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Preparation of steel substrates before application of paints and related products — Surface preparation methods —

Part 4: Acid pickling

Préparation des subjectiles d'acier avant application de peintures et de produits assimilés — Méthodes de préparation des subjectiles —

Partie 4: Décapage à l'acide

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 12, *Preparation of steel substrates before application of paints and related products*.

A list of all parts in the ISO 8504 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The performance of protective coatings of paint and related products applied to steel is significantly affected by the state of the steel surface immediately prior to painting. The principal factors that are known to influence this performance are:

— the presence of rust and mill scale;

— the presence of surface contaminants, including salts, dust, oils and greases;

— the surface profile.

The ISO 8501 series, the ISO 8502 series and the ISO 8503 series provide methods for assessing these factors. The ISO 8504 series however provides guidance on the preparation methods that are available for cleaning steel substrates, indicating the capabilities of each in attaining the specified levels of cleanliness.

This document describes acid pickling, which is an effective method for surface preparation. It is widely applicable because this method of surface preparation has a number of versatile features listed below.

a) In general, the equipment is stationary but can be mobile.

b) The method is applicable to most types and forms of steel surface, especially those that would deform by abrasive blast-cleaning.

c) It is possible to remove rust or mill scale and non-steel metal traces from internal, external and complex structures surfaces.

d) Acid pickling can be performed for decorative and or aesthetic purposes.

There are several items that should be included in the purchaser's procurement documents to supplement this document. Surface imperfections should be considered before surface preparation and coating application. The ISO 8504 series does not contain recommendations for surface cleaning of equipment and cleaning of pipelines (such as chemical pipelines, petroleum pipelines).

The ISO 8504 series does not contain recommendations for the protective coating system to be applied to the steel surface. The ISO 8504 series does not contain recommendations on surface quality requirements for specific situations even though surface quality can have a direct influence on the choice of protective coating and on its performance. Such recommendations are found in other documents such as national standards and codes of practice. The ISO 8504 series is used to ensure that the specified qualities are:

a) compatible and appropriate both for the environmental conditions to which the steel will be exposed and for the protective coating system to be used;

b) within the capability of the cleaning procedure specified.

Preparation of steel substrates before application of paints and related products — Surface preparation methods —

Part 4: Acid pickling

WARNING — The procedures described in this document are intended to be carried out by suitably trained and/or supervised personnel. The substances and procedures used in these methods may be injurious to health if adequate precautions are not taken. Attention is drawn in the text to certain specific hazards. This document refers only to the technical suitability of the methods and does not absolve the user from statutory obligations relating to health and safety.

1 Scope

This document describes the typical method for acid pickling generally used in a shop facility for the preparation of steel substrates before application of paints and related products. It is in general applicable to new steelwork.

This method is essentially intended to remove rust and mill scale. Typically, only slight oil residues can be removed during this process. It can be used on steel surfaces that are easily deformed by abrasive blasting.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8502 (all parts), *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
acid pickling
treatment to remove rust and mill scale from steel substrates by means of an acidic solution usually containing an *inhibitor* (3.3)

3.2
pickling liquid
liquid mixed of an etching component (an organic acid, inorganic acid and / or complexing agent), an *inhibitor* (3.3) and generally a *surfactant* (3.4)

3.3
inhibitor
chemical substance or mixture of substances that decreases the pickling rate of metals when added to the media solution in a certain concentration and form, while maintaining most of the pickling rate on metal oxides like rust and mill scales

3.4
surfactant
substance that can significantly change the interface state (reduce the surface energy) of the solution system and can boost the degreasing capabilities

3.5
fresh water
water with a conductivity less or equal to 1 200 µS/cm (at 25 °C), or water of sufficient purity and quality that it does not prevent the surface being cleaned from achieving the specified degree of surface cleanliness or non-visible contaminant criteria if contained in the procurement documents (project specification)

4 General

4.1 Pickling liquid

4.1.1 Requirements to the chemical materials

The chemical materials for acid liquid, inhibitor and surfactant should be industrial grade and shall meet the requirements of and conform to a quality certificate.

4.1.2 Requirements to the formulation and process conditions of a pickling liquid

The acid pickling procedures and the preparation of pickling liquid shall be suitable to the material of the parts to be cleaned, its surface property and quantity. Generally, inorganic acids to be used include hydrochloric acid, sulfuric acid and phosphoric acid. Organic acids to be used include citric acid and oxalic acid.

4.1.3 Example of formulation and process conditions of a pickling liquid

See Table A.2 for examples on the formulation and process conditions of a pickling liquid.

4.2 General requirements

4.2.1 Requirements to the bath equipment materials

The equipment exposed to pickling liquid, such as tanks and pipes, should be made of proper anti-corrosion material.

4.2.2 Requirements to the bath analysis

Check the concentration of the pickling liquid regularly and add the chemical substance in time to ensure the concentration of the liquid meets the requirements.

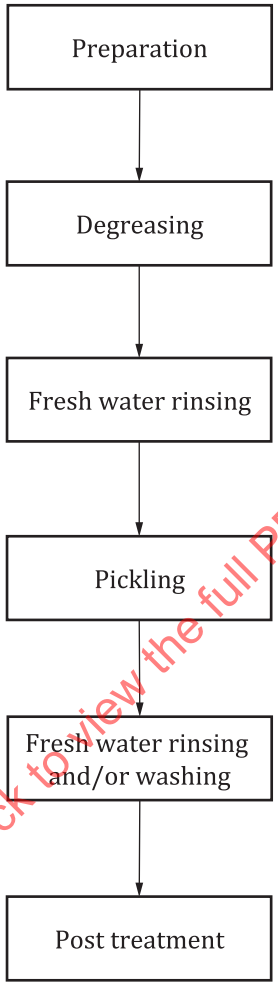
4.3 Health and safety

Equipment and materials used for surface preparation can be hazardous if used carelessly. Many national regulations exist for those materials that are considered to be hazardous during or after use (waste management), such as hazardous compounds or carcinogenic or toxic substances. The user shall be aware of these national or local regulations. It is important to ensure that adequate instructions are given and that all required precautions are exercised.

5 Method of acid pickling

5.1 Procedure for acid pickling

The typical procedure of acid pickling is shown in Figure 1.



NOTE 1 During the parts processing, the steel surface is coated by oil or grease normally, thus degreasing is needed. Degreasing and pickling also can be summarized in one step, according to the chemical solution used, if any.

NOTE 2 One or more fresh water washing processes can be necessary, depending on the ease of cleaning of a part.

Figure 1 — Procedure

5.2 Preparation

For the parts with heavy oil or grease, the surface is washed with organic solvent or water-based detergent before degreasing.

5.3 Degreasing

5.3.1 Components and conditions

Typically, alkaline solutions and surfactant shall be applied. Examples of the formulation and condition of degreasing liquid is shown in Table A.1.

5.3.2 Immersion method

Full immersion shall be adopted for degreasing.

5.3.3 Part placement

The placement of the parts shall be carefully arranged to avoid trapping air inside. Measures such as stirring or agitating the liquid with ultrasonic wave and compressed air shall be taken to continuously renew the liquid inside the parts.

5.3.4 Immersion time

The immersion time shall be controlled until all the surface of the part is clean (see Annex A).

5.3.5 Process temperature

If required, the waterborne degreaser temperature can be increased within the limits of the manufacturer's recommendations (see Table A.1).

5.4 Fresh water rinsing and/or washing

5.4.1 Fresh water rinsing process

The parts shall be rinsed to clean off any residue by using water with agitation. This can be accomplished by turning it over several times in the rinsing tank. The immersion time is typically 3 mins to 5 mins. The water shall be renewed continuously.

5.4.2 Rinsing water temperature

If required, the water temperature can be increased to 40 °C to 60 °C.

5.4.3 Fresh water washing process

The parts may be washed with a pressurized stream of water, or washed with a water jet. When the acid stain is washed away, the parts shall be put into the rinse pond.

5.5 Pickling

5.5.1 Immersion requirement

Full immersion shall be adopted for pickling.

5.5.2 Part placement

Gas can form during the pickling process. Parts should be placed in accordance with 5.3.3 to minimize the risk of trapping the formed gas.

5.5.3 Immersion time

The pickling is completed when the rust or mill scale on the part surface become loose. Further guidance on the immersion time is shown in Annex A.

5.5.4 Process temperature

If required, the temperature of the liquid may be increased within the limits of the manufacturer's recommendations.

5.6 Post treatment

5.6.1 Conversion layer

A conversion layer, such as phosphatising can be used after acid pickling to avoid flash rust and improve adhesion of subsequent coating. For further information on the phosphatising, see ISO 9717. Phosphatising can be replaced by phosphorus-free conversion, such as zirconium, titanium, silane and/or chrome(III)-based treatments.

NOTE Flash rust can also be avoided by additives in the rinsing water after pickling. This can be combined with the conversion systems named above.

5.6.2 Surface neutralization

If applicable, neutralization can be used after phosphatising, for example. Neutralize the remaining acid with slightly alkaline solutions and control the pH value of the solution to within 6 to 8. For further examples on the formulation and condition of neutralization liquid, see Table A.3.

5.6.3 Improvement of the phosphate layer

The corrosion resistance of the phosphate layer can be improved further by giving it a zirconium, titanium, silane and or chrome(III)-based treatment. This is instead of the alkaline passivation.

5.6.4 Quality check and assurance

The parts shall be checked after the above process. A protective coating shall be applied before degradation of the cleanliness to ensure the quality.

5.6.5 Drying

Natural drying can be used. Care shall be taken to prevent flash rust. When a dry product is needed for the continued process, then an accelerated drying process is recommended. Accelerated drying can be achieved by compressed air or by blowing hot air on the products. The temperature of the air can be between 40 °C and 100 °C.

6 Assessment of cleaned surface

Assess all cleaned surfaces as specified in the ISO 8502 series for conformity with the requirements agreed by all parties involved. In the event of non-conformity, repeat the procedure in Clause 5.

Work performed under this document is subject to assessment by a representative of those responsible for establishing the requirements. Work areas shall be accessible to the assessor. The procedures and times of assessment shall be as agreed by all parties involved.

Annex A
(informative)

Formulation and condition of common process liquids

The formulation and condition of common process liquids are shown in Tables A.1, A.2 and A.3.

Refer to the manufacturer's recommendation before increasing the temperature. Generally, an increase of 10 °C doubles the reactivity. However, this increase can make the inhibitor or surfactant less effective or break down both completely.

Table A.1 — Formulation and condition of degreasing liquid

No.	1	2	3	4	5
Sodium hydroxide (g/l)	30 to 40	—	3 to 10	3 to 10	—
Sodium carbonate (g/l)	30 to 40	25 to 35	3 to 10	3 to 10	0 to 2
12-Hydrate sodium phosphate (g/l)	30 to 40	25 to 35	3 to 10	3 to 10	—
Sodium tripolyphosphate (g/l)	—	—	3 to 10	3 to 10	0 to 2
5-Hydrate sodium metasilicate (g/l)	3 to 10	—	—	1 to 3	0 to 2
Organic acid (g/l)	0 to 5	0 to 5	0 to 5	0 to 5	1 to 10
Surfactant (g/l)	1 to 2	1 to 2	1 to 2	1 to 2	1 to 10
Temperature (°C)	80 to 90	80 to 100	40 to 60	40 to 60	1 to 10
Processing time (min)	3 to 8	3 to 8	2 to 5	2 to 5	20 to 50

Table A.2 — Formulation and condition of pickling liquid

No.	1	2	3	4
Sulfuric acid (g/l)	200 to 300	—	50 to 100	—
Hydrochloric acid (g/l)	—	300 to 800	100 to 300	—
Phosphoric acid (g/l)	—	—	—	150 to 250
Citric acid (g/l)	—	—	—	0 to 10
Tartaric acid (g/l)	—	—	—	0 to 10
Inhibitor (g/l)	1 to 2	1 to 2	1 to 2	1 to 2
Surfactant (g/l)	0 to 5	0 to 5	0 to 5	0 to 5
Temperature (°C)	60 to 85	5 to 40	5 to 40	5 to 50
Processing time (min)	2 to 10	3 to 8	5 to 25	5 to 25