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quali steel coat

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The right choice of pre-treatment of metal parts for later use

QIB
Qualitätsgemeinschaft
Industriebeschichtung

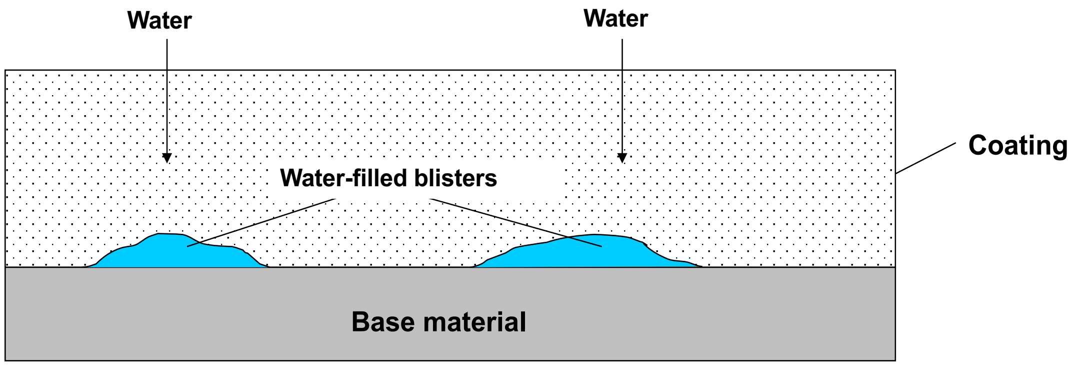
Content

1. General information

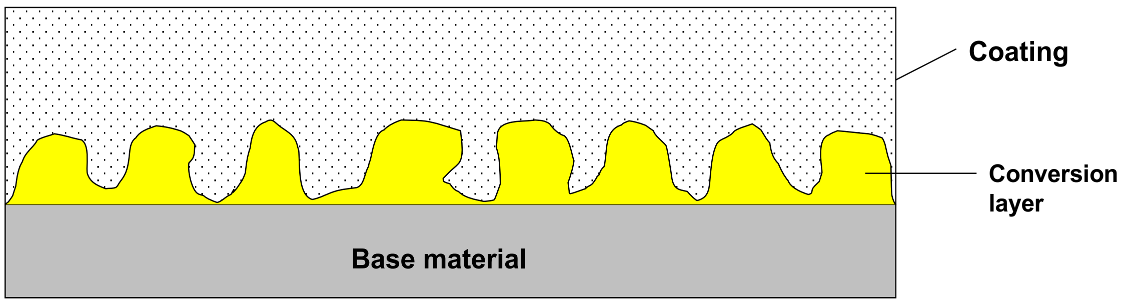
The type of pre-treatment is essential for the corrosion resistance or durability of parts coated with powder or liquid paint. In general, the basic prerequisite for a perfect coating is a metallic bright surface.

In most cases, the parts to be coated are covered with inherent or non-inherent residues. These include oxide layers, oxidation products and, in the case of steel, rust deposits. The non-inherent layers include oils and greases, corrosion protection coatings or coatings, sometimes in barely visible form (e. g. passivations, transparent chromates, welding sprays, pressed-in flow and drawing aids such as graphite residues, release agents, paints, sinterings and adhesive residues).

If not removed, these either act as a release agent and later reduce the adhesion of the paint film to the base material or lead to visible imperfections such as craters, specks or reveal wetting disorders when recoating.



In the absence of a chromate layer, water vapour can diffuse through the paint film and lead to blistering on the base material layer.



Here is the anchoring of the coating film in the conversion layer.

Moisture or water can penetrate through the applied paint film to the base material, depending on the position and the stress, and can also condense there in some cases. This can lead to blisters or paint peeling off if the layer is mechanically stressed in places.

The formation of reaction products with moisture, e. g. white rust on galvanized parts, also leads very quickly to lifting of the applied coating film due to the increase in volume and to significantly reduced coating film adhesion. Other liquids such as organic solvents, if they can penetrate the coating film, also lead to paint peeling off and wrinkling if pre-treatment measures are insufficient.

2. Types of pre-treatment

2.1. Physical cleaning

Physical cleaning includes all processes that work either with water in a warm or cold state with a surfactant (emulsifier additive) or with organic solvents. Adherent dirt deposits, including non-inherent contaminants, are not always removed. Oxide residues remain on the surface. The process is usually only used to remove easily adhering, partially water-soluble substances from the surface.

2.2. Mechanical cleaning

This includes all processes in which inherent or non-inherent coverings and impurities are removed from the surface by brushing, grinding or blasting. As a rule, these processes are also associated with a visual change to the surface. In most cases, roughening the surface improves the adhesion properties of the coating film that is to be applied subsequently.
These processes also allow removal of oxide residues to a large extent. Mechanical cleaning is only suitable for removing oils, greases and chlorides to a limited extent, depending on the blasting medium.

2.3. Chemical cleaning

During chemical cleaning, which also includes physical cleaning, evenly chemically active substances are used to remove oxide layers, rust deposits and the upper layer areas of the base material, thus creating a uniformly chemically active and completely grease-free surface. The cleaning solution applied by spraying or dipping can also achieve the cleaning success necessary for the subsequent coating in hollow chambers on the inside of parts of the workpiece that can hardly be processed mechanically.

2.3.1. Steel or stainless steel

Raw steel surfaces are treated in a solution based on nitric acid, sulphuric acid or hydrochloric acid, depending on the condition of delivery, to remove scale or oxide layers. Hot-dip galvanised parts (strip galvanised/send galvanised and piece galvanised) are usually cleaned in alkaline solutions and freed from light white rust (oxide residues) in acidic solutions containing fluoride.

Stronger white rust residues can only be removed mechanically (e. g. by sweeping). For galvanized and strip galvanized surfaces, make sure that the removal of the relatively thin zinc layer is kept as low as possible.

Stainless steel surfaces should only be treated with chlorine-free acidic cleaning agents, otherwise pitting corrosion may occur.

2.3.2 Aluminium

Aluminium is like zinc an amphoteric metal, i.e. they get attacked by both acidic and alkaline solutions. In the case of alloys with high additions of silicon, magnesium or similar, the cleaning treatments may have to be combined in alkaline and then in acidic media in order to remove insoluble or slightly soluble components from the surface and thus achieve the purity necessary for organic coating.

2.3.3 Copper and copper alloys

Here, too, cleaning with an acidic solution based on sulphuric or nitric acid usually works. It also applies that scale or oxide layers are removed without damaging the coating.

3. Types of adhesion promoting layers / conversion layers

Transformation or conversion layers are used for substrate pre-treatment or for temporary corrosion protection. They are formed by chemical or electrochemical reaction of the base material with a watery solution. Inherent conversion (reaction) layers can be formed or non-inherent inorganic layers can grow on the surface. In the case of non-inherent layers, which also include the so-called no-rinse conversion layers or chromium-free layers, components from the treatment solution are also incorporated. A characteristic feature of conversion layers is their good adhesive strength, which almost always prevents the coating from disbonding, e.g. by corrosion.

3.1. Steel

In many cases, steel surfaces are coated with a conversion layer by iron phosphating, which, in addition to the coating film adhesion, only have a low corrosion resistance. In most cases, cleaning and iron phosphating are carried out in a single operation.

For outdoor applications or corrosive stresses, zinc phosphating has proven effective. Chromate-free conversion layers are also possible.

In the case of galvanized or hot-dip galvanized coatings, yellow or green chromating and zinc phosphating represent the most optimal conversion layer treatment. Chromate-free conversion layers are also increasingly used here and can meet almost the same requirements for adhesion and corrosion protection.

In the case of stainless steels, only chemical cleaning with a corresponding vapour-proof primer has proven successful so far. Recently, chromium-free conversion coatings based on polymers have also been used with good success.

3.2. Aluminium

For more than 40 years, the standard process of yellow or green chromating has proven itself. Due to the REACH regulation, chromate-free polymer coatings based on titanium and zirconium are increasingly being used. They can also be used in the no-rinse process (no-rinse = without rinsing after application of the conversion layer). Special zinc phosphating processes are used in many cases, especially for material combinations of steel/aluminium. However, their suitability, especially for aluminium, must be proven (bath contamination).

Iron phosphating processes do not produce sufficient conversion layers on aluminium.

3.2.1. Other metals

For copper and copper alloys (brass), no conversion layer forming processes with the described equivalent properties are known, since such materials are mostly used outdoors without protective measures, as the oxide layer that forms provide sufficient protection, and the formation of a patina is desired. Patinated parts, on the other hand, can be easily coated with organic paints. One possibility is the use of chrome-free polymer coatings. Experience with this is not available on a large scale.

4. QIB stress groups and corrosion protection

The QIB stress groups I - V apply to all basic materials. They are determined for the base materials steel and galvanized steel on the basis of laboratory tests for the respective corrosivity category and protection period analogous to DIN 55633, DIN 556341 and DIN EN ISO 12944-6, even though the test requirements of the QIB are partly more strictly defined. For the stress groups I - V, the corrosivity categories (C1 - C5) are defined in conjunction with the expected protection period high (H).

Stress group VI is an exception. Here, the protection duration very high (VH) of the corrosivity category C5 is determined analogously to ISO 12944-6:2018.

Another exception is the base material aluminium. Here, independent requirements are specified for stress groups I - VI. Further explanations can be found in chapter A.1.4. of the QIB quality regulations.

5. Determining the QIB stress groups

In the following, the QIB has classified the stress groups based on the corrosivity categories of DIN EN ISO 12944, DIN 55633.

Stress group I:
The parts are only used indoors without humid or corrosive stress.

Stress group II:
The parts are occasionally resp. for a short term exposed to temperature or humidity stress. However, parts which have been pre-treated in such a way are mostly used indoors.

Stress group III:
The parts have a conversion layer allowing to expose them to slightly corrosive and humid stress for longer time.

Stress group IV:
Due to the high requirements on the applied conversion layers it is possible to expose these parts to usual corrosion as well as to humidity all over their service life. Special corrosion stress such as filiform corrosion resistance and the like is the only exception. This requires additional pre-treatment and protection measures for steel as well as for aluminum.

Stress group V:
Steel and aluminum parts are treated with mostly multi-layered coating systems due to the very high requirements for industrial, coastal, and offshore regions with a term of protection of more than 15 years. In the case of aluminum this is only possible by pre-anodizing or 2-layer structure.

Stress group VI:
Steel and aluminum parts are treated with mostly multi-layered coating systems due to the very high requirements for industrial, coastal, and offshore regions with a term of protection of more than 25 years. In the case of aluminum this is only possible by pre-anodizing.

The following table shows the comparison between QIB stress groups and the corrosivity categories of DIN EN ISO 12944 part 6 “Corrosion protection of steel structures by protective coating systems” and the test periods of the neutral salt spray test required herein:

Stress group according to QIB	**Test duration acc. to QIB stress group (h)**	**Test duration acc. to DIN EN ISO 12944-6 (h)**	**Short designation Corrosivity category and protection period acc. to DIN EN ISO 12944-6:2018**
I	96	-	C2 (high)
II	250	240	C3 (medium) C4 (low)
III	500	480	C2 (very high) C3 (high) C4 (medium) C5 (low)
IV	1.000	720	C3 (very high) C4 (high) C5 (medium)
V	1.500	1.440	C4 (very high) C5 (high)
VI *	2.200	-	C5 (very high)

** Only for coatings on galvanized base material with EDP primer or for aluminium with pre-anodisation.*

6. Selection of procedures for the application

The individual procedures and their assignment to the stress groups are listed below:

	Stress groups					
Materials	**I**	**II**	**III**	**IV**	**V**	**VI**
steel	W/D + B/S	W/D + B/S	W/D + B/S	W/D + B/S	-	-
steel, galvanized	W/D + B/S	W/D + B/S	W/D + B/S	W/D + B/S	W/D + B/S	-
stainless steel	W/D + B/S	W/D + B/S	W/D + B/S	W/D + B/S	W/D + B/S	-
aluminium	W/D + B/S	W/D + B/S	W/D + B/S	W/D + B/S	-	-

	Stress groups					
Materials	**I**	**II**	**III**	**IV**	**V**	**VI**
Steel	W/D	W/D + FeP	W/D + P-ZnP	W/D + P-ZnP	-	-
Steel galvanized	W/D + FeP	W/D + FeP	P-Cr-ZnP	P-Cr-ZnP	P-Cr-ZnP	-
Stainless steel	W/D	W/D	W/D	W/D		-
Aluminium	W/D	W/D	W/D + P-Cr	W/D + P-Cr/PA	W/D + P-Cr/PA	W/D + PA

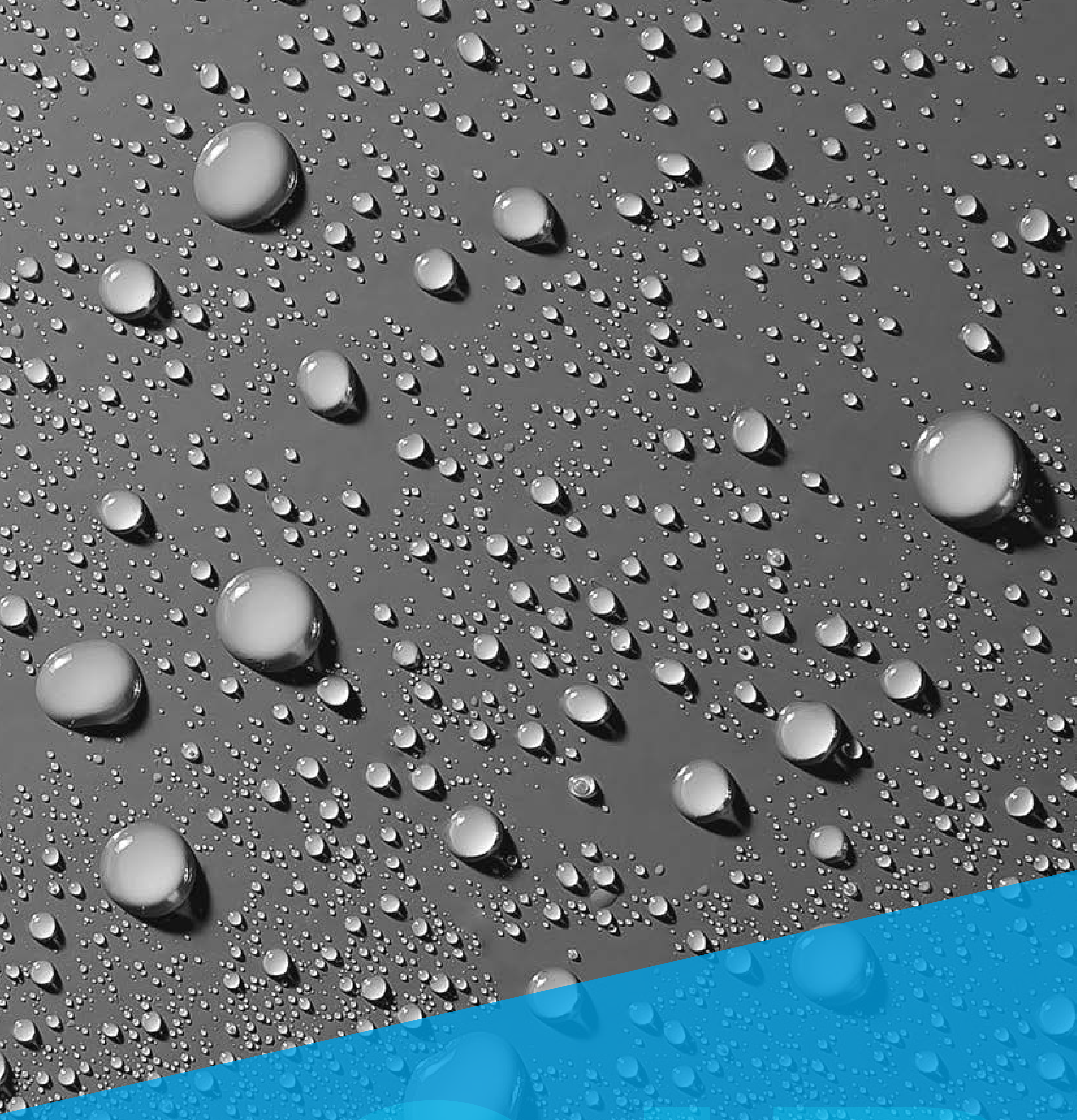
Explanation:

W/D = Washing/degreasing
Cr = Chromating
B/S = Blasting, sweeping
P = Polymer layers (chrome-free)
FeP = Iron phosphating
\+ = Combination
ZnP = Zinc phosphating
PA = Pre-anodisation

Remark:

By additionally applying a special primer, e.g. epoxy-based, the requirements can be improved and the assignment to a higher stress group can be made. For certain stress groups, a primer must be applied. Information on this can be found in chapter A 1.5 of the QIB quality regulations.

1) No experience is available on this yet.



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