Reliable corrosion protection during storage and transport

Apart from the industrial processes for a permanent corrosion protection like hot dip galvanizing, conversion coating and/or painting there are several less laboriously processes for short-, medium- and long-term protection during transport and storage.
This article provides an overview.

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Even if corrosion has often become invisible in every day life: every second 5 tons of steel are fully destroyed by corrosion. The economic losses are much higher than the simple material value since due to security or visual reasons work pieces or entire modules have to be reworked, repaired with high efforts or even exchanged. However, corrosion is not only an issue for the final work piece: it must not be underestimated that corrosion may affect also logistics chains significantly (intermediate in-house storage and transport between premises). Fluctuating parameters like seasons changes have to be considered. Especially in the transition periods from summer to autumn and from winter to spring, weaknesses in protection are observed. Since decades, Chemische Werke Kluthe offer a broad range of various rust preventives in order to meet the manifold demands of customers.

Active and passive corrosion protection

Passive corrosion protection is achieved by applying a surface coating which separates the metal from reaction partners. Active protection against corrosion, which is not considered in details in this article, interacts with the partners of this chemical reaction. There are cathodic corrosion protection methods with or without external current, e.g. with zinc as sacrificial anode. A zinc coating combines passive and active corrosion protection, but it is itself affected by the formation of white rust and therefore requires a final coating like a conversion coating basing on zinc phosphate and manganese phosphate respectively or phosphate-free thin layer technology. Rust preventive oils, varnishes or zinc flakes increase further the protection. Highly effective chromate (chromium(VI)) passivations are banned in Europe due to risks for health and environment; chromium(III)-based products which are highly efficient as well are loosing market share since chromium(III) compounds are produced starting from chromate.

Amine-based rust preventive systems

The corrosion preventive action of amines both in aqueous and non-aqueous systems is well known. Oil-free products based on alkanolamines like mono- and/or triethanolamine and their boric acid derivatives, respectively, are approved. The required concentrations are low. Such products are applied by dipping or spraying at ambient temperature up to 60 °C; pH value of the baths is in the range of pH 9.0 to 9.5. Total drying is mandatory for good corrosion protection.

Corrosion protection for bright, phosphated, galvanized or burnished workpieces.

Corrosion is not only a problem on the finished part, but is also a disruptive factor during storage and transport that should not be underestimated.

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After treatment with amine-based products, work pieces can be stored in-house or can be sent by truck or train to other premises for subsequent processing. Usually the parts are paintable without any issues, and residuals of the rust preventive do not interfere with subsequent manufacturing processes. Amine-based products can be easily combined with neutral cleaners either in process chains or as dual-use products, i.e. cleaning and protection in one step. Disadvantageous with conventional amine-based products are the limited protection period, the odour and eventually classification as hazardous material or Dangerous Good and VOC content. Furthermore, the products do not exhibit a specific biocide action, and carry-over of acidic substances will lower the effect. Selected novel amines can avoid or at least significantly reduce these disadvantageous without affecting other properties.

Anti-corrosion additives for water cycles are usually amine-based as well but contain further ingredients like poly-glycol ether and non-ferrous metal inhibitors.

Oils – Waxes – Varnishes

For several applications, the corrosion protection achieved with amine-based products is not sufficient. Then oil or wax based products are used which cover perfectly the surface due to their good wetting and superior adhesion and thus protect the surface from direct contact with water and humidity. These products are applied as delivered by dipping, spraying, flooding or brushing at ambient temperature. Clean and dry surfaces are a precondition because entrapment of humidity and/or salty residuals under the oil or wax film will cause corrosion.

Many of these products contain volatile ingredients which can be considered as VOC or not. During drying viscosity is increased, and the film consolidates. The achievable corrosion protection depends on the product characteristics, kind and amount of additives and the coating thickness: wax-like, thick films usually result in considerably higher protection values than thin, oily films. Removability depends on the product as well: depending on the product neutral, alkaline or solvent cleaners are applied.

Alternatively, oily or waxy film can be applied from aqueous emulsions that contain additional corrosion inhibitors

like sulfonates. These products are delivered either as concentrate (make up very often 5-8 %) or as ready-to-use emulsions. Several products can be applied at room temperature. Since a good drying is essential for the reachable corrosion protection, usually an application at 60-70 °C is recommended. Due to their composition, many of these products provide cleaning as well, so that low-to-medium contaminated work pieces can be cleaned and protected in one single treatment.

For highest demands e.g. during overseas transport during which changing temperatures and humid, salt containing air accelerates rust formation, low-VOC clear varnishes or hot melt coatings (thermoplasts) can directly be applied on to clean bare metal surfaces.

Dewatering agents

So-called dewaterings consist of a mixture of water displacing additives and rust preventives in an organic solvent. Special substances displace water from the surface, and after evaporation of the solvent a very thin film remains which prevents limited from corrosion and usually can be painted.

Product variants that build up an oily or wax-like (dry-to-touch) film offer a significantly higher corrosion protection, but work pieces protected which such products cannot be painted. Products vary in film characteristic, amount of film forming ingredients and kind of solvent. Due to the solvent content dewatering fluids have to be applied at ambient temperature; for drying warm air must not be applied due to the combustibility. Depending on the content of VOC (Volatile Organic Compounds) in the exhaust air, catalytic afterburning systems might become mandatory.

Rapid drying dewatering fluids are basing on solvents with low flash point, which are classified as VOC

Product category	Condensed water/ constant climate CH (KK)	Neutral salt spray test (NSS)	Indoor storage (23 °C, 40% r.h.)	Sheltered atmospheric corrosion testing
	DIN EN ISO 6270-2	DIN EN ISO 9227		DIN EN ISO 8565
Amine-based, aqueous			several months	for several days or weeks
Oils (with/without solvents)	days or weeks	several hours up to one day	approx. 1 year	several months
„Oils" with thick, wax-like protective film (usually solvent containing)	several weeks	for hours or days	several years	approx. 2 years
Emulsions	several days up to one week	several hours	several months	for weeks or months
Wax emulsions	approx. 2 weeks	approx. 48 hours	several years	approx. 1 year
Dewatering (almost residue-free)	few days		1-2 months	several weeks
Dewatering (film-forming)	days or weeks	several hours	for months or years	several months
Combination pre-treatment + varnish			nearly infinite	several years

Table 1 > . Performance of various product categories under standardized conditions (substrate: Q-panels Type R35, cold rolled strip, bare surface). VOC = Volatile Organic Compounds. FP = Flash point.

whereas VOC-free variants dry only (very) slow. Products based on a solvent with a flash point slightly above 60 °C are widely applied. Such solvents are classified as VOC, but due to their flash point, the products are no Dangerous Goods according to transport legislation, and for most customers drying is quick enough.

Corrosion protection depends on many factors

The corrosion protection values of bare metal parts obtained in industrial practice depend on the applied product category, the film thickness, surface quality and further parameters. The values in Table 1 provide a good over-view of the performance of various standard product categories under standard conditions (substrate: Q-panels Type R35, cold rolled strip, bare surface).

The combination of these corrosion preventives with conversion coatings like zinc, manganese or iron phosphate, phosphate-free thin-layer products and/or chromium(III)-based passivations increases considerably the corrosion protection values. Electroplated layers and black oxide finished coatings act similar. For special applications and demands, several highly specified products are available like bitumen-based products, underbody coatings or „rust converters".

Additional protective measures

Protection against mechanical damage and against humidity or other interfering substances will contribute con-siderably to the final corrosion protection of coated work pieces. Climate conditions during storage and transport, especially changes in temperature and humidity, have to be considered as well. The best corrosion protection system works only well when its technical limits are known and respected. A good and reproducible drying is mandatory for aqueous products (amine-based or emulsions). An appropriate packaging with special papers and foils, which release so-called Volatile Corrosion Inhibitors (VCI), is essential as well.

In order to select the best-suited corrosion protection system – now and in foreseeable future – it is necessary to consider the substrates borne in mind, any residues on the work pieces (if any) and the corrosion protective demands regarding corrosion resistance and subsequent processes. //

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