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Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media - Part 2: Coatings on metallic components

Beschichtungen und Auskleidungen aus organischen Werkstoffen zum Schutz von industriellen Anlagen gegen Korrosion durch aggressive Medien - Teil 2: Beschichtungen für Bauteile aus metallischen Werkstoffen

Systemes de revetements organiques de peinture et autres revetements rapportés pour la protection des appareils et installations industriels contre la corrosion par des milieux agressifs - Partie 2: Revetements pour composants métalliques

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Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media - Part 2: Coatings on metallic components

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This European Standard was approved by CEN on 25 October 2006.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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Foreword

This document (EN 14879-2:2006) has been prepared by CEN/BT/Task Force 130 “Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2007, and conflicting national standards shall be withdrawn at the latest by June 2007.

EN 14879 "Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media" consists of the following parts:

— *Part 1: Terminology, design and preparation of substrate*

— *Part 2: Coatings on metallic components*

— *Part 3: Coatings on concrete components*

— *Part 4: Linings on metallic components*

— *Part 5: Linings on concrete components*

— *Part 6: Combined linings with tile and brick layers*

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This European Standard specifies the requirements for and methods of testing of organic coatings which are applied to metallic process engineering equipment that will come in contact with chemical substances (liquids, solids and gases). The requirements specified here may be used for the purposes of quality control (e.g. as agreed between the contract partners or been given by national regulations).

The standard does not cover coatings as in EN ISO 12944-1, but it does apply to coatings which serve one or more of the following purposes:

— to protect the component from adverse effects of aggressive substances;

— to protect waters (e.g. ground water) against hazardous substances;

— to protect the charge from becoming contaminated by components released from the substrate material;

— to achieve a particular surface properties.

The described coatings are to be used for metallic process engineering equipment that will come in contact with chemical substances. The different coating systems are:

— laminate coating systems which contain cold-curing resins;

— trowelled coating which contain cold-curing resins;

— sprayed coating systems which contain resins (in special cases, such coatings may also be applied by brushing, rolling, flow coating, dipping, or by other means, such as providing sleeving for nozzles);

— powder coating systems which contain organic materials (powder coatings may be used as corrosion protection or for non-stick purposes).

For design and preparation of substrate see EN 14879-1.

2 Normative references

The following referenced documents are indispensable for the application 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.

EN 59, *Glass reinforced plastics — Measurement of hardness by means of a Barcol impressor*

EN 228, *Automotive fuels — Unleaded petrol — Requirements and test methods*

EN 590, *Automotive fuels — Diesel — Requirements and test methods*

EN 13687-3, *Products and systems for the protection and repair of concrete structures — Test methods — Determination of thermal compatibility — Part 3: Thermal cycling without de-icing salt impact*

EN 14879-1:2005, *Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media — Part 1: Terminology, design and preparation of substrate*

prEN 14879-4, *Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media — Part 4: Linings on metallic components*

EN ISO 175, *Plastics — Methods of test for the determination of the effects of immersion in liquid chemicals (ISO 175:1999)*

EN ISO 178, *Plastics — Determination of flexural properties (ISO 178:2001)*

EN ISO 291, *Plastics — Standard atmospheres for conditioning and testing (ISO 291:2005)*

EN ISO 527-3, *Plastics — Determination of tensile properties — Part 3: Test conditions for films and sheets (ISO 527-3:1995)*

EN ISO 868, *Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness) (ISO 868:2003)*

EN ISO 2811-1, Paints and varnishes — Determination of density — Part 1: Pyknometer method (ISO 2811-1:1997)

EN ISO 2811-2, *Paints and varnishes — Determination of density — Part 2: Immersed body (plummet) method (ISO 2811-2:1997)*

EN ISO 2815, *Paints and varnishes — Buchholz indentation test (ISO 2815:2003)*

EN ISO 3001, *Plastics — Epoxy compounds — Determination of epoxy equivalent (ISO 3001:1999)*

EN ISO 3251, Paint, varnishes and plastics — Determination of non-volatile-matter content (ISO 3251:2003)

EN ISO 3882, *Metallic and other inorganic coatings — Review of methods of measurement of thickness (ISO 3882:2003)*

EN ISO 4624, *Paints and varnishes — Pull-off test for adhesion (ISO 4624:2002)*

EN ISO 4625-1, *Binders for paints and varnishes — Determination of softening point — Part 1: Ring-and-ball method (ISO 4625-1:2004)*

EN ISO 8503-2, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 2: Method for the grading of surface profile of abrasive blast-cleaned steel — Comparator procedure (ISO 8503-2:1988)*

EN ISO 12944-4, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 4: Types of surface and surface preparation (ISO 12944-4:1998)*

ISO 813, *Rubber, vulcanized or thermoplastic — Determination of adhesion to a rigid substrate — 90° peel method*

ISO 2559, *Textile glass — Mats (made from chopped or continuous strands) — Designation and basis for specifications*

ISO 8130-2, *Coating powders — Part 2: Determination of density by gas comparison pyknometer (referee method)*

IEC 60093:1980, *Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials*

IEC 60167, *Methods of test for the determination of the insulation resistance of solid insulating materials*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14879-1:2005 and the following apply.

3.1
fibre reinforced coatings
resin coatings reinforced by means of glass, carbon or synthetic fibres, for the standard named "laminate coatings"

3.2
contract partners
coating material manufacturer, component manufacturer, person(s) responsible for applying the coating, and client ordering the coated component(s)

3.3
substrate
surface on which a coating is applied

3.4
coating system (on a metallic component)
continuous film on the surface of a metallic component, comprising one or more layers, with a total system thickness of at least 100 µm

NOTE For non-stick coatings as in 5.4, the minimum total thickness is 50 µm.

3.5
coating material (for use on a metallic component)
cold- or heat-curing material, in liquid, paste or powder form, which will form a continuous film (coating) on the surface of a metallic component. Liquid coating materials may or may not contain solvents

3.6
total coating system thickness
sum of the thickness of all layers in a coating system

NOTE When specifying requirements for various aspects such as the suitability of a coating, the method of application, the component design or the surface condition of the substrate, it is expedient to differentiate between the following categories of coating system thickness:

a) up to 200 µm;

b) above 200 µm up to 1 mm;

c) above 1 mm.

4 General

4.1 Selection criteria

4.1.1 General

The stress to be encountered by a protective coating shall be known before the requirements for it can be specified. For the scope of this European Standard, the stress types detailed in 4.1.2 to 4.1.8 are the most relevant. Where necessary, grades have been used to describe different levels of stress.

4.1.2 Exposing media

Aggressive substances or water pollutants may occur as solids, fluids or gases. Their aggressive action on metallic components usually occurs when they are in a liquid state (e.g. aqueous solutions or condensates). The substances may occur at varying intervals in their pure state or as mixtures.

These substances shall be designated using the Geneva nomenclature, IUPAC[1)] nomenclature or CAS[2)] number. They may also be designated by trivial names which have become established in the literature. Concentrations and any changes to these shall be given as a percentage by mass or volume, or as g/l, g/kg, mol/l etc. The pH value shall also be given for aqueous solutions.

All constituents, including traces and impurities, shall be named, even if they do not attack metallic components. Successive exposure shall be represented accordingly.

Table 1 lists commonly used chemicals, which may have the properties mentioned above.

1) International Union of Pure and Applied Chemistry.

2) Chemical Abstract Service.

Table 1 — Classification of commonly used chemicals

Type of chemical	Examples	
I. Inorganic chemicals		
Inorganic, non-oxidizing acids	HCl	Hydrochloric acid
	H_2SO_4	Sulfuric acid, up to 70 %
	H_3PO_4	Phosphoric acid
Inorganic, oxidizing acids	HNO_3	Nitric acid
	H_2SO_4	Sulfuric acid, over 70 %
	CrO_3, H_2CrO_4	Chromic acid
	$HClO_3$	Chloric acid
Inorganic acids, dissolving SiO_2	HF	Hydrofluoric acid
	H_2SiF_6	Hexafluorosilicic acid (containing HF)
	HBF_4	Tetrafluoroboric acid (containing HF)
Salts	NaCl	Sodium chloride
	$FeSO_4$	Iron(II) sulfate
	Na_2CO_3	Sodium carbonate
Bases	NaOH	Sodium hydroxide
	KOH	Potassium hydroxide
	CaO, $Ca(OH)_2$	Calcium oxide Calcium hydroxide
	NH_4OH	Ammonia solution (Ammonium hydroxide solution)
Oxidizing bases	NaOCl	Sodium hypochlorite
II. Organic chemicals		
Organic acids	HCOOH	Formic acid
	CH_3COOH	Acetic acid
	$CH_2ClCOOH$	Chloroacetic acid
	$(COOH)_2$	Oxalic acid
	$CH_3CHOHCOOH$	Lactic acid
Aliphatic hydrocarbons	C_6H_{14}	Hexane
	C_8H_{18}	Octane
Aromatic hydrocarbons	C_6H_6	Benzene
	$C_6H_5CH_3$	Toluene
	$C_6H_4(CH_3)_2$	Xylene
Alcohols	CH_3OH	Methanol
	C_2H_5OH	Ethanol
	C_4H_9OH	Butanol
	CH_2OHCH_2OH	Ethanediol
Aldehydes, ketones, esters	CH_2O	Formaldehyde
	CH_3COCH_3	Acetone
	$C_2H_5COCH_3$	Methyl ethyl ketone (2-butanone)
	$CH_3COOC_2H_5$	Ethyl acetate
Aliphatic halogenated hydrocarbons	CH_2Cl_2	Dichloromethane
	C_2HCl_3	Trichloroethylene
	$C_2Cl_3F_3$	Trichlorotrifluoroethane
Aromatic halogenated hydrocarbons	C_6H_5Cl	Chlorobenzene
	$ClC_6H_4CF_3$	Chlorobenzotrifluoride
Aliphatic amines	CH_3NH_2	Methylamine
	$(C_2H_5)_3N$	Triethylamine
	$NH_2C_2H_4NH_2$	Ethylene diamine
Aromatic amines and pyridine	$C_6H_5NH_2$	Aniline
	C_5H_5N	Pyridine
Phenols	C_6H_5OH	Phenol
	$CH_3C_6H_4OH$	Cresol
Fats, oils		Vegetable and animal fats and oils

4.1.3 Type and frequency of fluid loading

The requirements for the protective or sealing function of a surface protection system are linked to the type and frequency of the fluid loads to which it will be exposed. Exposure shall be graded as follows.

Grade 0: no exposure to fluids;

Grade 1: constant or frequent exposure to a film of fluid, due to condensation and the like (e.g. gas ducts, stacks);

Grade 2: operational exposure to a constant flow of fluid involving no significant hydrostatic pressure (e.g. pipes);

Grade 3: constant exposure to fluid for unlimited periods (e.g. vessels).

4.1.4 Thermal loading

The thermal load caused by medium effect or other sources of heat affects the effectiveness of a surface protection system in the following way:

a) Aggressiveness of medium

Elevated temperatures increase the aggressiveness of the medium by raising the levels of its chemical reactions and diffusion, and also through the accumulation of volatile substances in the vapour space.

b) Thermal stress

Temperatures which deviate from the installation temperature cause thermal stress between the substrate and the surface protection system and may cause peeling, cracks etc. This may result from the direct action of hot or cold media, or from radiant heat and extreme ambient temperature.

The maximum thermal load shall be stated in °C.

4.1.5 Changes in temperature

Changes in temperature include:

a) temperature changes at the protective surface during exposure to fluid loads of grades 1 to 2 as in 4.1.3 caused by increased/decreased medium temperatures;

b) temperature changes as otherwise constantly heated or cooled surfaces, resulting from operational circumstances, such as start-up and shutdown.

c) process-related changes in the temperature of the medium under loading conditions corresponding to grade 3 (as in 4.1.3).

Temperature changes due to climatic influences are dealt with in 4.1.7.

The extent, direction, speed and frequency of temperature changes shall be taken into consideration when assessing their effect.

The following grades serve in assessing the effects of temperature changes, whereby details of the frequency and the duration of temperature changes are to be given for grades 1 to 4.

Grade 0: no temperature changes;

Grade 1: infrequent temperature changes up to 50 K;

Grade 2: infrequent temperature changes of more than 50 K;

Grade 3: frequent temperature changes of not more than 50 K;

Grade 4: frequent temperature changes of more than 50 K;

Grade 5: temperature changes involving thermal shock.

4.1.6 Mechanical loading

The effectiveness of a surface protection system may be impaired through exposure to mechanical loads or hydrostatic pressure during operation or assembly. The following grades shall be used to assess such loads.

Grade 0: no loads, or hydrostatic pressure up to 0,05 bar;

Grade 1: hydrostatic pressure from 0,05 bar to 0,5 bar;

Grade 2: hydrostatic pressure greater than 0,5 bar.

4.1.7 Climatic influences

Climatic influences may affect the durability of a surface protection system, and shall be graded as follows.

Grade 0: no climatic influences: the component is located inside a building and is not exposed to climatic influences;

Grade 1: limited climatic influences: a roof protects the component, which is exposed to limited climatic influences;

Grade 2: full climatic influences: the component is located outside, and is fully exposed to climatic influences.

4.1.8 Additional requirements

Additional requirements may derive from special applications, and are not fully covered by this European Standard. They may refer to water protection, explosion protection, fire behaviour, decontamination, health and safety (particularly in the case of foodstuffs and drinking water), non-slip surfaces and smoothness.

4.2 Load profile

The loads described in 4.1.2 to 4.1.8 shall be recorded, together with the grades selected. The form reproduced in Annex A should be used.

Tables G.1 to G.2 list frequently occurring load profiles and suitable surface protection systems.

4.3 Requirements

4.3.1 Components

The component to be coated shall meet the requirements of EN 14879-1.

4.3.2 Coating materials

Coating materials shall be selected which ensure that the coating will meet the requirements of this standard.

The manufacturer shall provide an adequate description of the material as regards its characteristics, processing and container marking. This can include, for instance, the items listed in Annex B.

4.3.3 Coating system

4.3.3.1 General

The coating system shall meet the requirements of this European Standard. To this end, the coating material manufacturer shall provide an adequate description of the system, including, for instance, the items listed in 4.3.3.2 to 4.3.3.8 (see for example Annex C).

4.3.3.2 Application methods

a) Laminating as in 5.1.

b) Trowelling as in 5.2.

c) Spraying as in 5.3.

d) Methods of applying powder coatings as in 5.4.

4.3.3.3 Coating system design and designation

The coating system design and designation shall be as specified in this European Standard (see Table 2).

Table 2 — Coating thickness (approximate values)

Type of coat or layer	Coating method			
—	Brushed, sprayed or rolled	Trowelled or floated	Laminate coating	Powder coatings
—	Coating thickness, in mm			
Primer	≥ 0,05	≥ 0,05	≥ 0,05	≈ 0,05
Intermediate layer [a]	-	≈ 1,0	≈ 1,0	-
Laminate layer	-	-	1,5 up to 4,0	-
Top coat	≤0,5 up to 2,0	1,5 up to 4,0	0,2 up to 2,0	0,05 up to 1,5
Sealant	-	0,1	0,2 up to 0,4	-
[a] Necessary for furane or phenolformaldehyde resins, except a thicker primer is applied.				

4.3.3.4 Surface properties

a) Colour.

b) Texture.

c) Gloss.

4.3.3.5 Mechanical properties

a) Adhesion.

b) Hardness.

c) Elongation at break.