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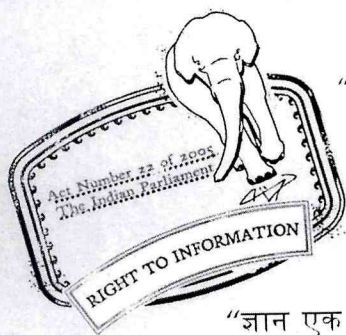
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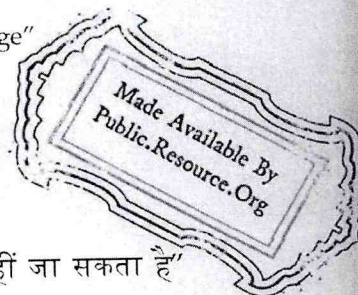
“Step Out From the Old to the New”

IS 2629 (1985): Recommended Practice for Hot-Dip Galvanizing of Iron and Steel [MTD 7: Light Metals and their Alloys]



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“Invent a New India Using Knowledge”



“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bharthari—NitiSatakam

“Knowledge is such a treasure which cannot be stolen”

IS : 2629 - 1985
(Reaffirmed 1994)

Indian Standard
RECOMMENDED PRACTICE FOR
HOT-DIP GALVANIZING OF IRON AND STEEL
(*First Revision*)

Third Reprint AUGUST 1997

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

AMENDMENT NO. 1 DECEMBER 1988
TO
IS : 2629 - 1985 RECOMMENDED PRACTICE FOR
HOT-DIP GALVANIZING OF IRON AND STEEL
(*First Revision*)

(*Pages 15, 16 and 17, Appendix A, last column*) — Substitute ' May be rejected ' for ' Yes ' and ' May be accepted ' for ' No ' wherever appearing.

(SMDC 28)

Printed at Dee Kay Printers, New Delhi, India

AMENDMENT NO. 2 MARCH 1995
TO
IS 2629: 1985 RECOMMENDED PRACTICE FOR
HOT-DIP GALVANIZING OF IRON AND STEEL

(First Revision)

(Page 3, clause 0.3.2, first sentence) — Substitute the following for the existing

‘The galvanizing process can be grouped together under three categories, namely (a) wet process, (b) dry process, and (c) a combination of dry and wet process by continuous or batch galvanizing.’

(Page 9, clause 5.4) — Add the following at the end of clause.

‘A lead bed may be maintained as it assists in dressing.’

(Page 11, clause 5.9, line 7) — Add ‘up to’ before ‘1 percent’

(MTD 20)

Printed at Dee Kay Printers, New Delhi 110015 India

**AMENDMENT NO. 3 JANUARY 2001
TO
IS 2629 : 1985 RECOMMENDED PRACTICE FOR
HOT-DIP GALVANIZING OF IRON AND STEEL**

(First Revision)

(Page 8, clause 5.1) — Substitute the following for the existing :

'5.1 Quality of Zinc — Zinc used for galvanizing shall conform to any of the grades specified in IS 209 : 1992 Zinc ingot (*fourth revision*) or IS 13229: 1991 Zinc for galvanizing.'

(MTD 20)

Reprography Unit, BIS, New Delhi, India

IS : 2629 - 1985

Indian Standard
RECOMMENDED PRACTICE FOR
HOT-DIP GALVANIZING OF IRON AND STEEL
(First Revision)

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(Continued on page 2)

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(Continued from page 1)

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Indian Standard

RECOMMENDED PRACTICE FOR
HOT-DIP GALVANIZING OF IRON AND STEEL
(*First Revision*)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 20 June 1985, after the draft finalized by the Hot-Dip, Sprayed and Diffusion Coatings Sectional Committee had been approved by the Structural and Metals Division Council

0.2 This standard was first published in 1966. The present revision has been prepared in the light of the experience gained since its first publication and further technical developments in this field. The continuous galvanizing process has been included in this revision. The typical photographs for the various defects in galvanized coatings on iron and steel have also been included in Appendix A.

0.3 Hot-dip galvanizing is an old and well known process of applying zinc coating to iron or steel surface for protection against corrosion. The zinc coating firstly protects the base metal by acting as an impervious shield between the metal and the atmosphere and secondly affords sacrificial protection even when moderately sized areas ($\frac{1}{4}$ mm dia, for example) of the base metal surface are exposed.

0.3.1 When a thoroughly cleaned article is immersed in a galvanizing bath, the metal surface reacts with molten zinc to form a zinc-iron alloy. As the article is withdrawn from the bath, it picks up pure zinc which solidifies on cooling and forms the outer layer. The intermediate alloy layer provides a strong bond between the ferrous base material and the pure zinc and also resists corrosion and abrasion in the event of the pure zinc layer being removed. Under same conditions of process or composition of the material the whole coating may consist of zinc-iron alloy layers.

0.3.2 The galvanizing process can be grouped under three broad categories, namely (a) the wet process, (b) the dry process, and (c) the continuous galvanizing process. Continuous galvanizing process consists of cleaning base steel surface by first oxidizing and subsequently reducing the surface oxides under controlled atmosphere or by any other in-line cleaning

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method. The strip is heat-treated in line annealing/normalizing furnace followed by continuous feeding through molten zinc bath and passivating treatment by suitable agent like chromic acid. After galvanizing, when the sheet emerges from the zinc bath, the excess molten zinc on them is wiped off by air or gas jets. There is no fluxing in this process.

0.3.3 Continuous galvanizing process has got advantages over both wet and dry processes with respect to high productivity, control of coating thickness, uniformity of coating along the length, better coating adherence, less dross formation, better surface appearance, etc.

0.4 A summary of defects, along with the typical photographs for illustration, commonly met with in the hot-dip galvanizing practice, their causes and remedial measures are given in Appendix A. In this appendix, the information given in the last column aids inspectors in interpreting the appearance of the article and help them in arriving at a correct decision for accepting or rejecting the finished material.

0.5 Working conditions and safety measures which should be observed in galvanizing plants are given in Appendix B.

1. SCOPE

1.1 This standard recommends important guidelines for general hot-dip galvanizing of iron and steel.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Ash — A mixture of zinc oxide and varying quantities of metallic zinc. The former is formed as a result of oxidation of clear zinc on the bath surface and when the oxide is skimmed off, a certain amount of metallic zinc gets entrapped and removed along with it.

2.2 Dross — An intermetallic compound (FeZn_{13}), which is a complex mixture of zinc and iron, forms in the galvanizing bath as a result of the reaction of molten zinc with iron or iron salts and settles down at the bottom of the bath. Zinc content in dross will vary between 94 to 97 per cent depending on the quantity of metallic zinc entrained in dross during its removal from the pot.

2.3 Flux — A chemical compound applied in the form of an aqueous solution and dried on to the work in the dry process or spread as a molten blanket over the zinc bath in the wet process. The primary purpose of the flux is to help in keeping the surface of both work and molten zinc free from oxide at the time of reaction. In both the galvanizing processes fluxing helps maintaining the surface of work free from oxides.

2.4 Over-Pickling — The undue attack of the underlying ferrous surface by the pickling solution after the removal of scale.

2.5 Inhibitor — A substance added to pickling solution to prevent undue attack on clean metal without affecting the scale removing property of the pickling solution.

2.6 White Rust — A white corrosion product, mainly containing zinc oxide and basic zinc carbonate, that accumulates on the galvanized surface exposed to water film or moist atmosphere.

2.7 Wetting Agent — A substance added to pickling and prefluxing solutions to facilitate wetting of the work surface.

3. BASE METAL FOR GALVANIZING

3.1 Steel — Mild steel is the most common material that is galvanized and the variations in the range of compositions used have little influence on the galvanizing process. The steel, however, should contain minimum amount of segregation, slag inclusions, rolled-in millscale, etc.

3.1.1 Carbon and silicon tend to increase the rate of reaction between steel and molten zinc. This effect, however, is not so apparent in the range of compositions encountered in mild steels as in high carbon and high silicon steels.

3.2 Cast Iron — Cast iron react with zinc differently depending on the exact composition, in particular, the silicon and phosphorus contents.

4. PREPARATION OF THE METAL SURFACE FOR GALVANIZING

4.1 Cleaning — If an article is contaminated by oil, grease or paint, pretreatment in special solvents will be necessary for their removal. Several proprietary reagents are available. Generally a sodium hydroxide solution obtained by dissolving 10 to 15 kg of sodium hydroxide in 100 litres of water is used.

4.1.1 The work should be so handled in the degreasing bath as to allow free circulation of liquid over all parts, taking care to clean the scum that may collect. If necessary, the work should be raised and lowered in order to allow the degreasing solution to enter inaccessible areas, threaded sections, etc, for a thorough cleaning action. When using sodium hydroxide solution, the temperature of the solution may be usually kept between 85 and 90°C and the immersion time varying from 1 to 20 minutes depending on the nature and degree of contamination. When using other proprietary degreasing agents; manufacturers' recommendation should be followed.

4.1.1.1 Immediately after degreasing, the work should be rinsed in hot water (60°C) followed, if possible, by a final rinse in cold running water. An ideal arrangement for rinsing would be to provide an inlet and outlet on two opposite sides of the rinsing tank; the inlet should be at the bottom of the tank and water should overflow from the top. This way the rinse water is in a dynamic state thereby ensuring an efficient and a thorough rinsing operation.

4.1.2 When lubricating materials have contaminated with the surface of the metal, it may be necessary to heat the part to bluing or scaling temperature in order to burn off the offending material. Since this is an expensive and difficult process, prior care should be taken to avoid such contamination.

4.2 Cleaning of Castings — Grey iron and malleable iron castings if not properly cleaned before annealing, develop burnt-on and patches at the surface which are not removed by normal pickling. Except in the case of light castings which would be damaged, all castings should be shot or grit blasted prior to galvanizing. It is generally recommended to give a quick rinse in running water followed by cleaning with one of the pickling acids. It is then processed according to normal fluxing practice

4.2.1 An alternative but less efficient method of cleaning castings with burnt-on sand is to employ a pickle solution containing hydrofluoric acid. For use, the commercial acid is diluted to various strengths, ranging from one volume of acid and 59 volumes of water for a very weak pickle to one volume of acid and 9 volumes of water for a very strong solution. With a weak solution pickling may take as long as 24 hours, while the strong solution should pickle satisfactorily in 10 to 30 minutes.

4.2.1.1 A hydrofluoric acid pickle leaves a gelatinous layer on the surface of the castings which shall be thoroughly removed by hosing with water and scrapping and brushing. The casting shall then go through the ordinary pickling process.

4.2.1.2 Solution containing 6 parts by volume of commercial hydrofluoric acid , 4 parts by volume of technical grade hydrochloric acid (*see* IS : 265-1976*) and 40 parts by volume of water may also be used for pickling. When pickling of castings is done occasionally, a solution consisting of 4 parts of dilute hydrochloric acid (1 : 1) and 1 part of hydrofluoric acid may be used.

4.3 Pickling — Both hydrochloric acid (*see* 4.3.1) and sulphuric acid (*see* 4.3.2) solutions may be used for pickling. Hydrochloric acid is used at room temperature while with sulphuric acid best results are obtained when it is hot (60 to 80°C).

*Specification for hydrochloric acid (*second revision*).

4.3.1 Hydrochloric Acid Solution (100-150 g/l) — Dilute technical grade acid conforming to IS : 265-1976* with an equal volume of water. The actual concentration of hydrochloric acid solutions and the time of immersion will depend on the nature of the work to be pickled.

4.3.1.1 A suitable inhibitor should be used with hydrochloric acid.

4.3.2 Sulphuric Acid Solution (100-150 g/l) — Dilute 6 to 8 ml of technical grade acid conforming to IS : 266-1977† to 100 ml. The actual concentration of sulphuric acid solutions, the temperature of the bath and the time of immersion will depend on the nature of the work to be pickled.

4.3.2.1 A suitable inhibitor should be used with sulphuric acid.

4.3.3 Agitation — Mild agitation of the work in the pickling tank reduces the time of pickling. Raise or lower the work once or twice to change the acid layer in contact with the work. Air agitation is not recommended.

4.3.4 Control of the Acid Solution — To make the best use of the solution, reasonably close control of its acid content is necessary. The solution should be tested for acid and iron contents at regular intervals in accordance with the methods given in Appendix C. The strength of the solution should be maintained by periodic addition of fresh concentrated acid. The iron salts in the pickling bath gradually accumulate with continued working and when the iron content reaches to about 100 to 120 g/l, the solution should be discarded.

4.3.5 Disposals of Waste Liquor — The acid and iron compounds may be recovered from the waste pickling solution. Where this is not done the pickling solution should be neutralized before dumping into sewers or streams.

4.4 Rinsing — After pickling, the article should be rinsed in running water. Two rinse tanks are preferable, the water cascading from one into the other, that is cascading from the second tank into the first tank.

4.5 Cleaning of Strip in the Continuous Galvanizing Process (ARMCO Sendzimir Process) — The cold-rolled strip is passed through an oxidizing furnace at temperature around 450°C where rolling lubricant is burnt and surface gets slightly oxidized. This is followed by reduction of surface oxides in the annealing/normalizing furnace under controlled atmosphere and subsequently allowing the strip to pass through molten zinc bath.

*Specification for hydrochloric acid (second revision).

†Specification for sulphuric acid (second revision).

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4.6 Fluxing

4.6.1 The rinsed article, in the dry process, is dipped in a strong solution of zinc ammonium chloride ($\text{ZnCl}_2 \cdot 3\text{NH}_4 \text{Cl}$), although ammonium chloride is also used to a certain extent. The actual concentration of the flux solution and its temperature depend on the work being undertaken and on individual circumstances. The working level is generally between 200 to 400 g of zinc ammonium chloride per litre. Some wetting agent is usually added to the flux solution. The temperature may range from room temperature to 80°C.

4.6.1.1 When dry galvanizing is adopted, the article shall be thoroughly dried after fluxing over a hot-plate or in an air-oven. The temperature should be about 120°C and should not exceed 150°C as the flux decomposes above this temperature.

4.6.1.2 In the wet process, a deep flux cover is used on the zinc bath and the work is immersed through the flux layer with or without fluxing. In this case drying is not considered essential.

4.6.2 The article that has been prefluxed and dried should be galvanized without delay, as the flux coating picks up moisture from the air and also tends to oxidize. The recommended time limit for galvanizing is within an hour of fluxing.

4.6.3 Control of Fluxing Solution — The specific gravity of the flux solution should be controlled by adding required quantities of flux crystals and water to make up for the drag-out losses.

4.6.3.1 Free acid content of the solution should also be checked, particularly if rinsing is not very thorough and pickle is carried over. The method described in Appendix C may be used for determination of free acid but the actual titration should be made on a 100 ml sample as the concentration of acid in the solution will be very low. When more than 2 g of free acid per litre of the solution is present, it should be neutralized by adding ammonia solution or addition of zinc spelter.

5. GALVANIZING

5.1 Quality of Zinc — Zinc containing at least 98.5 percent Zn should be used for the purpose of galvanizing.

5.1.1 Galvanizing Bath — The molten metal in the galvanizing bath should contain not less than 98.5 percent by mass of zinc.

5.2 Aluminium Additions — Aluminium may be added to the galvanizing bath in the dry process to the extent of about 0.005 percent (0.007 percent *Max*) (0.05–0.07 g/kg of zinc) to reduce the rate of oxidation of the molten metal and brighten the appearance of the article. In the continuous strip galvanizing process, addition of aluminium is made in the bath in the form of Zn-Al alloy to maintain aluminium between 0.12 to 0.20 percent to control alloy layer thickness and thereby imparting better adherence. Lead is also added in the form of Zn-Pb alloy to provide spangle on the surface.

5.3 Bath Temperature — The control of bath temperature is essential if the quality of the product is to be consistent and zinc is to be used economically. Articles should be galvanized at the lowest possible temperature which will allow the free drainage of zinc from the work piece during withdrawal. A low temperature reduces the formation of ash and dross, besides safeguarding the pot and conserving fuel. The bath temperature may vary from 440°C to 460°C and a working temperature of 450°C is commonly used. The temperature of the molten metal should not ordinarily exceed 475°C to prevent excessive attack of molten zinc on the work as well as on the pot. In case of high silicon steels, a higher galvanizing bath temperature of 550°C is adopted in order to obtain normal coating mass — the behaviour of silicon steels at 550°C is similar to that of ordinary steels at the normal galvanizing temperature at 450°C. However, for high temperature galvanizing, top heated ceramic bath are generally used.

5.4 Suspended Dross — Dross should be allowed to settle at the bottom of the zinc bath, and should not be disturbed more than necessary during the dipping operation (*see* 5.5). As far as practicable the article should not be sunk to the bottom of the bath during galvanizing. After drossing operations, by dipping the articles once again, some time should be allowed for the dross still remaining in the kettle to settle down.

5.5 Rate of Immersion — The work should be immersed as rapidly as possible but with due regard to operator's safety. This is especially important in wet galvanizing, where the amount of dross increases with the time of contact with the flux blanket. The speed of immersion also influences the uniformity of coating, particularly with long work piece where the difference in immersion time between the first and the last part to enter the bath may be considerable.

5.5.1 In case of continuous strip galvanizing the rate of immersion/withdrawal is dependent on the thickness of the strip and line speed governed by furnace design.

Top dross is removed at regular interval from the surface of the bath. Coating rolls and grooves are cleaned regularly.

5.5.2 Time of Immersion — The time of immersion for a job depends on several factors like its chemistry, size, thickness, type of job, etc. In most cases the article shall be left in the bath until it reaches the temperature of the bath which is usually indicated by the stopping of the boiling action. It is then withdrawn without much delay.

5.6 Withdrawal — The rate of withdrawal, which determines the thickness of the unalloyed zinc layer left on the article, varies according to the type of the process being operated and the form of article. With long article for which withdrawal occupies a large part of the total handling time, speeds are necessarily maintained at higher levels to ensure a reasonable rate of production. It is better to use special jigs and carriers for dipping and withdrawing the work in batches. The rate of withdrawal should be controlled so that zinc drains freely from the surface.

5.6.1 Articles are withdrawn through a bath of clear zinc to avoid contamination by flux. However, withdrawal through a flux blanket has also its advantages in the removal of surplus zinc from the surface and in producing a uniform coating at relatively higher speeds. In the latter case it is recommended to quench the material (see 5.7) to remove flux residues.

5.7 Water Quenching — Where the article is withdrawn through a flux blanket, the quench water needs to be changed frequently to prevent the accumulation of corrosive salts. For this purpose tanks having overflow weir may be used with advantage.

5.7.1 Light gauge articles should be spun quickly through the surface of water so that they retain sufficient heat after quenching to enable quick drying. Heavy articles retain sufficient heat for drying.

5.8 Centrifuging — Small articles handled in baskets should be centrifuged to remove excess of zinc immediately after galvanizing while the coating is still in the molten condition. The quality of the finish depends on the rapidity with which the material is transferred from the galvanizing bath to the centrifuge. It is also important that the centrifuge should be powered by a high starting torque electric motor to give rapid acceleration to peak speed within 2 to 3 seconds. After centrifuging, the articles should be immediately tipped into water to allow the coating to set and prevent the articles from sticking to each other.

5.8.1 Thread Brushing — Threads on articles which are unsuited for centrifuging shall be cleaned with a rotating wire brush immediately after galvanizing and before the coating sets. This process reduces the thickness and the protective value of the coating. It should only be confined to the threaded portions of the article.

5.9 Post-Treatment — The zinc coating on freshly galvanized surfaces when exposed to humid, poorly ventilated conditions during storage and/or transport react with the moisture, carbon dioxide, oxygen, etc, in the atmosphere forming a mixture of salts which are white in colour. This is known as 'white rust' or 'wet storage stain'. Normally a post-treatment like chromating is recommended. This is a temporary treatment and retards white rust attack. The chromating solution contains 1 percent sodium dichromate and half percent sulphuric acid solution — the solution is kept at room temperature and its temperature should never be allowed to rise above 65°C. The galvanized articles are dipped into the chromating solution after the galvanizing and water quenching operations.

5.9.1 In case of continuous strip galvanizing the strip is sprayed with chromating solution, such as chromic acid and properly spread uniformly by means of squeezer rolls. Temperature of the chromic acid bath is maintained around 70-75°C.

5.10 Stacking — Articles should not be stacked immediately after quenching (see 5.7) to avoid flaking of coating. The galvanized articles should be allowed to dry before any further handling operation.

6. TESTING AND INSPECTION

6.1 Freedom from Defects — The zinc coating shall be adherent, smooth, reasonably bright, continuous and free from such imperfections as flux, ash and dross inclusions, bare and black spots, pimples, lumpiness and runs, rust stains, bulky white deposits and blisters.

6.2 Uniformity in Thickness — Galvanized articles shall be tested for uniformity in thickness of coating in accordance with prece test given in IS : 2633-1986*. For quick approximate measurements of thickness, magnetic gauges may be used, but such instruments shall be suitably calibrated before use.

6.3 Mass of Coating — The mass of zinc coating may be determined in accordance with IS : 6745-1972†.

6.4 Adhesion Tests

6.4.1 Pivoted Hammer Test for Zinc Coated Fabricated Products (Fabricated from Plates, Bars, Strip, etc) — The adherence of the zinc coating on steel shall be determined by the pivoted hammer test. The hammer used shall conform to the drawing shown in Fig. 1. The hammer shall be made of normalized 0.3-0.4 percent carbon steel. The hammer blow shall be controlled by holding the pivoted base of the handle on a horizontal surface.

*Method of testing uniformity on zinc coated articles (second revision)

†Methods for determination of mass of zinc coating on zinc coated iron and steel article.

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of the galvanized member and allowing the hammer head to swing freely through an arc from vertical position to strike the horizontal surface. The test shall consist of two or more standard blows forming parallel impressions with 6 mm spacing and a common axis, as illustrated in Fig. 1. No part of an impression shall be closer than 12 mm to the edge of the member. Removal or lifting of the coating in the area between the impressions shall constitute failure. An extruded ridge less than 2 mm wide immediately adjacent to the impression shall be disregarded. The specimen is tested in several places throughout its length.

6.4.2 Knife Test for Zinc Coated Hardware and Assembled Steel Products — When the coating is cut or pried into, such as with a stout knife applied with considerable pressure in a manner tending to remove a portion of the coating, it shall only be possible to remove small particles of the coating and it shall not be possible to peel any portion of the coating so as to expose the underlying iron or steel.

6.4.3 Bend and Wrapping Tests for Zinc Coated Sheet and Wire — The material such as sheet or wire shall be tested by bending or wrapping in accordance with tests given in the relevant Indian Standards.

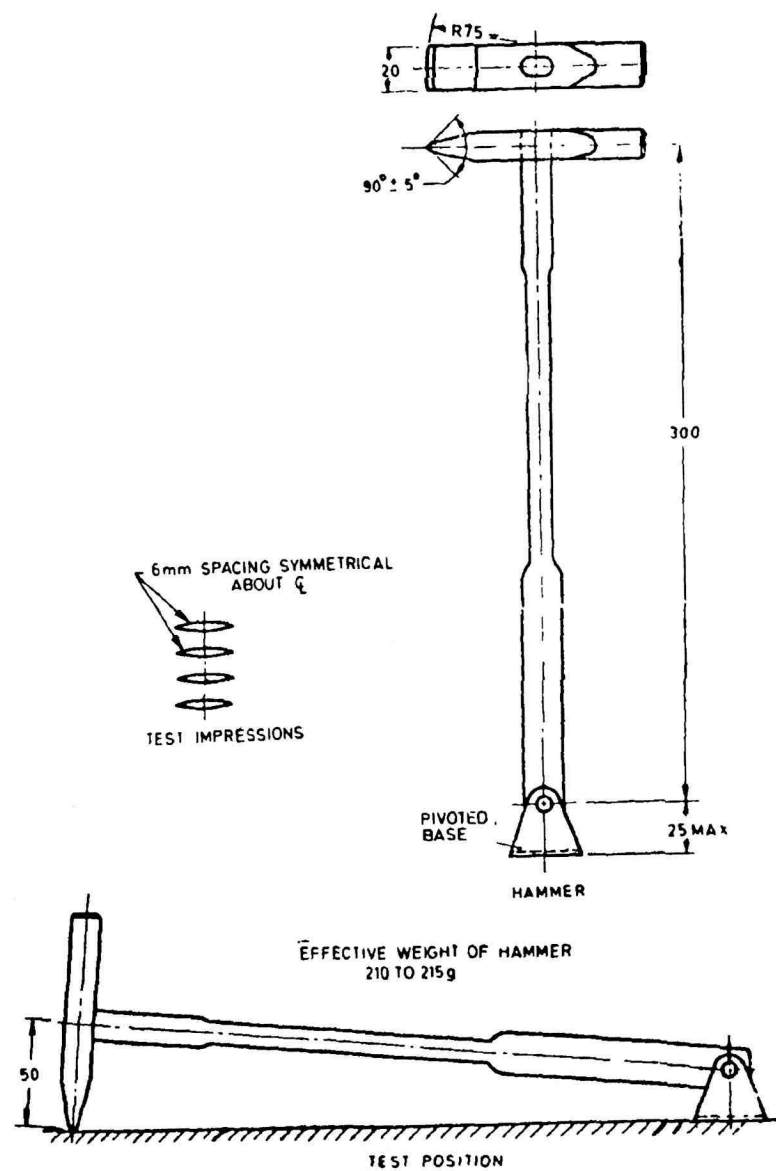
6.5 In case of continuous galvanized sheets, inspection and testing is carried out in accordance with IS : 277-1977* or any other standard specifications.

7. STORING, PACKING AND HANDLING

7.1 Sufficient care should be exercised while storing, packing and handling of galvanized products. While storing and transporting them, adequate ventilation should be provided as otherwise 'white rust' or 'wet storage stain' may result when galvanized coatings react with humidity and atmospheric gases. It is sometimes necessary to store galvanized articles with spacers in between them, they are also kept at an inclination to facilitate drainage of water collected on the articles. In areas where there is a substantial variation in day and night temperatures and hence condensation, the storage area kept warm by provision of heaters. In many cases, it will be advisable to give a post-treatment like chromating to minimise the chances for formation of white rust.

*Specification for galvanized steel sheets (plain and corrugated) (third revision).

IS : 2629 - 1985



All dimensions in millimetres.
FIG. 1 PIVOTED RIVETING HAMMER

DEFECTS, THEIR CAUSES AND REMEDIAL MEASURES

A purple under in crosscope)

FIGURE



DEFECTS	CAUSES	RECOMMENDED ACTIONS	GUIDANCE FOR ACCEPTANCE/REJECTION
Lumpiness and runs (uneven drainage)	Withdrawal speed too high	Remove work slowly	Only by prior agreement
	Cold galvanizing bath	Increase temperature	
	Delayed run-off seams, joints, bolt holes, etc	Remove work slowly	
	Articles in contact during withdrawal	Keep articles separated	

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Flux inclusions	Stale flux burnt on during dipping	Refresh or renew flux blanket	Flux stain if left over on the job after flux removal, is not considered as flux inclusion and hence should not be rejected
	Surface residues on steel	Check steel preparation	
	Flux picked up from top of bath	Skim before withdrawal	

16



(A microstructure of flux inclusion)

FIGURE



DEFECTS	CAUSES	RECOMMENDED ACTIONS	GUIDANCE FOR ACCEPTANCE/REJECTION
Ash inclusions	- Ash burnt on during dipping - Ash picked up from top of bath	- Skim bath before dipping - Skim bath before withdrawal	Yes, if in gross lumps

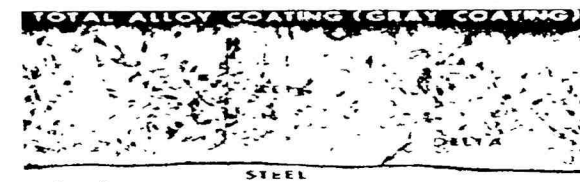


(A microstructure of ash inclusion)

17



Dull grey coating (all alloy no free zinc)	- Steel composition (high silicon, phosphorus or carbon) or severe cold work - Slow cooling after galvanizing - Release of absorbed hydrogen during solidification of coating	- Check steel supply for composition in order to adjust for galvanizing - Avoid hot stacking, quench - Avoid over-pickling, use inhibitor	Not if due to steel composition or condition, or limited to occasional areas. Control by prior agreement. Grey coating is only displeasing to the eye and is, not a defect at all. In fact, grey coating, compared to a bright coating, is abrasion resistant and is chemically more protective in some environment for instance, acidic environment.
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(Under a microscope, the cross section)

Rust stains	'Weeping' of acid, etc, from seams and folds - Storage near rusty material	- Check product design and fabrication - Check storage condition	No
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Guidance for
Acceptance
Requirements
No, then white
deposits can be
removed by
hand rubbing,
brushing, etc.
If deposits are
heavy, they
shall be removed
and the zinc
coating beneath
should be tested
for thickness
before accepting
or rejecting the
white rust affected
product
is recommended

RECOMMENDED
ACTIONS

Confinement of
store and ship in
close packed
dry well-ventilated
conditions.
Articles under
damp cond-
itions should
be treated
temporarily with
muriatic acid
solution like chro-
mium treatment
making is recom-
mended before pack-
ing. Include de-
siccant & tem-
perature protec-
tion treatment
like chromating
is recommended

CARE

Defects
Bulk, white
deposits
(wet
rust stain,
white rust)



Blister

Expansion of
Check steel ques-
tion
dropped by
hydrogen in-
flow
Driving off of
hydrogen ab-
sorbent during
pickling
Improper mat-
terializing (for
zinc practice)
Check malpractice
supply
Use shot blast
instead of pic-
kle
Check steel

Yes, if general



(A blister under microscope)

Tiny blis-
ters

Effect some-
times obser-
ved on ques-
tioned work.
Inable cast-
ing
May be caus-
ed by gas-
evolved from
the work
from above
been hydra-
tized
down of
carbon near
surface

Yes, if blistering
is general
widespread

FIGURE

APPENDIX B

(Clause 0.5)

WORKING CONDITIONS AND SAFETY MEASURES

B-1. WORKING CONDITIONS

B-1.1 The galvanizing shop should be kept neat and tidy. Where possible, increased use should be made of hoods, extraction ducts and exhaust fans to give as good an atmosphere as possible.

B-2. SAFETY MEASURES

B-2.1 All safety measures should be properly exhibited.

B-2.2 The workers at the galvanizing bath should be provided with:

- a) eye or face shield,
- b) rubber boots,
- c) steel-capped boots,
- d) leather or leather on woollen base gloves,
- e) rubber and leather aprons, and
- f) long rubber or PVC or neoprene gloves.

B-2.3 While cleaning the articles with sodium hydroxide solution, the operators should be warned that it produces severe flash burns. Special precautions should be taken to protect them from splashes of sodium hydroxide solution.

B-2.4 Hydrofluoric acid sometimes used for pickling of castings (see 4.2) is dangerous and causes very severe burns and sores when it comes in contact with the skin. It should, therefore, be carefully handled by wearing rubber boots, gloves and aprons.

B-2.5 Arrangement should be made to protect the galvanizer from the fumes over the zinc bath.

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APPENDIX C

(Clauses 4.3.4 and 4.6.3.1)

TEST METHODS

C-1. QUALITY OF REAGENTS

C-1.1 Unless otherwise specified, pure chemicals shall be employed in tests and distilled water (*see* IS : 1070-1977*) shall be used when the use of water as a reagent is intended.

NOTE — ' Pure chemicals ' shall mean chemicals that do not contain impurities which affect the results of analysis.

C-2. DETERMINATION OF ACID CONTENT OF THE PICKLING SOLUTION

C-2.1 Reagents

C-2.1.1 *Standard Sodium Carbonate Solution* — Approximately 0.5 N.

C-2.1.2 *Methyl Orange Indicator Solution* — Dissolve 0.05 g of methyl orange in 100 ml of alcohol.

C-2.2 *Procedure* — Filter exactly 25 ml sample of the pickle liquor into 250-ml measuring cylinder and make up to 250 ml by adding distilled water mix thoroughly. Pipette out 25 ml of this solution in a 250 ml conical flask. Add a few drops of methyl orange indicator and titrate it with the standard sodium carbonate solution to yellow end point.

C-2.3 Calculation

$$\text{Mass of hydrochloric acid in g/l} = \frac{A \times B \times 36.5}{2.5}$$

$$\text{Mass of sulphuric acid in g/l} = \frac{A \times B \times 49}{2.5}$$

where

A = volume in ml of the standard sodium carbonate solution required, and

B = normality of the standard sodium carbonate solution.

*Specification for water for general laboratory use (*second revision*).

C-3. DETERMINATION OF IRON CONTENT OF THE PICKLING SOLUTION

C-3.1 Measure density of the pickling solution with a hydrometer, then on the corresponding nomograph (see Fig. 2 and 3) depending on the acid used for pickling, join with a transparent ruler the point representing this reading shown on the left hand line with the point on the right hand line representing the acid content of the pickle. Read off the iron content on the middle line.

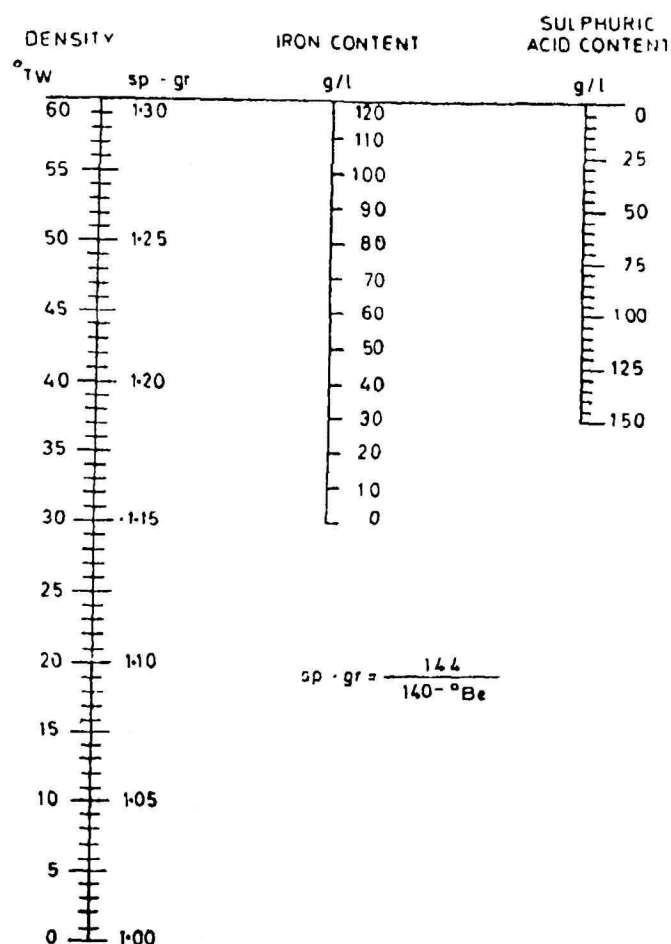


FIG. 2 NOMOGRAPH RELATING THE IRON CONTENT OF SULPHURIC ACID PICKLE TO THE ACID CONTENT AND DENSITY

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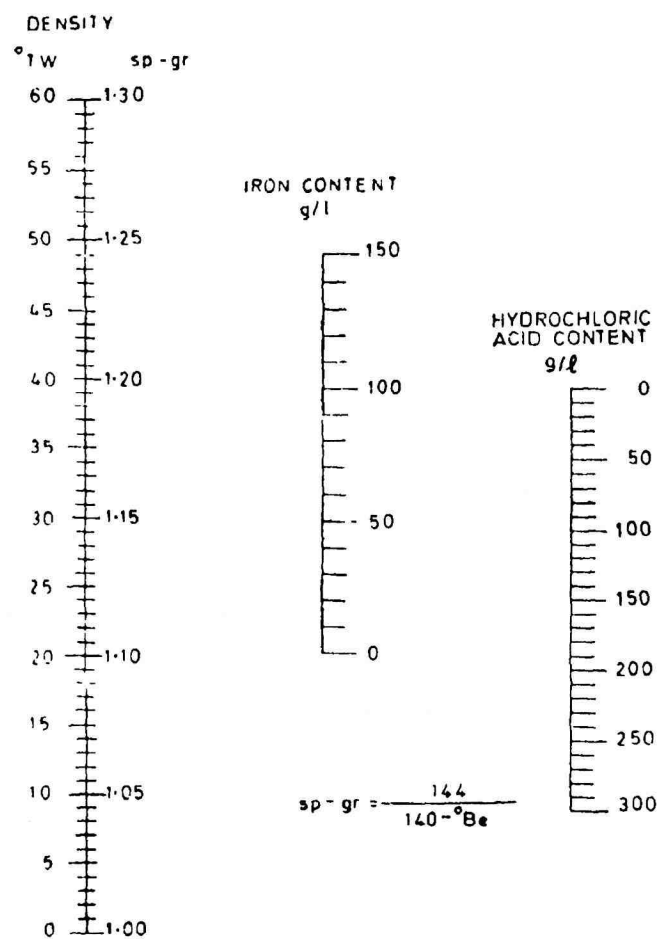


FIG. 3 NOMOGRAPH RELATING THE IRON CONTENT OF HYDROCHLORIC ACID PICKLE TO THE ACID CONTENT AND DENSITY

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