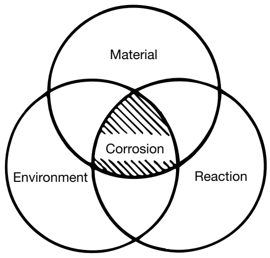
Corrosion protection: General information

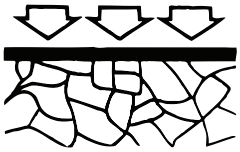
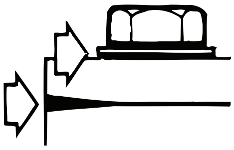
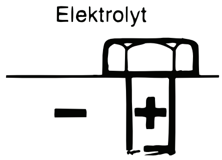
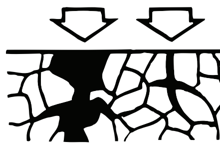
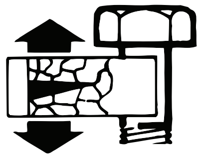
General information



Corrosion is the reaction of a metallic material with its environment which causes a measurable change in the material and can negatively influence the function of a metallic component or an entire system. In most cases, this reaction is of an electrochemical nature, but, in some cases, it can be of a chemical or a metal-physical nature. (Definition: Basic principle of "Corrosion" according to ISO 8044)

Table 1 shows the most important corrosion types from a selection of different corrosions which need to be considered with "mechanical fasteners".

Table 1: Corrosion types

				
Surface corrosion, e.g. rust Pitting corrosion	Crevice corrosion	Electrochemical corrosion (Contact corrosion) (see Table 2)	intergranular/ transgranular corrosion	Stress corrosion cracking

Corrosion is unavoidable, but damage due to corrosion is avoidable, provided the proper planning of suitable corrosion protection measures is in place. The corrosion protection of screw fastenings needs to be at least as corrosion-resistant as the components to be connected.

The task of constructive planning is to determine the necessary corrosion protection measures. Here the resilience of the corrosion protection in known operating conditions is to be taken into account until maintenance is due or until the limitation of damages has been reached. Surface or material specifications are to be listed in the article order text according to standards.

The next page provides a rough overview of the corrosion protection options for fasteners.

Inspection standards for corrosion protection procedures, compiled in DIN pocketbook 175, stipulate uniform conditions for the type and setup of equipment and methods for checking adherence to the specified coating type, layer thickness and optical appearance. The inspections according to these standards do not provide any information on the effect or fatigue strength of the corrosion protection under practical operating conditions.

An overview of the friction coefficients for various surface combinations ➜ TI assembly. The friction ratios in the screw fastenings are vital when determining the correct tightening torque (➜ VDI 2230).

Electrochemical corrosion

The combination of electrochemical noble and ignoble metals in humid conditions (= electrolyte) generates corrosion currents which spread from ignoble (anodic) metal to more noble metal (cathode). This means that less noble metal will be more eroded or corroded. The corrosion current thicknesses are also vital. If the ignoble, anodic part is small in comparison with the surrounding cathodic area (screw head on sheet surface), a very high anodic current thickness will generate which will carry off a lot of material.

Example 1:
Zinc plated screws for fastening a copper sheet:
Zinc is considerably less noble compared to copper. In humid conditions, a very high corrosion current thickness occurs on the small, ignoble, anodic screw head (left column zinc - small) in the direction of the noble, cathodic copper sheet (upper row - copper). The galvanized surface of the screw erodes in a short space of time and red rust appears on the steel.

Remedy:
In relation to the metallic building component, the fasteners should be as similar as possible if not more noble.

Screw	Component
zinc plated	zinc plated
nickel plated	steel, copper, brass
stainless	steel, zinc plated, aluminium, copper, brass

Example 2:
Copper or stainless steel screws which work in a similar way for fastening a zinc plated metal sheet:
This time, the ignoble, anodal, galvanized section is very large in relation to the small, noble, cathodic screw head. The corrosion current which stretches over the entire surface has very low tightness in the anode. The material degradation occurs across the entire surface and shows hardly any corrosion. This process actually additionally protects the nobler screw head against corrosion.
If unfavourable metal pairings cannot be avoided, they should be isolated from each other, e.g. using intermediate layers or coatings. Here, it must be made sure that the full strength of the connection remains intact.

Table 2: Electrochemical corrosion with metal pairings

S = strong corrosion of the observed material
M = moderate corrosion of the observed material (in very humid environments)
G = negligible or zero corrosion of the observed material

In regard to contact corrosion of observed material ▼	Area ratio*	Magnesium alloy	Zinc	Hot-dip galvanized steel	Aluminium alloy	Cadmium coating	Construction steel	Low-alloy steel	Cast steel	Chrome steel	Lead	Tin	Copper	Stainless steel
Magnesium alloy	small large		S M	S M	S M	S M	S S	S S	S S	S S	S S	S S	S S	S S
Zinc	small large	M G		G G	M G	M G	S G	S G	S G	S G	S G	S G	S G	S G
Hot dip galvanized steel	small large	M G	G G		M G	M G	S G	S G	S G	S G	S G	S G	S G	S G
Aluminium alloy	small large	M G	G M	G M		G G	M G	G	S M	M	S S	S	S S	S M
Cadmium coating	small large	G M	G G	G M	G G		S G	S G	S G	S G	S G	S G	S G	S G
Construction steel	small large	G G	G G	G G	G G	G G		M G	S G	S G	S G	S G	S G	S G
Low-alloy steel	small large	G G	G G	G G	G G	G G	G G		G G	S G	S G	S G	S G	S G
Cast steel	small large	G G	G G	G G	G G	G G	G G	M G		S G	S G	S G	S	S
Chrome steel	small large	G G	G G	G G	G G	G G	G G	G G			M G	M G	S	S G
Lead	small large	G G	G G	G G	G G	G G	G G	G G	G M	G G		G G	G	G
Tin	small large	G G	G G	G G	G G	G G	G G	G G	G	G M	G G			
Copper	small large	G G	G G	G G	G G	G G	G G	G G	G	M	M G	S M		G
Stainless steel	small large	G G	G G	G M	G G	G G	G	G G	G G	M	G M	G M	G	

* ratio of the surface of the "observed" material to the surface of the "pairing material" (Source: "FEUERVERZINKEN" (HOT DIP GALVANIZATION) information centre)

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