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Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media - Part 5: Linings on concrete components

Organische Beschichtungs- und Auskleidungssysteme zum Schutz von industriellen Anlagen gegen Korrosion durch aggressive Medien - Teil 5: Auskleidungen auf Untergründen aus Beton

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/SS C02.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Foreword

This document (prEN 14879-5:2005) has been prepared by Working Group 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 document is currently submitted to the CEN enquiry.

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*

The Annexes D, E, F and G are normative, the Annexes A, B, C and H are informative.

1 Scope

This document describes the requirements for and methods of testing of organic linings which are applied to concrete process engineering equipment that will come in contact with aggressive 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).

The standard applies to linings which serve one or more of the following purposes:

— to protect the component from damaging 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.

The different lining systems are:

a) bonded linings;

b) mechanically fixed linings;

c) loose linings of sheeting material;

d) loose linings of pre-formed pieces or lining units.

This standard establishes recommendations which may be used as guidelines for quality control procedures by the contracting parties (the manufacturer of the lining materials, the manufacturer of the precast concrete parts to be coated, the lining manufacturer and the purchaser of the finished product.

Handling of aggressive or water pollutant materials is understood to include

a) storage

b) filling

c) loading and unloading

d) manufacture

e) treatment

f) use.

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 977:1997, *Underground tanks of glass-reinforced plastics (GRP) — Method for one side exposure to fluids*

EN 1081, *Resilient floor coverings — Determination of the electrical resistance*

EN 1339, *Precast concrete paving flags*

EN 1766, *Products and systems for the protection and repair of concrete structures — Test methods — Reference concretes for testing*

EN 1767, *Products and systems for the protection and repair of concrete structures — Test methods — Infrared analysis*

EN 10204, *Inspection documents for metallic products (included Amendment A1:1995)*

EN 12350-1, *Testing fresh concrete — Part 1: Sampling*

EN 13067, *Plastics welding personnel — Qualification testing of welders — Thermoplastic welded assemblies*

EN 13238, *Reaction to fire tests for building products — Conditioning procedures and general rules for selection of substrates*

EN 13318, *Screed material and floor screeds — Definitions*

EN 13813, *Screed material and floor screeds — Screed material — Properties and requirements*

EN 14879-1, *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 22286, *Rubber- or plastics-coated fabrics — Determination of roll characteristics (ISO 2286:1986)*

EN 24624, *Paints and varnishes — Pull-off test for adhesion (ISO 4624:1978)*

EN ISO 75-1, *Plastics — Determination of temperature of deflection under load — Part 1: General test method (ISO 75-1:1993)*

EN ISO 175, *Methods of test for 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 179:1993, *Plastics — Determination of Charpy impact strength*

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

EN ISO 1183-1, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pyknometer method and titration method (ISO 1183- 1:2004)*

EN ISO 4600, *Plastics — Determination of environmental stress cracking (ESC) — Ball or pin impression method (ISO 4600:1992)*

EN ISO 6272, *Paints and varnishes — Falling-weight test (ISO 6272:1993)*

EN ISO 6721-2, *Plastics — Determination of dynamic mechanical properties — Part 2: Torsion-pendulum method (ISO 6721-2:1994, including Technical Corrigendum 1:1995)*

EN ISO 14632, *Extruded sheets of polyethylene (PE-HD) — Requirements and test methods (ISO 14632:1998)*

EN ISO 15013, *Extruded sheets of polypropylene (PP) — Requirements and test methods (ISO 15013:1998)*

ISO 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties / Note: To be replaced by ISO/DIS 37 (2004-03)*

ISO 554, *Standard atmospheres for conditioning and/or testing — Specifications*

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

ISO 1133:1997, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics*

IEC 60093:1993, *Methods of test for insulating materials for electrical purposes — Volume resistivity and surface resistivity of solid electrical insulating materials (IEC 60093:1980)*

IEC 60167, *Methods of test for insulating materials for electrical purposes — Insulation resistance of solid materials (IEC 60167:1964)*

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions in addition of those of EN 14879-1 apply.

NOTE The terms used to designate structural elements requiring surface protection are usually based on the function of the elements in the process plant. For the sake of consistency, the most common of these elements are referred to here on the basis of their function within the structure.

3.1
floor (bottom)
flat or inclined surface, such as the floor of a production or storage area, and the bottom of a vessel

3.2
wall
vertical or almost vertical limiting surface, such as the wall of a production and storage area, and the wall of a vessel

3.3
ceiling (top)
upper limiting surface, such as the ceiling of a production and storage area, and the top of a vessel

3.4
gutter
open indentation, moulded in the floor, through which fluids may drain away

3.5
trench
open or covered element in the floor of any shape or size, whose invert is considerably lower than the floor, and through which fluids may drain away

3.6
pipe
hollow cylinder of any shape or size, through which fluids, gases and vapours may pass

3.7
sump
depression in the floor, designed as the lowest point from which collected substances can be drained off

3.8
collecting basin
tight basin or area designed to collect any water pollutants leaking in an emergency

3.9
tank
open or closed facility of any shape or size designed to contain permanently fluids, solids, gases and vapours. Typical designations for containers are basin, cistern, vessel, tank

4 Concepts and selection criteria

4.1 Surface protection types and systems

4.1.1 General

Surface protection is usually applied as a lining as in 4.1.2 and clause 5, as a coating as in EN 14879-4 or as a composite coating or lining system as in EN 14879-6. The last of these combines a chemically resistant sealing coat with a wearing layer.

4.1.2 Protective linings

Linings based on organic binders, such as

a) **Bonded linings**

Bonded linings comprise pre-fabricated sheets that are fixed to the substrate by means of an adhesive applied over the entire surface area. The sheets are then jointed using an adhesive or by welding.

b) **Mechanically fixed linings**

Linings made of thermoplastic units (e.g. sheets, slabs or pre-formed pieces) that are fixed to the concrete substrate by means of fasteners systematically arranged on the units' underside. The lining units are then jointed by welding.

These linings may be applied either during the construction of the concrete member or after construction has been completed, in which case the lining is attached to a layer of facing concrete.

c) **Loose linings of sheeting material**

Pre-fabricated linings that are laid loosely on the substrate, jointed and then fixed to the walls by means of metal beads, for example.

The sheets are usually surfaced with gravel or screed, or protected against exposure to sunlight, warping and mechanical damage by means of a masonry facing.

d) **Loose linings of pre-formed pieces or linings units**

Linings made of pre-formed pieces laid in the concrete member (e.g. tanking of containers) and then fixed or welded at the top edge, if necessary.

4.2 Selection criteria

4.2.1 General

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

4.2.2 Aggressive substances

Aggressive substances or water pollutants may occur as solids or fluids. Their aggressive action on concrete 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 concrete at varying intervals.

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 concrete. Successive exposure shall be represented accordingly.

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

1) International Union of Pure and Applied Chemistry.

2) Chemical Abstract Service.

Table 1 — Classification of frequently (commonly) used chemicals

Type of chemical	Examples	
I. Inorganic chemicals		
Inorganic, non-oxidizing acids	HCl H_2SO_4 H_3PO_4	Hydrochloric acid Sulphuric acid, up to 70 % Phosphoric acid
Inorganic, oxidizing acids	HNO_3 H_2SO_4 CrO_3, H_2CrO_4 $HClO_3$	Nitric acid Sulphuric acid, over 70 % Chromic acid Chloric acid
Inorganic acids, dissolving SiO_2	HF H_2SiF_6 HBF_4	Hydrofluoric acid Hexafluorosilicic acid (containing HF) Tetrafluoroboric acid (containing HF)
Salts	$NaCl$ $FeSO_4$ Na_2CO_3	Sodium chloride Iron (II) sulphate Sodium carbonate
Bases	$NaOH$ KOH CaO, $Ca(OH)_2$ NH_4OH	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_3COOH $CH_2ClCOOH$ $(COOH)_2$ $CH_3CHOHCOOH$	Formic acid Acetic acid Chloroacetic acid Oxalic acid Lactic acid
Aliphatic hydrocarbons	C_6H_{14} C_6H_{18}	Hexane Octane
Aromatic hydrocarbons	C_6H_6 $C_6H_5CH_3$ $C_6H_4(CH_3)_2$	Benzene Toluene Xylene
Alcohols	CH_3OH C_2H_5OH C_4H_9OH CH_2OHCH_2OH	Methanol Ethanol Butanol Ethanediol
Aldehydes, Ketones, esters	CH_2O CH_3COCH_3 $C_2H_5COCH_3$ $CH_3COOC_2H_5$	Formaldehyde Acetone Methyl ethyl ketone (2.butanone) Ethyl acetate
Aliphatic halogenated hydrocarbons	CH_2Cl_2 C_2HCl_3 $C_2Cl_3F_3$	Dichloromethane Trichloroethylene Trichlorotrifluoroethane
Aromatic Halogenated hydrocarbons	C_6H_5Cl $ClC_6H_4CF_3$	Chlorobenzene Chlorobenzotrifluoride
Aldehydes	CH_2O	Formaldehyde
Aliphatic amines	CH_3NH_2 $(C_2H_5)_3N$ $NH_2C_2H_4NH_2$	Methylamine Triethylamine Ethylene diamine
Aromatic amines	$C_6H_5NH_2$ C_6H_5N	Aniline Pyridine
Phenols	C_6H_5OH $CH_3C_6H_4OH$	Phenol Cresol
Fats, oils		Vegetable and animal fats and oils

4.2.3 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: sporadic exposure to droplets of fluid (e.g. laboratory floors, floors in small units, walls).

Grade 2: frequent, short-term exposure to splashes of fluid, where the surfaces are regularly flushed (e.g. floors of closed production plants).

Grade 3: exceptional and limited exposure to fluids during operations (e.g. due to plant failure) in, for example, collecting basins.

Grade 4: constant or frequent exposure to a film of fluid, due to wetness, condensation, puddles, trickles and the like (e.g. floors in production plants, electroplating plants or pumping stations).

Grade 5: operational exposure to a constant flow of fluid involving no significant hydrostatic pressure (e.g. open gutters, trenches and their pump sumps, closed trenches and pipes).

Grade 6: constant exposure of containers to fluid contents for unlimited periods (e.g. vessels, pits).

4.2.4 Thermal loading

Temperature influences the effectiveness of a surface protection system in the following ways.

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 headspace.

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.

4.2.5 Changes in temperature

Changes in temperature include

a) temperature changes at the protective surface during exposure to fluid loads of grades 3 to 5 as in 4.2.3 involving changed medium temperatures;

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

c) temperature changes, possibly involving thermal shock, which occur during cleaning operations;

d) process-related changes in the temperature of the medium under loading conditions corresponding to grade 6 (as in 4.2.3).

Temperature changes due to climatic influences are dealt with in 4.2.7.

The source, degree, 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 of not more than 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.

4.2.6 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: loads up to 0,2 N/mm^2 (e.g. pedestrian traffic, light transport, static loading).

Grade 2: loads up to 1 N/mm^2 (e.g. vehicles with pneumatic tires, static loading).

Grade 3: loads over 1 N/mm^2, for example

a) loads of 1 N/mm^2 to 7 N/mm^2 (e.g. vehicles with Vulkollan wheels, static loading).

b) loads over 7 N/mm^2 (e.g. vehicles with polyamide wheels, static loading).

Grade 4: impact loads, such as those resulting from setting down sharp-edged objects (e.g. barrels), and from scraping (e.g. shovel loaders).

Grade 5: hydrostatic pressure from 0,05 bar to 0,5 bar.

Grade 6: hydrostatic pressure greater than 0,5 bar.

4.2.7 Weather factors

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.

4.2.8 Additional requirements

Additional requirements may derive from special applications, and are not fully covered by this 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.

4.3 Load profile

The loads described in 4.2.2 to 4.2.8 shall be recorded, together with the grades selected, using the form reproduced in Annex A.

Tables B.1 to B.5 in Annex B list frequently occurring load profiles and suitable surface protection systems.

5 Concepts

5.1 Lining materials

Lining materials, including materials used for attaching the lining to the substrate and for jointing, shall be capable of withstanding the chemical, mechanical and thermal loads included in the 'load profile' drawn up as specified in sub-clauses 4.2.3 to 4.2.8 and in Annex B.

Specific properties (e.g. compatibility between chemicals and the lining, resistance to mould and bacterial growth, resistance to ultraviolet or radioactive radiation, or electrostatic dissipation) may be required for special applications.

5.2 Lining materials manufacturer

Manufacturers of lining materials shall have suitable, functional manufacturing equipment and qualified personnel.

Lining materials shall be accompanied upon delivery by a type 3.1 inspection document, or 'inspection certificate', as in EN 10204.

5.3 Applicator

The applicator shall have suitable equipment and qualified personnel; this will ensure that the lining is properly applied in accordance with this standard.

6 Materials

6.1 Materials for bonded linings

6.1.1 Soft rubber

Soft rubber linings shall consist of single- or double-ply sheets of self-vulcanising, or partially or completely vulcanised soft rubber. Lining systems of soft rubber may be applied in multiple layers.

Table 2 lists commonly used rubbers and the maximum temperatures for which they are suitable.

Table 2 — Recommended maximum operating temperatures for soft rubbers

Symbol	Rubber type	Maximum temperature in °C
NR	Isoprene rubber (Natural rubber)	+ 80
CR	Polychloroprene rubber	+ 80
IIR	Isobutene-isoprene rubber (Butyl rubber)	+ 100
BIIR	Bromo-isobutene-isoprene rubber (Bromobutyl rubber)	+ 100
CIIR	Chloro-isobutene-isoprene rubber (Chlorobutyl rubber)	+ 100
CSM	Chlorosulfonated polyethylene	+ 80
NBR	Acrylonitrile-butadiene rubber (nitrile rubber)	+ 80

The operating temperatures for which the rubbers are suitable will depend on the type and duration of loading. Table 3 specifies requirements for soft rubber sheeting.

Table 3 — Requirements for soft rubber sheeting

Sheeting type	Rubber type	Nominal thickness, in mm (testing as in EN 22286)	Density in g/cm^3 (testing as in EN ISO 1183-1)	Shore A hardness (testing as in ISO 868)	Tear strength in N/mm^2 (testing as in ISO 37)	Elongation at break, as a percentage (testing as in ISO 37)
Vulcanised single-ply sheets	IIR, BIIR, CIIR CSM	2 to 5 2 to 5	1,10 to 1,30 1,20 to 1,70	50 to 65 55 to 70	≥ 4 ≥ 3	≥ 300 ≥ 300
Vulcanised double-ply sheets	IIR, BIIR, CIIR, CSM NBR	2 to 5 2 to 5	1,10 to 1,30 1,20 to 1,40	50 to 65 60 to 80	≥ 3 ≥ 4	≥ 300 ≥ 300
Partially vulcanised single-ply sheets[a]	CIIR and BIIR	2 to 5	1,10 to 1,30	50 to 65	≥ 3	≥ 300
Self-vulcanising single-ply sheets[a]	CIIR, BIIR NR CSM CR	2 to 5 2 to 5 2 to 5 2 to 5	1,10 to 1,30 1,10 to 1,40 1,20 to 1,50 1,40 to 1,70	50 to 65 50 to 65 55 to 70 55 to 70	≥ 4 ≥ 4 ≥ 4 ≥ 5	≥ 300 ≥ 400 ≥ 300 ≥ 300

[a] Values refer to the rubber in its completely vulcanised state.

6.1.2 Thermoplastics

Thermoplastics sheets shall be of polyisobutylene (PIB) or plasticised polyvinyl chloride (PVC-P).

The operating temperatures for which these thermoplastics are suitable are given in Table 4.