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Phosphate conversion coatings for metals — Method of specifying requirements

Couches de conversion au phosphate sur métaux — Méthode de spécification des caractéristiques

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9717 was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*.

Annexes A, B, C, D, E, F, G, H and J of this International Standard are for information only.

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Introduction

Phosphate conversion coatings are applied to ferrous metals, aluminium, zinc, including zinc plated steel, cadmium and their alloys, either as an end finish or as an intermediate layer for other coatings.

They are intended to

a) impart corrosion resistance;

b) improve adhesion to paints and other organic finishes;

c) facilitate cold forming operations such as wire drawing, tube drawing and extrusion;

d) modify surface frictional properties so as to facilitate sliding.

A general description of the principle processes are given for guidance in annex A. Recommendations for coating and after-treatment for each end use are given in annex B , annex C, annex D and annex E.

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Phosphate conversion coatings for metals — Method of specifying requirements

1 Scope

This International Standard describes a method of specifying requirements for phosphate conversion coatings, intended primarily for application to ferrous metals, aluminium, zinc, cadmium and their alloys.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3768:1976, *Metallic coatings — Neutral salt spray test (NSS test).*

ISO 3892:1980, *Conversion coatings on metallic materials — Determination of coating mass per unit area — Gravimetric methods.*

ISO 4519:1980, *Electrodeposited metallic coatings and related finishes — Sampling procedures for inspection by attributes.*

3 Information to be supplied by the purchaser to the coater

NOTE 1 Close liaison between designers, manufacturers and conversion coaters is necessary to obtain satisfactory conversion coatings and to avoid adverse effects on the mechanical properties of the article.

3.1 Essential information

The following information shall be supplied by the purchaser to the conversion coater:

a) the number of this International Standard i.e. ISO 9717;

b) the nominal composition or specification and metallurgical condition of the basis material;

c) the sampling procedure to be adopted and acceptable quality levels (AQL'S) required (see clause 5);

d) the coating classification code (see clause 4);

e) the coating mass per unit area (see 7.2) and, if agreed, the coating thickness (see 7.2, note 5) required;

f) any requirements for after-treatment [see 4.2 d)];

g) the surface preparation required prior to phosphate conversion coating (see annex A, clause A.2);

h) the surface appearance (see 7.1);

i) the requirement for corrosion resistance (see 7.3 and annex H).

3.2 Additional information

The following additional information may be required and, if so, shall be specified by the purchaser, if necessary in consultation with the coater:

Any requirements for stress relieving treatment before phosphating and/or hydrogen embrittlement reduction after phosphating (see annex F).

4 Coating classification code

4.1 Types of coating

The principle types of phosphate conversion coatings and their designations are given in table 1.

Table 1 — Summary of principle types of phosphate conversion coatings

Coating type	Designation
Zinc phosphate	Znph
Zinc-calcium phosphate	ZnCaph
Manganese phosphate	Mnph
Iron(II) phosphate	Fehph
Iron(II) phosphated (produced by alkali-metal phosphate treatment)	Feph

NOTE 2 Other coating types exist including zinc phosphate modified with iron and/or nickel and/or manganese. The modifying metal will normally be present in the form of a double salt such as $Zn_2Me(PO_4)_2.4H_2O$, where Me represents Fe(II), Ni or Mn. Zinc remains the main metal constituent of these coatings which, to avoid confusion, have not been given separate designations. It should also be noted that metal from the substrate material will often be incorporated in the conversion coating.

4.2 Conversion coating classification code

The coating classification code comprises the following four elements.

a) A symbol given in table 1, which is the designation of the type of coating;

b) A symbol indicating the function of the conversion coating, as follows:

r — corrosion protection;

z — to facilitate cold forming;

g — to facilitate sliding action.

c) A number indicating the coating mass per unit area, in grams per square metre, with a tolerance of ± 30 %.

d) A symbol indicating any after-treatment of the conversion coating, as follows:

e — dyeing;

f — application of grease or oil;

w — application of wax;

s — application of soap;

a — application of paints, varnishes or similar coating materials;

d — application of inorganic or non film-forming organic sealants.

The conversion coating classification code, which is appended to the designation of the basis metal of the components to be phosphated, will not necessarily contain the four elements, for example only three elements would be needed if no after-treatment is required. Combinations of after-treatment may be employed, for example dyeing (c), followed by oiling (f) or sealing (d), followed by painting (a).

An example of a complete phosphate conversion coating classification code is as follows:

A zinc phosphate type coating applied to give corrosion protection at a mass per unit area of 3 g/m² ± 0,9 g/m² and for which the after-treatment is painting, has the coating classification number

Znph r 3 a

5 Sampling

Samples for test purposes shall be selected in accordance with the appropriate procedures given in ISO 4519.

These samples shall be of the same metal or alloy as the components that they represent, and shall possess similar surface characteristics to them.

6 Treatment of basis metals before coating

6.1 Stress relief

If the purchaser specifies that stress relief treatment is required (see 3.2) the necessary heat treatment should be carried out in accordance with annex F, clause F.1.

6.2 Shot peening

See annex F, clause F.1.

7 Phosphate conversion coating

7.1 Appearance

Inspection of the surface should be in accordance with the information given in annex G, to evaluate the appearance (colour and crystal size) and uniformity of the coatings.

7.2 Coating mass per unit area

The coating mass per unit area should be in accordance with the appropriate recommendations given in annex B, annex C, annex D and annex E and shall be determined in accordance with the appropriate method specified in ISO 3892.

NOTES

3 For quality assurance purposes, instruments which are available and which give a direct reading of coating mass per unit area may be used. It is, however, essential that they be calibrated against standard coatings having coating mass per unit area of the same order as those being inspected.

4 If required, the type of coating used may be identified by means of the method specified in annex J.

5 If the case of heavy coatings, the amount of phosphate deposited is sometimes expressed in terms of coating thickness, particularly for quality control purposes. The use of this alternative (and selection of a relevant test method) should be a matter for agreement between the purchaser and the coater.

6 Other properties of the coating such as surface profile and crystal size may be specified as an agreement between the purchaser and the coater.

7.3 Corrosion resistance

The corrosion resistance of the coated component should be determined using the appropriate procedure specified in annex H.

7.4 Suitability of coating to facilitate cold forming

Test methods to determine the suitability of a phosphate conversion coating to facilitate cold forming are not specified because of the difficulty of simulating actual processing conditions. Selection of the appropriate coating should therefore be in accordance with the recommendations given in annex D.

7.5 Suitability of coating to facilitate sliding action

Test methods to determine the suitability of a phosphate conversion coating to facilitate sliding action are not specified because of the difficulty of simulating actual processing conditions. Selection of the appropriate coating should therefore be in accordance with the recommendations given in annex E.

8 Heat treatment after coating

If the purchaser specifies that hydrogen embrittlement relief is required (see 3.2), the necessary heat treatment should be carried out in accordance with annex F, clause F.2.

9 After treatment

If the purchaser specifies that after-treatment of the phosphate coated surface is required [see 3.1 f)] the necessary treatment should be carried out in accordance with the appropriate requirements of annex B, annex C, annex D and annex E.

Annex A
(informative)

Guidance information

A.1 General

Phosphate conversion coatings are produced by treatment with solutions, the main constituents of which are the appropriate dihydrogen orthophosphates shown in table A.1. These coatings are applied principally to ferrous materials, aluminium, zinc and cadmium and differ in coating mass per unit area and apparent density, depending on

a) the construction material and surface condition of the components;

b) previous mechanical and chemical treatment of the components;

c) processing conditions for phosphating.

NOTE 7 All phosphate conversion coatings are more or less porous but can be substantially sealed by appropriate after-treatment.

The main types of phosphate conversion coatings and their characteristics are summarized in table A.1.

A.2 Surface preparation

A.2.1 Before processing, all scale, rust, grease, oil, finger prints and foreign matter should be removed from the surface to be coated by a method, or combination of methods, suitable for the particular phosphating process concerned, i.e. methods which give rise to a coarse crystalline structure may not be desirable. To avoid a phosphate conversion coating of coarse grain size or excessive coating mass per unit area, the use of strong alkalies or acids for cleaning should be minimized. If the conditions of components require such cleaning prior to phosphating, a neutralizing rinse should be used. The cleaned component should be adequately rinsed in cold or hot water to remove any residues from the cleaning process which might affect the composition of the bath solution or the quality of the coating. A conditioning rinse may be used immediately prior to phosphating to favour the formation of fine grain coatings without further rinsing. Materials based on titanium salts are currently used and are widely available from proprietary sources. It is also possible to incorporate such materials in mildly alkaline spray cleaners, thus obviating the need for a separate conditioning rinse. However, in this case rinsing before phosphating is essential.

NOTE 8 Certain phosphating processes combine surface preparation with phosphating.

A.2.2 Where acid pickling has been employed, it may be necessary to follow the use of pickling solutions containing wetting agents or inhibitors, by dipping in an acid solution without wetting agent or inhibitor or by dipping in a suitable alkaline solution in order to remove absorbed films.

A.3 Methods of application

Phosphating is usually carried out by immersing the component in a coating bath (with agitation of the solution if necessary), or by copious application or spraying of the component with the coating solution. Roller application may however be used in the case of galvanized or ungalvanized steel strip. The phosphated components are then rinsed with water, dried and after-treated according to their intended end use. Full details of the process conditions may, of course, be obtained from the appropriate operating instructions.

NOTE 9 Sludge is formed as a normal by-product of the phosphating reaction. The sludge does not usually interfere with processing but forms of agitation, which cause sludge to be deposited on the component, should be avoided. Filtration of the bath prevents sludge deposition on the work pieces.

Recommendations for the phosphate conversion coating and after-treatment of ferrous metals, aluminium, zinc and cadmium in respect of

— corrosion protection;

— improving the adhesion of paints, varnishes and related coatings and the corrosion resistance of the basis metal;

— facilitating cold forming;

— facilitating sliding action;

are given in annex B, annex C, annex D and annex E. respectively.

A.4 Heat treatment after phosphating

See annex F, clause F.2.

Table A.1 — Characteristics of phosphate conversion coatings

Main constituent(s) of phosphating bath	Coating type produced	Designation of coating	Usual appearance of coating	Coating mass per unit area (g/m^2) on			
				Ferrous materials	Aluminium	Zinc	Cadmium
$Zn(H_2PO_4)_2$	Zinc phosphate	Znph	Light grey to dark grey, crystalline	1 to 30	0,3 to 10	1 to 60	1 to 60
$Zn(H_2PO_4)_2$ $Ca(H_2PO_4)_2$	Zinc-calcium phosphate	ZnCaph	Light grey to dark grey, finely crystalline	1 to 10	—	1 to 10	—
$Mn(H_2PO_4)_2$	Manganese phosphate	Mnph	Light grey to dark grey, crystalline	1 to 30	—	—	—
$Me(I)H_2PO_4$ [1]	Phosphate of treated metal (plus oxides of iron in the case of ferrous materials)	Feph	Amorphous coatings of about 0,1 g/m^2 to 1 g/m^2 Iridescent e.g. yellowish to bluish grey Coatings over about 1 g/m^2 Grey	0,1 to 1,5	< 0,3	0,1 to 2	—
$Fe(H_2PO_4)_2$	Iron(II) phosphate	Fehph	Dark grey, crystalline	5 to 60	—	—	—

1) Me(I) denotes cation of alkali metal or NH_4^+.

Annex B
(informative)

Recommendations for phosphate conversion coatings to provide corrosion protection

Recommandations for phosphate conversion coatings and after-treatment to provide corrosion protection are summarized in table B.1.

Phosphate conversion coatings for corrosion protection are usually given a final rinse with aqueous solutions containing chromium or certain organic compounds, such as tannins. Where a water-soluble organic finish is to be applied without intermediate drying, a final rinse with de-ionized water is recommended.

In the absence of after-treatment, phosphate conversion coatings provide corrosion protection of only short duration. If the period of protection is to be extended, additional treatments appropriate to the end use of the phosphated surface are necessary e.g. the application of corrosion-protecting oils, greases or waxes (see table B.1). Such after-treatment should preferably be carried out prior to longer term storage of the phosphated components.

Table B.1 — Recommendations for phosphate conversion coatings and after-treatment to provide corrosion protection

Basis metal	Phosphate coating		After treatment	Corrosion protection effect obtained	Typical applications and end uses
	Preferred type of treatment	Coating mass per unit area g/m²			
Ferrous materials	Feph	0,1 to < 1,5	None	Temporary protection in dry environment (no condensation)	Short term, in-plant storage of machine components (⩽ 24 h)
	Znph	1 to 5	None		
	Znph Mnph	> 5 but preferably > 10	None None	Longer term protection in dry environment (no condensation)	Longer term, in-plant storage of machine components (⩽ 7 days)
	Znph Fehph Mnph	> 5 but preferably > 10	Protective oils or waxes as required, after dyeing of the coating	Long term protection in dry environment (no condensation) Temporary protection outdoors but with overhead cover	Corrosion protection in transit during long term storage
	ZnCaph	> 5			

Annex C
(informative)

Recommendations for phosphate conversion coatings to ensure good adhesion of paints, varnishes and related coatings and to improve corrosion resistance

Recommendations for phosphate conversion coatings to ensure good adhesion of paint, varnishes and related finishes, and to improve corrosion resistance of the basis metal, are summarized in table C.1.

If phosphated components are to be painted, varnished or similarly coated, they should first be rinsed in clean tap water and then preferably in demineralized water, so as to ensure that the surfaces are free from any water-soluble residues from previous processing etc., which could give rise to blister formation in the applied film. It is equally important that the phosphated surface to be painted should be free of additional contamination such as dust or finger prints.

Table C.1 — Recommendations for phosphate conversion coatings to ensure good adhesion of painted and related coatings and to improve corrosion resistance

Basis metal	Phosphate coating		After-treatment	Typical applications and end uses
	Preferred type of treatment	Coating mass per unit area g/m²		
Ferrous materials Zinc Aluminium Cadmium	Znph ZnCaph	1 to 10, but preferably 1 to 4	Paints, varnishes and related coatings	Motor vehicle bodies, refrigerator and washing machine cabinets
Ferrous materials	Feph	0,1 to < 1		
Zinc	Znph	1 to 5		Motor vehicle bodies, sheets and strips which are formed after painting and in particular where flexing of an organic after-treatment is involved