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R 2081

ELECTROPLATED COATINGS OF ZINC ON IRON AND STEEL

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BRIEF HISTORY

The ISO Recommendation R 2081, *Electroplated coatings of zinc on iron and steel,* was drawn up by Technical Committee ISO/TC 107, *Metallic and other non-organic coatings,* the Secretariat of which is held by the Ente Nazionale Italiano di Unificazione (UNI).

Work on this question led to the adoption of Draft ISO Recommendation No. 2081, which was circulated to all the ISO Member Bodies for enquiry in September 1970.

The Draft has been approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Australia	Israel	South Africa, Rep. of
Chile	Italy	Sweden
Czechoslovakia	Netherlands	Switzerland
France	New Zealand	Thailand
Greece	Norway	U.A.R.
Hungary	Portugal	United Kingdom
India	Romania	U.S.S.R.

The following Member Body opposed the approval of the Draft :

Germany

This Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided to accept it as an ISO RECOMMENDATION.

FOREWORD

This ISO Recommendation covers a range of coatings of zinc for the protection of iron and steel against corrosion under various service conditions.

The minimum thickness requirements apply only to those portions of the significant surface that can be touched by a ball 20 mm in diameter.

Passivation by chromate conversion coatings gives additional protection against corrosion and should be applied unless there is reason to the contrary.

Articles to be painted may require alternative treatment such as phosphating to provide good adhesion.

IT IS ESSENTIAL THAT THE PURCHASER STATE THE SERVICE CONDITION NUMBER OR THE CLASSIFICATION NUMBER.

MERELY TO ASK FOR PLATING TO BE CARRIED OUT IN ACCORDANCE WITH ISO RECOMMENDATION R 2081 WITHOUT THIS NUMBER IS INSUFFICIENT.

ISO Recommendation R 2081 October 1971

ELECTROPLATED COATINGS OF ZINC ON IRON AND STEEL

1. SCOPE AND FIELD OF APPLICATION

This ISO Recommendation applies to electroplated coatings of zinc on iron and steel for protection against corrosion, except for the following :

- coatings applied to machine screw threads (with tolerance);
- coatings applied to sheet, strip or wire in the unfabricated form, or to coil springs.

This ISO Recommendation does not specify the surface condition of the basis metal prior to plating; agreement on the degree of roughness which is acceptable should be reached between the purchaser and the supplier.

2. DEFINITION

For the purposes of this ISO Recommendation the following definition applies :

Significant surface. The part of the surface which is essential to the appearance or serviceability of the article and which is to be covered, or is covered, by the coating.

When necessary the significant surface should be the subject of agreement, and should be indicated on drawings or by the provision of suitably marked samples.

3. CLASSIFICATION

3.1 Grading of service conditions

The service condition number indicates the severity of the service conditions in accordance with the following scale :

4 – exceptionally severe

3 – severe

2 – moderate

1 – mild

These designations are conventional and it is recommended that the choice of the service condition number corresponding to the use of the part to be plated should be the subject of agreement between the purchaser and the supplier.

3.2 Classification of coatings

The classification number comprises :

- the chemical symbol, Fe, for the basis metal (iron or steel);
- the chemical symbol for zinc, Zn;
- a number indicating the minimum thickness (in micrometres) of the zinc coating;

the letter "c" indicating that passivation has been applied (to be omitted if agreed to the contrary – see section 5).

3.3 Coatings appropriate to each service condition number

The Table below shows the coating classification number and minimum thickness appropriate for each service condition number.

TABLE – Coatings of zinc on iron or steel

Service condition number	Classification number	Minimum thickness μm
4	Fe/Zn 40 c	40
3	Fe/Zn 25 c	25
2	Fe/Zn 12 c	12
1	Fe/Zn 5 c	5

NOTE. – In any particular environment the protective value of a zinc coating is directly proportional to its thickness. When very long service life is desired, as for example on structural steel components, thicker coatings are required and these are usually applied by hot-dip galvanizing or by metal spraying.

4. HEAT TREATMENT OF STEEL

When required by the purchaser, heat treatment as described below should be performed on certain steels to reduce the risk of damage by hydrogen embrittlement.

It is recommended that steels of tensile strength above 1500 N/mm^2 (or corresponding hardness*) should not be electroplated with zinc by conventional methods. It should also be noted that steels of tensile strength above 1000 N/mm^2 (or corresponding hardness**) will require heat treatment to minimize this risk.

4.1 Stress relief before plating

Severely cold-worked steel parts or parts made from steel of tensile strength of 1000 N/mm^2 (or corresponding hardness**) or greater which have been ground or subjected to severe machining after tempering, should normally be stress relieved. As a guide they may be maintained, preferably, at the highest temperature within the limit imposed by the tempering temperature for 30 minutes, or maintained at a temperature of 190 to 210 °C for not less than 1 hour.

Some steels which have been carburized, flame-hardened or induction-hardened and subsequently ground would be impaired by the treatment given before as guidance and should instead be stress relieved at a lower temperature; for example, at 170 °C for not less than 1 hour.

4.2 Heat treatment after plating

Components subject to fatigue or sustained loading stress in service and made from severely cold-worked steels or from steels of tensile strength of 1000 N/mm^2 (or corresponding hardness**) or greater should be heat treated after plating. Guidance is given in Annex A.

Where the heat treatment temperatures would be harmful, as for example, to certain surface hardened articles, it may be necessary to apply a lower temperature for a longer time.

5. PASSIVATION

Passivation by coloured or colourless chromate conversion coatings enhances the corrosion resistance of electroplated coatings of zinc and should be applied unless there is agreement to the contrary.

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* 45 HRC, 440 HV, 415 HB (Approximate values).

** 30 HRC, 295 HV, 280 HB (Approximate values).

6. REQUIRED CHARACTERISTICS

6.1 Appearance

Over the significant surface the plated article should be free from clearly visible plating defects such as blisters, pits, roughness, cracks or unplated areas. The extent to which blisters can be tolerated on non-significant surfaces should be the subject of agreement between the supplier and purchaser. On articles where a contact mark is inevitable, its position should also be the subject of agreement between the supplier and the purchaser.

The article should be clean and free from damage. Unless the purchaser specifies otherwise the zinc deposit should be bright. If necessary, a sample showing the required finish should be supplied or approved by the purchaser.

6.2 Thickness

The number following the chemical symbol Zn indicates, in micrometres, the minimum thickness of the zinc coating on the significant surface which should satisfy the appropriate value in the Table of clause 3.3.

In the case of articles having a significant surface area of 100 mm^2 or greater, this minimum thickness should be regarded as the minimum value of local thickness measured by the method given in ISO Recommendation R 1463, *Measurement of metal and oxide coating thicknesses by microscopical examination of cross-sections,* at points on the significant surface agreed between the purchaser and supplier or at any point on the significant surface that can be touched by a ball 20 mm in diameter.*

If the design of the article is such that it cannot at all points be touched by a 20 mm ball, the minimum thickness permitted on specified areas should be agreed between the purchaser and the supplier.

In the case of articles having a significant surface area less than 100 mm^2 this minimum thickness should be regarded as the minimum value of average thickness measured by the method given in Annex B.

6.3 Adhesion

The coating should continue to adhere to the basis metal when subjected to the method of test given in Annex C.

6.4 Continuity of passivation film

The passivation film should be continuous over the zinc surface. The presence of a colourless film is verified by the test method given in Annex D.

6.5 Adhesion of passivation film

The passivation film should be adherent and coloured films should be tested by one of the methods given in Annexes E and F.

6.6 Corrosion resistance of colourless passivation films

Colourless passivation films should be tested in accordance with the method given in Annex G. After the passivated article has been subjected to two cycles of the humidity test, there should be no breakdown of the film, or any appearance of white corrosion products. Slight staining may be ignored.

NOTE. – When heat treatment is required after plating it is usual to passivate after the heat treatment process. This is because many passivation films are affected by heat. In any event, tests on passivation films should be made after heat treatment.

6.7 Manner of specifying requirements

When ordering articles to be plated in accordance with this ISO Recommendation, the purchaser should state, in addition to the number of the ISO Recommendation, either the service condition number denoting the severity of the condition the coating is required to withstand (see clause 3.1) or the classification number of the particular coating required (see clause 3.2). The purchaser should also indicate any heat treatment required before and after plating.

7. SAMPLING

The method of sampling should be agreed between the contracting parties.

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* Other methods of thickness determination may be suitable for control purposes but are not mentioned in this ISO Recommendation.

ANNEX A

GUIDANCE ON HEAT TREATMENT OF STEEL PARTS AFTER PLATING

Tensile strength	Maximum sectional thickness of part	Minimum period at 190 to 210 °C
N/mm²	mm	hours
1000 to 1150	Less than 12	2
	12 to 25	4
	Over 25	8
1150 to 1400	Less than 12	4
	12 to 25	12
	25 to 40	24 Heating to commence within 16 hours of plating
	Over 40	Requires experimental determination

ANNEX B

DETERMINATION OF AVERAGE THICKNESS*

B.1 STRIPPING SOLUTION

Dissolve 20 g of antimony trioxide in 1000 ml of cold hydrochloric acid (d = 1.16 to 1.18).

B.2 PROCEDURE

Accurately determine the area of the plated part. If the article is of complex shape an area should be agreed between the contracting parties. Degrease it with an organic solvent, for example, trichloroethylene, dry thoroughly and weigh to an accuracy of 1/10 000. Then totally immerse it in the stripping solution and turn it over so that the solution has free access to all surfaces. After the effervescence has ceased, remove the sample immediately, wash, wipe to remove the loose coating of antimony and immerse in clean acetone to remove any trapped water. Then remove the sample, dry by the process previously used, and re-weigh.

B.3 CALCULATION

Thickness of zinc coating, in micrometres, is given by the formula :

$$\frac{141 \times 10^3 \, (m_1 - m_2)}{A}$$

where

m_1 is the original mass of the sample, in grammes;
m_2 is the final mass of the sample, in grammes;
A is the area of coating, in square millimetres.

NOTE. – The above calculation assumes a density of 7.1 g/cm³ for zinc.

* The presence of a passivation film can be ignored in making this test.

ANNEX C

BURNISHING TEST FOR ADHESION*

Rub an area of not more than 650 mm^2 of the plated surface rapidly and firmly with a smooth metal implement for 15 seconds.

The pressure should be sufficient to burnish the coating at every stroke, but not so great as to cut the deposit. Poor adhesion will be shown by the appearance of a loose blister which grows as rubbing is continued. If the quality of the deposit is also poor, the blister may crack and the plating will peel away from the basis metal.

More than one area may be tested if desired.

ANNEX D**

TEST FOR PRESENCE OF PASSIVATION FILM

Prepare a test solution consisting of 50 g of lead acetate (hydrated) in 1 litre of distilled or de-ionized water.

Place a drop of this test solution on the surface and allow it to remain there for 5 seconds. After this period, remove the drop by blotting gently, taking care not to disturb any deposit that may have formed.

A dark deposit or black stain is indicative of the absence of a passivation film.

For comparative purposes, a surface that is known not to have been passivated may be similarly treated.

ANNEX E**

PAPER TEST FOR ADHESION OF COLOURED PASSIVATION FILMS

The adhesion of a coloured passivation film is tested by rubbing the surface with soft white tissue paper. Failure is indicated by the appearance of anything more than a faint stain on the paper.

ANNEX F**

ERASER TEST FOR ADHESION OF COLOURED PASSIVATION FILMS

Rub the chromated surface with a gritless gum eraser (art-gum) for 2 or 3 seconds (about 10 strokes) using normal hand pressure and a stroke approximately 50 mm long. The passivation film should not be removed or worn through to the underlying metal as a result of this treatment.

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* This method should be regarded as tentative until adhesion testing has been studied by Technical Committee ISO/TC 107.

** (*a*) These methods are valid until the adoption of an ISO Recommendation relating to passivation.

(*b*) Before subjecting a chromate conversion coating to any test, it should be aged at room temperature in a clean environment for at least 24 hours after the passivation treatment.