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Powder Coating as a Corrosion Protection Method

Paint with Pride

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Introduction

Corrosion is due to a chemical reaction between metal and its environment, causing changes in the metal's properties which often damage the metal, its environment or the technical system in question.

Corrosion prevention or anti-corrosion protection either slows down or prevents damage due to corrosion. Corrosion protective painting provides corrosion prevention for metal surfaces based on an anti-corrosive paint, which can be either wet paint or powder coating. The international standard for protective paint systems is ISO 12944.

Increasing quality requirements, more demanding usage conditions and longer warranty periods create a need for verified data on the durability of coatings.

Teknos has been testing its anti-corrosive INFRALIT powder coatings with methods compliant with standard EN ISO 12944 for years now, even though the standard does not actually cover powder coatings. This brochure is intended to serve as a set of instructions for the corrosion protective painting, with powder coatings, of metal objects over 3 mm thick, cleaned to preparation grade Sa 2½, and of chemically pretreated sheet metals, as well.

Typically, corrosion protection of sheet metals is based on a combination of chemical pretreatment suitable for the required corrosivity category and a powder coating, on which you can obtain detailed information from Teknos' sales department for industrial products.

ISO 12944 standard consists of following parts

PART 1 GENERAL INTRODUCTION
PART 2 CLASSIFICATION OF ENVIRONMENTS
PART 3 DESIGN CONSIDERATIONS
PART 4 TYPES OF SURFACE AND SURFACE PREPARATION
PART 5 PROTECTIVE PAINT SYSTEMS
PART 6 LABORATORY PERFORMANCE TEST METHODS
PART 7 EXECUTION AND SUPERVISION OF PAINT WORK
PART 8 DEVELOPMENT OF SPECIFICATIONS FOR NEW WORK AND MAINTENANCE

Durability of the protective paint system

According to standard ISO 12944-1, the durability range of the paint system is divided in three categories:

2–5 YEARS.....(L) – LOW
5–15 YEARS.....(M) – MEDIUM
OVER 15 YEARS .....(H) – HIGH

A durability category is not a "guarantee period". The durability category refers to the presumed time until a perfect service painting is needed. Durability time is an estimate, which can help the owner in the preparation of a maintenance programme.

Classification of environments

The local atmosphere and special stresses of the structure greatly affect the durability of corrosion protective painting and the planning of such painting. Standard ISO 12944-2 classifies atmospheric environments into six categories:

C1 .....very low
C2 .....low
C3 .....medium
C4 .....high
C5-I.....very high (industry)
C5–M .....very high (marine)

This classification is based on the corrosion speed of steel and zinc during the first year.

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Corrosivity categories

In the first instance, paint types are selected in accordance with the protection requirements of the object. Paints must also withstand stresses caused by preparation and installation.

When describing the prevailing conditions of the target, part 2 of standard ISO 12944 is used. This part divides up environmental conditions on the basis of the corrosion effect on metal in atmospheric-corrosivity categories C1-C5 and immersion corrosivity categories Im1-Im3.

The most common environmental conditions indoors belong to corrosivity categories C1 and C2, provided that no significant amounts of corrosion-effective elements are present in addition to moisture. Outdoor conditions belong to corrosivity category C2-C5. According to the quality and amount of impurities in the air, local atmospheric environments can be classified into rural, urban, marine or industrial atmospheres.

In addition to the above mentioned corrosivity categories, special stresses occur, for instance in chemical, paper and pulp industry plants, and in bridges and structures buried in soil or immersed in water. Typical corrosion stresses that appear under special conditions include corroding gases, chemical dust, splashes, biological and mechanical abrasion, heat and immersion stresses.

When estimating the environmental stress category of a target, special account must be taken of the corroding factors of the immediate surroundings. From the corrosion protection point of view, these immediate surroundings (micro atmosphere) have fundamentally greater significance than the local atmospheric environment (macro atmosphere).

For instance, Finland's basic climate type is chilly, moist and clean compared to most industrialised countries. Since, in principle, the same kinds of paints may differ in their application and durability characteristics, it is important to select a protective paint system of which you have good experiences in practice.

Structures

Part 3 of standard ISO 12944 "Design considerations" instructs designers of steel constructions on taking account of the demands of corrosion protection painting in the design of structures.

The location and features of the structure, such as sharp edges, corners and other similar areas that are difficult to paint, have a fundamental effect on the execution of corrosion protection paint work, its inspection and maintenance as well as the durability of the painting.

For targets that are difficult to paint, better "corner coverage" is obtained through powder coating than with a traditional wet paint, even for one-layer painting.

Paint systems

The protective paint system comprises the painting substrate, surface preparation for the substrate and the combination of coatings based on which the substrate is painted.

Standard ISO 12944-5 presents the most common protective paint types and paint systems.

Paint type	ISO 12944-5
Acrylic paints	AY
Alkyd paints	AK
Epoxy paints	EP
Epoxy tar paints	CTE
Chlorinated rubber paints	CR
Polyurethane paints	PUR
Polyurethane tars	CTPUR
Ethyl silicate	ESI
Zinc epoxy	EPZn(R)

Powder coating type	Teknos symbol
Epoxy	EP
Polyester	PE
Epoxy-polyester	EP/PE
Polyurethane	PUR
Silicone	SI

Paint system and marking under standard ISO 12944-5

The standard includes ten charts (A.1 – A.10), in which painting systems of various corrosivity categories for steel and zinc surfaces are presented.

In the footnote for the charts, various binder types are clarified and additional information is given on the paints.

For instance:

A5I.04 C5-I/M	EPZn(R)EP 240/4 FeSa 2½
	*(EP 8026-05 60/1, EP 8026-00 180/1 FeSa 2½)

* The marking in brackets is Teknos' own, which does not accord with the standard.

Measuring the film thickness

Nominal film thickness refers to the paint's dry film thickness, as mentioned in the specification. These measurements must average at least as much as the nominal thickness of the dry film. The maximum film thickness is agreed on a case-by-case basis, or together with the paint manufacturer.

Selection of the paint system

The paint system is selected according to the structure, substrate, required service life and external appearance in question. These must match the available surface preparation method and the prevailing painting conditions. The coatings must form a protective layer thick enough to provide economically viable corrosion protection.

Substrate preparation

Preparation grades
The state of steel surface immediately after cleaning is indicated as preparation grade or preparation quality grade. Standard ISO 8501-1 specifies the surface preparation grades by describing verbally, together with illustrative photographs, the visual texture of the surface.

Surface preparation performed using abrasive blast cleaning is designated with the marking "Sa". The preparation grades for abrasive blasting are Sa 1, Sa 2, Sa 2½ and Sa 3.

Surface preparation with hand or power tools – scraping or wire brushing manually, or wire brushing or grinding using power tools – is designated with the marking "St".

Grading of blast-cleaned steel surface profile
The surface profile refers to the surface micro-roughness, which is normally indicated as a ratio of the highest profile peak and the lowest profile valley. Grading of the surface profiles is given in ISO 8503-1.

For further information about substrate preparation, please see Teknos' "Handbook for Corrosion Protection", available on Teknos' website.

Chemical pretreatments

Powder coating is most often applied to sheet metal products, which are typically pretreated chemically.

The usual pretreatment methods for powder-coated sheet metal products are iron or zinc phosphating. The phosphating process forms a firmly adherent, thin and fine-grained layer of phosphates on the metal surface. Metal objects are treated after cleaning with a phosphate solution using either dipping, spraying or brush application.


Photograph: Chemetall

The test results indicate that iron phosphating is a suitable preparation method for cold-rolled steel up to corrosivity category C3, but should not be used in highly demanding conditions requiring greater corrosion resistance and longer service life. Zinc phosphating is a more durable preparation technology. The test results for zinc phosphating corresponded to mechanical preparation grade Sa 2½, which meets the requirements of corrosivity category C4.

In terms of traditional preparation methods, chromating is technically a more suitable method for aluminium and galvanized surfaces. However, it is noteworthy that chromium will be discontinued in the near future.

Thin film technology

Ever stricter environmental requirements and legislation have contributed to the abandonment of traditional pretreatment chemicals in favour of new, environmentally friendlier alternatives free of phosphates and chrome. New breakthroughs in chemistry have reduced the thicknesses of chemical layers, and thin film technology is nowadays a commonly used concept.

Teknos' R&D department has been closely following the changes brought by new chemical agents to corrosion resistance and testing the functionality of chemical pretreatment with INFRALIT powder coatings. All test results are based on a test series performed in compliance with standard EN ISO 12944.*

The test results indicate that the corrosion resistance provided by the new pretreatment chemicals combined with a single coat of powder coating can easily achieve corrosivity category C4 and in some cases even C5.

Even though corrosivity categories of C5-M and up have been achieved with single-layer powder coating, two-layer paint system is recommended for demanding environments requiring greater corrosion resistance.

The quality and design of the metal work have a vital role in the corrosion resistance of the end product. Sharp edges and the hard-to-reach areas for spray application need to be taken into consideration. That is why two-layer application of powder coating is recommended for C4-M classification and above to ensure sufficient protection against corrosion.

Corrosivity category	Paint System	Iron phosphating	Zinc phosphating	Thin film technology
C3-M	INFRALIT PE 8350 80/1	x	x	x
C4-M	INFRALIT PE 8350 100/1		x	x
C4-H	INFRALIT PE 8350 80/1 INFRALIT PE 8350 80/1		x	x
C4-H	INFRALIT EP/PE 8087-30 80/1 INFRALIT PE 8350 80/1		x	x
C4-H	INFRALIT EP 8024 120/1		x	x
C5-M/H	INFRALIT EP 8026-05 60/1 INFRALIT PE 8350 100/1		x	x
C5-M/H	INFRALIT EP 8024 120/1		x	x
C5-M/H	INFRALIT PE 8350 80/1 INFRALIT PE 8350 80/1		x	

TESTING METHODS

EN ISO 9227 Corrosion tests in artificial atmospheres. Salt spray tests.
EN ISO 6270-1 Paints and varnishes. Determination of resistance to humid atmospheres. Part 1: Continuous condensation.
EN ISO 2812-1 Paints and varnishes. Determination of resistance to liquids. Part 1: Immersion in liquids other than water.

*The tests were performed on cold-rolled steel painted in laboratory conditions. Preparation of test panels was performed in pretreatment chemical suppliers' laboratory.

VOC or Volatile Organic Compounds

The reduction of solvent emissions sets demands and challenges, both for paint manufacturers and paint shops. Because powder coatings do not contain organic volatile compounds, coating with powder is an excellent alternative with respect to reducing solvent emissions. Totally solvent-free INFRALIT powder coatings meet the directive 1999/13/EC EU emission standards.

INFRALIT powder coatings (with the exception of the so-called zinc-rich powder coatings) also meet the RoHS requirements of EC directive 2011/65/EC.

Durable surface

Since a powder-coated surface is extremely hard and elastic, transport and installation damage is kept insignificantly small. This improves corrosion protection and reduces the need for service painting.

Examples of protective paint systems

ISO 12944-5:2007 System no.	Powder Coating System INFRALIT	Teknos Paint System Symbol (powder coating)	Paint System (wet paint)	Teknos Paint System Symbol (wet paint)
A2.01 C2/L	PE 8350 60/1 FeFo	P214a	AK 80/2 FeSa 2½	K12a
A3.08 C3/M	PE 8350 80/1 FeSa2½	P218b	EP 160/2 FeSa 2½	K18b
A3.11 C3/H	EP 8026-05 60/1 EP 8026-00 100/1 FeSa 2½	P219a	EPZn(R)EP 160/3 FeSa 2½	K19a
A3.11 C3/H	EP 8026-05 60/1 PE 8350 100/1 FeSa 2½	P227a	EPZn(R)EPPUR 160/3 FeSa 2½ Zh	K27a
A4.08 C4/M	PE 8350 120/1 FeSa2½	P218d	EP 240/3 FeSa 2½	K18d
A5I.04 C5-I/M	PE 8316-05 60/1 PE 8350 100/1FeSa 2½	P219f	EPZn(R)EP 240/4 FeSa 2½	K19c
A5M.06 C5-M/H	PE 8316-05 60/1 PE 8350 100 /1 FeSa 2½	P219f	EPZn(R)EP 320/4 FeSa 2½	K19e
A6.04 Im 1/H	EP 8024-00 480/1 (2) FeSa 2½	P234c	EP 500/2 FeSa 2½	K34c
A7.10 C4/M	EP 8026-00 60/1 PE 8350 60/1 ZnSaS	P229g	EPPUR 120/2 ZnSaS	K29g
A7.11 C4/H	PE 8350 120/2 ZnSaS	P229h	EPPUR 160/3 ZnSaS	K29h

Norsok M-501 approved powder coating systems

Surface treatment	Specification	DFT µm	Product comments	Test report number
FeSa 2½ + Zn-phosph.	INFRALIT PE 8316-05 INFRALIT PE 8350	80 100	Zinc rich polyester powder Polyester powder	VTT-S-07499-08 VTT, Finland
		Total DFT 180		

> Powder coatings are an economical and eco-friendly choice.

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The largest and most modern powder coating factory in the Nordic countries is located in Rajamäki, Finland.

State-of-the-art **Powder Coating Factory**

Teknos has over 40 years of experience in powder coating manufacturing. In 1971, Teknos began powder coating production in Helsinki factory. In 1977, the capacity had to be increased and the production moved to the new factory in Rajamäki.

The extension of Teknos' powder coating plant, completed autumn 2007, comprises 10,000 m² and has increased our powder coating manufacturing capacity to 20,000 tonnes per year. If necessary, production can be doubled. The new, fully automated factory is the largest and most modern powder coating factory in the Nordic countries. Thanks to the state-of-the-art factory, Teknos is able to provide customers with a faster and more efficient service.

Teknos invests heavily in the product development of powder coatings by developing new paint types for new applications. Teknos INFRALIT Powder Coatings are ISO 9001 and ISO 14001 certified.

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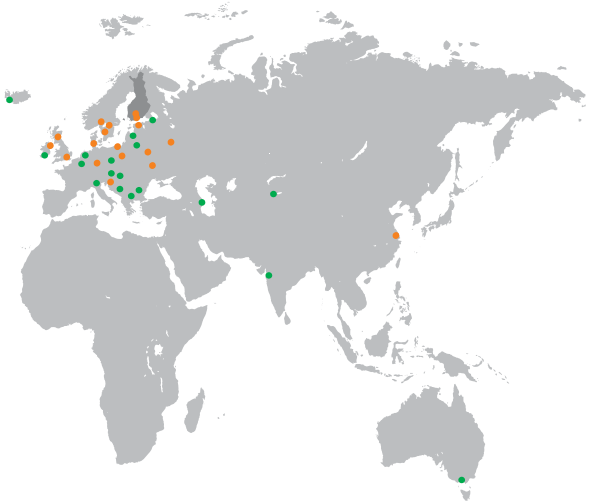
The Teknos Group

Teknos is one of Europe's leading suppliers of industrial coatings with a strong position in retail and architectural coatings.

Teknos has its own production in seven countries: Finland, Sweden, Denmark, Germany, Poland, Russia and China. In addition, Teknos has sales companies in 15 countries and exports to more than 20 countries via a well-established network of dealers.

Teknos employs around 1 200 staff. Teknos was established in 1948 and is one of Finland´s largest family-owned businesses.



● **Group companies** ● **Network of dealers**

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