3.5)面积大于 2 m^2 的制件(即大件) 样本中的每个制件至少应取 3 个基本测量面;

b) 主要表面(见 3.5)面积大于 10 000 mm^2～2 m^2(包括 2 m^2)的制件 样本中每个制件应至少取一个基本测量面;

c) 主要表面(见 3.5)面积为 1 000 mm^2～10 000 mm^2(包括 10 000 mm^2)的制件 样本中每个制件应取一个基本测量面;

d) 主要表面(见 3.5)面积小于 1 000 mm^2 的制件 应由足够数量的制件共同提供至少 1 000 mm^2 的面积作为一个单独的基本测量面。基本测量面的总数应按表 1 最后一列来取。因此,用于测量的制件总数等于提供一个单独的基本测量面所需的制件数乘以表 1 最后一列提供的数量,这一用于测量的制件总数与检查批(见 3.13)的大小有关(如果批不大,也可取全部的制件用于进行试验)。如果不采用上述规定,也可以按 ISO 2859-1 或 ISO 2859-3 规定的抽样程序进行。

注:10 000 mm^2=100 cm^2;

1 000 mm^2=10 cm^2;

2 m^2 典型的表示为 200 cm×1 00 cm;

10 000 mm^2 典型的表示为 10 cm×10 cm;

1 000 mm^2 典型的表示为 10 cm×1 cm。

7.2.3 **厚度测量方法**(参见附录 E)

镀层的厚度可采用以下方法测量:

a) 称量法 是仲裁的方法,按 GB/T 13825 要求进行。按本方法测得的镀锌层的镀覆量应按镀层的密度(7.2 g/cm^3)换算成镀层的厚度(参见附录 E.2)。本方法是破坏性试验方法。在制件数量少于 10 件的情况下,如果称量法可能牵涉到制件损坏和由此发生的补救费用令需方不可接受,则需方不应勉强接受称量法。

b) 磁性法 是非破坏性试验方法,按 GB/T 4956 要求进行。测量时,其基本测量面应置于能够为称量法所选中作为基本测量面的典型区域内。在每个不小于 1 000 mm^2 的基本测量面内采用磁性法测厚时,应至少取 5 个测量点测厚,其算术平均值即为该基本测量面的镀层局部厚度(见 3.9)。只要该平均值不低于表 2 或表 3 中局部厚度所要求的值,允许个别测量点上的测量值低于表 2 或表 3 中的值。磁性法最适用于在工厂内进行在线质量控制。由于用该方法测量的每个区域都非常小,个别测量值可能低于镀层的局部厚度或平均厚度值。如果用磁性法在一个基本测量面内进行了足够次数的测量,测得的局部厚度值趋近于用称量法测得的值。

c) 横截面显微镜法 是破坏性试验方法而且仅仅代表某一点,所以不适用大件或贵重件的常规检查,但可观察某点的金相,按照 GB/T 6462 要求进行。

d) 阳极溶解库仑法 是破坏性试验方法,按照 GB/T 4955 要求进行。

注:也可采用电磁法,电磁法是非破坏性试验方法(参见附录 E.1)。

在上述测量方法中,破坏性试验方法会对热浸镀锌制件造成损坏,一般情况下应采用非破坏性试验方法,但是,若产生争议,则应采用称量法仲裁。若制件很小,必须要 5 个以上制件的主要表面积之和才能达到 1 000 mm^2,在每个制件都有适合于磁性法的基本测量面的条件下,可采用磁性法,否则应采用

称量法。镀层厚度与镀覆量的换算方法参见附录E。

7.3 附着力试验

只要镀锌层与基体的附着力能满足制件在使用和一般操作条件下的要求，通常不需专门测试镀锌层和基体之间的结合力。

若需方有特殊要求，可由供需双方协商确定附着力的试验方法(参见附录C.6)。附着力试验应在主要表面和使用过程中对附着力有一定要求的区域内进行。

8 合格证书

根据需要，热浸镀锌厂家应提供符合本标准要求的证书。

附 录 A
（资料性附录）
本标准章条编号与 ISO 1461:1999 章条编号对照

表 A.1 给出了本标准章条编号与 ISO 1461:1999 章条编号对照一览表。

表 A.1 本标准章条编号与 ISO 1461:1999 章条编号对照

本标准章条编号	对应的 ISO 1461 的章条编号
4.1	4.2 和附录 A
4.2	第 4 章注 1
4.3	4.1
4.4	4.3
第 4 章注	第 4 章注 2
6,7	6
8	7
附录 C	附录 C
D.1 和 D.2	附录 B
附录 E	附录 D
参考文献	附录 E
注：表中的章条以外的本标准其他章条编号与 ISO 1461:1999 其他章条编号均相同且内容相对应。	

附 录 B
（资料性附录）
本标准与 ISO 1461:1999 的技术性差异及其原因

表 B.1 给出了本标准与 ISO 1461:1999 的技术性差异及其原因。

表 B.1 本标准与 ISO 1461:1999 技术性差异及其原因

本标准章条编号	技术性差异	原 因
6.2	采用爆锌代替离心处理或同时采用爆锌和离心处理的镀锌制件(见 C.4)其镀层厚度可参照表 3 要求。	我国很多热浸镀锌厂家采用爆锌或离心加爆锌处理。
D.3	要求采取措施，防止飞溅的锌液烫伤人体。	我国很多厂家在热浸镀锌前无烘干工序或制件未完全烘干即进行热浸镀锌。

附 录 C
（资料性附录）
热浸镀锌的影响因素

C.1 基体金属

C.1.1 成分

碳钢、低合金钢及灰口铸铁和马口铸铁一般都适合热浸镀锌，其他铁基金属需热浸镀锌时，需方应向供方提供资料或样品，以决定这些钢热浸镀锌后是否能获得满意的结果。含硫的易切削钢不适合热浸镀锌。

C.1.2 表面状态

进入热浸镀锌浴之前的基体金属表面应干净。酸洗是清洗表面的推荐方法，但是应避免过度酸洗。不能酸洗掉的表面污物，如：碳膜（如轧制油的残余物）、油污、油漆、焊渣以及类似的污染物应在酸洗前去除，去除这些杂质的责任应由供需双方商定。

铸铁件表面应尽可能无孔隙和缩孔，并应采用喷砂、抛丸、电解酸洗或其他适用于铸铁件的方法进行清理。

C.1.3 钢材的表面粗糙度对镀锌层厚度的影响

钢表面粗糙度对镀层厚度和镀层结构有影响，基体金属表面不均匀性在热浸镀锌之后一般仍会保留。

钢材在酸洗前进行喷砂、粗磨等处理可获得粗糙表面，如此处理的钢材热浸镀锌后获得的镀层要厚于仅进行酸洗处理的。反之，表面光滑的制件较难获得较厚的镀锌层。

火焰切割改变了火焰切割区域内钢材的组织和成分，以至于该区域内难以得到 6.2 以及表 2 和表 3 规定的镀层厚度，为了得到规定的镀层厚度，可磨去火焰切割表面后再热浸镀锌。

C.1.4 基体金属中的活性元素对镀锌层厚度及外观的影响

大多数钢都能满意地热浸镀锌，但是钢中的一些活性元素会影响热浸镀锌，如硅（Si）和磷（P）。钢材的表面成分将会影响镀锌层的厚度和外观。在一定的成分范围内，硅和磷可能会导致形成不均匀的光亮和（或）暗灰色镀层。这些部位的镀层可能较脆较厚。法国标准 NF A35-503:1994（见参考文献）给出了可适用于热浸镀锌的钢及其性能指南，但是关于钢中特殊元素影响的研究仍在进行之中[参见 ISO 14713（见参考文献）]。

C.1.5 基体金属中的内应力

基体金属中部分应力在热浸镀锌过程中会被去除，同时可能会引起镀锌制件的变形。

钢制件经一定程度的冷加工（例如弯曲）后会变脆，这取决于钢的种类和冷加工程度。热浸镀锌是一个热处理过程，如果被镀钢材对形变时效敏感，会加速形变时效的发生而使钢铁制件脆化。为了避免这种脆化危险，可使用对形变时效-硬化不敏感的钢。如果认为某种钢对形变时效敏感，在可能的情况下应避免深度冷加工；若不能避免深度冷加工，则应在酸洗和热浸镀锌之前进行去应力热处理。

注：形变时效硬化敏感性和随之产生的脆性增加主要是由钢中氮所引起，更确切地说极大地取决于钢的生产过程。在现代化工业生产中，一般不会产生此类问题。铝镇静钢可将形变时效降到最低程度。

经过热处理和冷加工强化的钢在热浸镀锌的同时还会受热回火而使经热处理或冷加工获得的强度降低。

淬火钢和（或）经深度拉伸的钢会有内应力，如此大的内应力可使酸洗和热浸镀锌过程增加钢制件在锌浴中开裂的危险性。在酸洗和热浸镀锌之前对制件进行消除应力处理可以减小这种开裂风险。但是对此类钢材进行热浸镀锌处理时应向专家咨询。

结构钢一般不会在酸洗时由于吸氢而产生脆断，残留的氢(即使有的话)一般不会影响结构钢。对于结构钢而言，被吸入的氢在热浸镀锌过程中会被释放出去，如果钢的硬度高于 34HRC、340HV 或 325HB(见 ISO 4964)，在前处理中应尽量将吸氢量降到最低程度。

对于防止脆断而言，如果某个地方的经验表明，特殊的钢材、预处理、热处理和机械处理、酸洗以及热浸镀锌方法可以获得满意的结果，则这些经验对于其他地方相同的钢材、预处理、热处理和机械处理、酸洗以及热浸镀锌方法将具有指导作用。

C.1.6 制件几何尺寸的影响

大尺寸和常规制造方法制成的厚钢件的冶金学性质这两个因素要求制件在热浸镀锌浴中停留较长的时间，这会导致形成厚的镀层。

C.1.7 热浸镀锌工艺

作为热浸镀锌处理技术的一部分，在热浸镀锌浴(符合 4.3 的要求)中加入少量合金元素，可以显著地降低硅和磷的不利影响(见 C.1.4)或改善镀层外观。这些可能添加的元素不影响热浸镀锌层的一般质量，耐腐蚀寿命和镀锌产品的力学性能，对此类添加元素无需进行标准化。

C.2 设计

C.2.1 总则

热浸镀锌制件的设计应适应热浸镀锌工艺，在设计和制造热浸镀锌产品之前，需方应向热浸镀锌厂家进行咨询，因为可能有必要使制件的结构适合于热浸镀锌工艺。

C.2.2 配合螺纹件的尺寸公差

有两种不同的预留加工的余量方法：一是下切外螺纹；二是上切内螺纹。如果是紧固件可参见有关紧固件的规定和标准。一般情况下有配合要求的螺纹件上应预留加工余量，以容纳镀层厚度。对热浸镀锌后加工出或再加工出的内螺纹上的镀层不做要求。

螺纹元件的镀层厚度指的是螺纹元件经热浸镀锌之后立即进行离心或爆锌处理而获得的镀层厚度，进行这样的后处理的目的是保证螺纹清洁。

注 1：内外螺纹件配合在一起时，外螺纹件上的镀层可对内螺纹形成阴极保护，因此不要求内螺纹上有镀锌层。

注 2：经热浸镀锌的螺纹件应有足够的强度以满足原设计的要求。

C.2.3 工艺加热的影响

在热浸镀锌浴中加热会受到不利影响的材料不应热浸镀锌。

C.3 热浸镀锌浴

在有特殊要求的场合，需方可规定镀锌浴或镀锌层中的添加元素或杂质的含量。

特别是要对锅炉(即热水贮槽和罐)进行热浸镀锌处理并将其与热浸镀锌钢管一道用于饮用水系统的情况下，需方可要求其镀层成分同样符合 EN10240(见参考文献)对管子镀层提出的成分要求。

C.4 后处理

一般情况下，当制件还是热的和湿的状态时，制件不应堆集在一起。小制件可散放在料筐中或置于料架上，从热浸镀锌浴中取出后立即离心甩掉或爆除多余的锌。

为了防止制件在潮湿环境中存放时表面产生白锈，不再涂装的制件镀锌之后应进行适当的表面处理。

如果制件镀锌后要涂漆或粉末喷涂，需方应在热浸镀锌之前告知供方。

C.5 漏镀面和损伤面的修复

若制件镀锌后需要涂装，供方应告知需方允许对损伤面进行修复，还应告知修复漏镀或损伤区域的

推荐方法和材料。需方和后续涂层的涂覆方应保证后续涂层体系与所采用的修复方法和材料的相容性。

6.3 规定了修复层厚度的验收要求。损伤面的现场修复可以采用同样的方法进行。修复面的大小应与漏镀面的大小一致；如果某一尺寸的漏镀面是可以接受的，则同样大小的修复面也应是可以接受的。

C.6 附着力试验

镀层与基体结合力强是热浸镀锌工艺的特点，所以通常不需测试镀锌层和基体之间的结合力。但是

附 录 D
（规范性附录）
安全要求

D.1 热浸镀锌生产过程应按国家有关安全、环保和人体健康的法规和标准要求进行。

D.2 严禁对包含有封闭内腔的制件进行热浸镀锌，除非在封闭内腔上适当开孔，以防止封闭内腔内的空气受热后压力增加产生爆炸。另外，适当开孔可保证热浸镀锌后，内腔内的锌液能顺利地流出。在国家的安全和健康法规未具体涉及内腔的排气和导流问题的情况下，需方应提供开孔的方法或其他处理措施，否则由供方自行处理。开孔排气导流的方法可参见 ISO 14713（见参考文献）。

D.3 未经完全烘干的制件，表面会残留溶剂的水溶液或其他水分，进入锌浴后会爆炸，应采取措施防止飞溅的锌液烫伤人体。

附 录 E
（资料性附录）
厚度测定

E.1 总则

镀锌层厚度的检测方法有破坏法和非破坏法（无损测厚法）。

最常用的非破坏法是磁性法（参见 6.2 和 GB/T 4956）。电磁法也是一种非破坏试验方法（参见 ISO 2808）。

破坏法包括称量法（参见 GB/T 13825）、阳极溶解库仑法（参见 GB/T 4955）和横断面显微镜法（参见 GB/T 6462）。

应仔细研究第 3 章，特别是对使用磁性法得到的局部厚度和平均厚度的关系有争议时，其测量结果应以称量法为准。

E.2 单位面积镀层镀覆量与镀层厚度之间的换算（参考方法）

用 GB/T 13825 规定的称量法可测出单位面积镀层的镀覆量，用 g/m^2 表示，除以镀层密度（7.2 g/cm^3）可将镀层的镀覆量换算成镀层厚度。与表 2 和表 3 中镀层厚度对应的近似镀层的镀覆量见表 E.1 和表 E.2。

表 E.1 未经离心处理的镀层的镀覆量和厚度的关系

制件及其厚度/mm	局部值(min)		平均值(min)	
	镀覆量/(g/m^2)	厚度/μm	镀覆量/(g/m^2)	厚度/μm
钢厚度≥6	505	70	610	85
3≤钢厚度<6	395	55	505	70
1.5≤钢厚度<3	325	45	395	55
钢厚度<1.5	250	35	325	45
铸铁厚度≥6	505	70	575	80
铸铁厚度<6	430	60	505	70

表 E.2 经离心处理的镀层的镀覆量和厚度的关系

制件及其厚度/mm		局部值(min)		平均值(min)	
		镀覆量/(g/m^2)	厚度/μm	镀覆量/(g/m^2)	厚度/μm
螺纹件	直径≥20	325	45	395	55
	6≤直径<20	250	35	325	45
	直径<6	145	20	180	25
其他制件（包括铸铁）	厚度≥3	325	45	395	55
	厚度<3	250	35	325	45

参 考 文 献

1 ISO 2808:1997 色漆和清漆 漆膜厚度的测定
2 ISO 4964:1984 钢 硬度换算
3 ISO 14713:1999 钢铁结构件腐蚀防护 锌和铝镀层 指南
4 ISO 12944-4:1998 色漆和清漆 钢结构涂装体系的腐蚀防护 第4部分:表面和表面准备的类型
5 ISO 12944-5:1998 色漆和清漆 钢结构涂装体系的腐蚀防护 第5部分:保护涂装体系
6 EN 10240 钢管的内和(或)外保护层 自动化设备镀覆的热浸镀锌钢管技术要求
7 NF A35-503:1994 铁和钢——热浸镀锌用钢