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

Beschichtungen und Auskleidungen aus organischen Werkstoffen zum Schutz von industriellen Anlagen gegen Korrosion durch aggressive Medien - Teil 4: Auskleidungen 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 4: Revetements rapportés 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 4: Linings on metallic components

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This European Standard was approved by CEN on 24 June 2007.

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EN 14879-4:2007 (E)**Foreword**

This document (EN 14879-4:2007) has been prepared by Technical Committee 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of an identical text or by endorsement, at the latest by February 2008, and conflicting national standards shall be withdrawn at the latest by February 2008.

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 lining 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, Bulgaria, 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.

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1 Scope

This document describes the requirements for and methods of testing of organic linings which are applied to metallic process engineering equipment that will come in contact with chemical substances. The requirements specified here may be used for the purposes of quality control (e.g. as agreed between the contract partners¹⁾).

The standard applies to linings 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) from harmful substances;
- to protect the charge from becoming contaminated by components released from the substrate material;
- to achieve a particular surface quality.

This standard applies to vessels, apparatus, piping parts and other components for process plants made of metallic substrate materials which are in contact with media and are provided with a surface protection made of

- a) prefabricated, natural or synthetic rubber based sheeting (subsequently named rubber lining), to be applied in the workshop or on site;
- b) prefabricated, phenol formaldehyde or epoxy resin based sheeting (subsequently named duroplastic lining), to be applied in the workshop only;
- c) prefabricated, thermoplastic products (e.g. foils, sheeting, plates, pipes) (subsequently named thermoplastic lining), to be applied in the workshop or on site.

The standard specifies the requirements, acceptance inspection, packaging, transport, storage and installation of organic linings for metallic materials.

The tests described in this standard are intended for verification of the suitability of sheeting used for linings and for acceptance inspection to be carried out on the products during or after application of the lining or as part of routine inspections to determine any changes effected in the lining during service.

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 12814 (series), *Testing of welded joints of thermoplastics semi-finished products*

prEN 13122, *Hot gas welding of semifinished products of thermoplastic materials*

EN 14728, *Imperfections in thermoplastic welds — Classification*

1) For the purposes of this standard, the contract partners are the lining material manufacturer, the component manufacturer, the person(s) responsible for applying the lining, and the client ordering the linings.

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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*

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

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

EN ISO 2039-1, *Plastics — Determination of hardness — Part 1: Ball indentation method (ISO 2039-1:2001)*

EN ISO 4624:2003, *Paints and varnishes — Pull-off test for adhesion (ISO 4624:2002)*

EN ISO 8503-1, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 1: Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast-cleaned surfaces (ISO 8503-1:1988)*

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)*

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*

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

ISO 1817, *Rubber vulcanised — Determination of the effect of liquids*

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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

loose lining

loose shirt lining

lining partly fixed mechanically but not glued to the surface

4 General

4.1 Materials

4.1.1 Metallic substrates and semi-finished products

In accordance with EN 14879-1.

4.1.2 Linings

4.1.2.1 General

The lining materials used shall be suitable for the respective chemical, thermal, mechanical and other stresses to be expected in service. The requirements for the lining shall be subject to agreement between the user/customer and the manufacturer. Verification of suitability shall be performed in accordance with Clause 9.

The linings shall be tight and free from pores. For the purpose of this standard, pores are interconnected depth-penetrating cannular cavities (voids). The linings shall show no visible imperfections such as blisters, inclusions or impurities, which are likely to reduce their protective properties.

4.1.2.2 Rubber linings

A distinction shall be made between soft and hard rubber linings.

a) Soft rubber linings

Non-vulcanised and vulcanised semi-finished rubber based products shall be used as lining materials. The nominal lining thickness should be 4 mm. Other thickness has to be agreed and referenced in the standard designation.

The following types of soft rubber materials are commonly used (symbols in accordance with ISO 1629):

<u>Symbol</u>	<u>Name</u>
NR	Natural rubber
IR	Isoprene rubber, synthetic
CR	Chloroprene rubber
IIR	Isobutene-isoprene rubber (butyl rubber)
BIIR	Bromo-isobutene-isoprene rubber (Bromobutyl rubber)
CIIR	Chloro-isobutene-isoprene rubber (Chlorobutyl rubber)
CSM	Chlorosulfonylpolyethylene (Hypalon)
SBR	Styrene-butadiene rubber
NBR	Acrylonitrile-butadiene rubber (nitrile rubber)

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b) Hard rubber linings

Non-vulcanised semi-finished rubber based products shall be used as lining materials. The nominal lining thickness shall be at least 3 mm. Other thickness has to be agreed and referenced in the standard designation.

The following types of hard rubber materials are preferably used (symbols in accordance with ISO 1629):

<u>Symbol</u>	<u>Name</u>
NR	Natural rubber
IR	Isoprene rubber, synthetic
SBR	Styrene-butadiene rubber
NBR	Acrylonitrile-butadiene rubber (nitrile rubber)

4.1.2.3 Duroplastic linings

Duroplastic linings shall be made of non-cross linked materials in the form of sheeting. The nominal lining thickness shall be at least 3 mm. Other thickness has to be agreed and referenced in the standard designation.

The following types of resin based lining materials are commonly used (symbols in accordance with EN ISO 1043-1):

<u>Symbol</u>	<u>Name</u>
PF	Phenol-formaldehyde resin
EP	Epoxy resin

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4.1.2.4 Thermoplastic linings <https://standards.iteh.ai/catalog/standards/sist/88a1c7ed-50b9-464f-aba2-d4a456a35e1e/sist-en-14879-4-2009>

Prefabricated thermoplastic products shall be used as lining materials. Preferably, the lining thickness should be 3 mm. Other thickness has to be agreed and referenced in the standard designation.

The following thermoplastics are commonly used (symbols in accordance with EN ISO 1043-1):

<u>Symbol</u>	<u>Name</u>
PVC-U	Unplasticised poly(vinyl chloride)
PVC-P	Plasticised poly(vinyl chloride)
PP	Polypropylene
PTFE	Polytetrafluoroethylene
MFA/PFA	Perfluoro alkoxy alkane resins
FEP	Perfluoro(ethylene-propylene) plastic
E/CTFE	Ethylene/chlorotrifluoroethylene
PVDF	Poly(vinylidene fluoride)
PIB	Polyisobutene
PEEK	Polyetheretherketone

4.1.2.5 Composite thermoplastic/rubber lining

In accordance with 4.1.2.2 and 4.1.2.4.

The nominal thickness of the composite lining shall be at least 4 mm. Bonding between the individual materials shall be permanent. Other thickness has to be agreed and referenced in the standard designation.

4.1.2.6 Specific requirements for lining materials

4.1.2.6.1 Resistance to the service fluid

The performance of the lining shall not be impaired when it is subjected to stresses due to contact with the service fluid. Since linings are usually subjected to a variety of stresses, additional measures such as thermal insulation or a combination of different protective layers, e.g. brick lining, may be necessary to ensure their proper performance.

4.1.2.6.2 Physical properties

The values required for the physical properties of the selected lining material, e.g. density, tensile strength, elongation at fracture, modulus of elasticity, softening point and hardness, shall be specified as appropriate for the intended application and be verified as part of the quality control.

4.1.2.6.3 Characteristics of lining material

Semi-finished products to be used for linings shall meet the requirements agreed upon (see 4.1.2.1).

Multilayer materials shall be fully bonded interfacial and there shall be sufficient adherence between the individual layers.

4.1.2.6.4 Thickness of semi-finished products to be used for lining

The thickness of semi-finished products to be applied as linings shall be equal to the agreed nominal thickness and the permitted deviation shall be $\pm 10\%$.

4.1.2.6.5 Adhesion system

Adequate and long time adhesion of the lining to the substrate over the entire area shall be ensured. The adhesion system to be applied shall therefore be selected in consideration of the requirement for the lining material, except for linings applied without adhesion system, e.g. by "loose shirt" technique.

4.1.2.6.6 Additional requirements for the lining material

Other relevant requirements for the lining material, e.g. physiological safety, resistance against fluid based tension tear resistance, resistance to radiation, electrical conductivity and decontamination properties, shall be subject to agreement, if necessary.

4.2 Selection criteria

4.2.1 General

The stress to be encountered by a protective lining shall be known before the requirements for it can be specified. For the scope of this standard, the stress types detailed in 4.2.2 to 4.2.8 are the most relevant. Where necessary, grades have been used to describe different levels of stress.

EN 14879-4:2007 (E)**4.2.2 Aggressive substances**

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

These substances shall be designated using the Geneva nomenclature, IUPAC²⁾ nomenclature or CAS³⁾ 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 materials. Successive exposure shall be represented accordingly.

Table 1 lists chemicals which are commonly used, having the properties mentioned above.

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2) International Union of Pure and Applied Chemistry.

3) Chemical Abstract Service.

Table 1 — Classification of frequently (commonly) used chemicals

Type of chemical	Examples	
I. Inorganic chemicals		
Inorganic, non-oxidizing acids	HCl H ₂ SO ₄ H ₃ PO ₄	Hydrochloric acid Sulfuric acid, up to 70 % Phosphoric acid
Inorganic, oxidizing acids	HNO ₃ H ₂ SO ₄ CrO ₃ , H ₂ CrO ₄ HClO ₃	Nitric acid Sulfuric acid, over 70 % Chromic acid Chloric acid
Inorganic acids, dissolving SiO ₂	HF H ₂ SiF ₆ HBF ₄	Hydrofluoric acid Hexafluorosilicic acid (containing HF) Tetrafluoroboric acid (containing HF)
Salts	NaCl FeSO ₄ Na ₂ CO ₃	Sodium chloride Iron (II) sulfate Sodium carbonate
Bases	NaOH KOH CaO, NH ₄ OH	Ca(OH) ₂ Sodium hydroxide Potassium hydroxide Calcium oxide Calcium hydroxide Ammonia solution (Ammonium hydroxide solution)
Oxidizing bases	NaOCl	Sodium hypochlorite
II. Organic chemicals		
Organic acids	HCOOH CH ₃ COOH CH ₂ ClCOOH (COOH) ₂ CH ₃ CHOHCOOH	Formic acid Acetic acid Chloroacetic acid Oxalic acid Lactic acid
Aliphatic hydrocarbons	C ₆ H ₁₄ C ₈ H ₁₈	Hexane Octane
Aromatic hydrocarbons	C ₆ H ₆ C ₆ H ₅ CH ₃ C ₆ H ₄ (CH ₃) ₂	Benzene Toluene Xylene
Alcohols	CH ₃ OH C ₂ H ₅ OH C ₄ H ₉ OH CH ₂ OHCH ₂ OH	Methanol Ethanol Butanol Ethanediol
Aldehydes, Ketones, esters	CH ₂ O CH ₃ COCH ₃ C ₂ H ₅ COCH ₃ CH ₃ COOC ₂ H ₅	Formaldehyde Acetone Methyl ethyl ketone (2. butanone) Ethyl acetate
Aliphatic halogenated hydrocarbons	CH ₂ Cl ₂ C ₂ HCl ₃ C ₂ Cl ₃ F ₃	Dichloromethane Trichloroethylene Trichlorotrifluoroethane
Aromatic halogenated hydrocarbons	C ₆ H ₅ Cl ClC ₆ H ₄ CF ₃	Chlorobenzene Chlorobenzotrifluoride
Aliphatic amines	CH ₃ NH ₂ (C ₂ H ₅) ₃ N NH ₂ C ₂ H ₄ NH ₂	Methylamine Triethylamine Ethylene diamine
Aromatic amines	C ₆ H ₅ NH ₂ C ₅ H ₅ N	Aniline Pyridine
Phenols	C ₆ H ₅ OH CH ₃ C ₆ H ₄ OH	Phenol Cresol
Fats, oils		Vegetable and animal fats and oils