Non-ferrous metals

Aluminium, Nickel, Titanium, etc & alloys

Introduction

While steel is by far the most commonly encountered construction metal other metals are also used for special purposes e.g. aluminium for lightweight constructions. In many cases these metals have sufficient corrosion resistance on their own and do not require any protective coating. In other situations they may require protection from chemicals, chloride or coatings are specified for decorative or marking purposes.

Safety

Use adequate personal safety equipment and follow sound procedures. Apply only in well-ventilated areas. Observe safety labels on packaging and paint containers and consult Hempel's Safety Data Sheets for the products to be applied.

Standards & specification

The well-known standard ISO 12944 for corrosion protection does not have non-ferrous metals in scope. Norsok M501, Eds. 7 has system 6D covering aluminium in atmospheric service. The recommendation is 2 x epoxy + topcoat to a total film thickness of minimum 225 µm. This is close to the 240µm recommended in ISO 12944 for durability very High for galvanised and metallised surfaces. For now this is the best guidance available for system build where barrier protection is required.

Coating with metallic pigments (e.g. zinc or aluminium) as well as antifouling coatings based on cuprous oxide (see below) should be avoided. Other (non-metallic, inert) pigments including MIO and zinc-phosphate are compatible with non-ferrous metals although their benefit may not be obvious.

Surface preparation

Cleaning & degreasing
The very step in surface preparation is usually degreasing/cleaning. This is important because the surface is often covered by a layer of more or less visible grease or wax depending on the method of production, e.g. extrusion, drawing, rolling etc.

Some metals have limited resistance to alkaline as well as acidic cleaning solutions and neutral or almost neutral detergents, free of chlorides and chlorinated solvents such as Hempel's Light Clean 99350 should be used. It is essential to ensure that the surfaces are thoroughly rinsed by means of copious amounts of fresh water upon the cleaning /degreasing before the drying up of the applied emulsifier.

Abrasive blasting
The recommended surface preparation consist in sweep blasting to SSPC-SP 16. In general a good result can be obtained with corundum abrasives with a grain size up to maximum 0,5 mm. The optimum blasting pressure may need to be adjusted according to the hardness of the substrate. E.g. for Aluminium a reduced air pressure, maximum 4 bar.

When cleaning steel with either mill scale or rust the progress of the blasting is easily visible. This is often not the case on other metals. The abrasive sweep blasting should leave the surface uniformly matt with a dense sharp surface profile. No un-swept/blasted areas should be visible, when inspected at x 10 magnification.

Surface profile
No distinction is normally made between ordinary construction steel and other metal substrates in terms of adequate surface profile for a given paint system. Accordingly, the recommended roughness profile for steel in the given service conditions also applies to other metals in the same service conditions.

Abrasives
To avoid the risk of galvanic corrosion of the metal through contact with other metals it is advised to avoid metallic blasting materials. Suitable materials include corundum (aluminium oxide), garnet and ordinary silica sand free of copper, nickel, steel and chloride.

Other non-metallic abrasives of the grit type, including various slags are acceptable, provided they are free of metals.
Note that the contents, for instance, of free copper or nickel in "clean" copper-slag and "clean" nickel-slag respectively may be low enough for blasting of steel but may not acceptable for blasting of other metals.

When sweep blasting is not possible – use of adhesion primers
In some situations, sweep blasting is not necessary or possible. In such cases care should be taken to achieve the best possible roughness with the available methods. E.g. sanding in a cross pattern. Avoid polishing.

Furthermore the effect of reduced roughness may to some extend be compensated by the use an epoxy primer with chemically enhanced adhesion properties (sometimes called adhesion primers) e.g., Hempadur 15553, Hempadur 15554 or Hempel's epoxy primer HV 15410. A full system can be built by applying one or more layers on top.

In moderately aggressive environments (e.g. for marking or decorative coatings in mild conditions) this may offer long durability of the coating system and be a good solution to cover the surface with the required colour. However, in aggressive environments the absence of a suitable anchor profile created by abrasive blasting will always increase the risk of detachment. While adhesion primers are the best available option for this they can never fully compensate for the missing roughness.

Special consideration for aluminium

When exposed to the atmosphere aluminium will form a very thin, hard, electrically insulating and rather stable film of protective aluminium oxides (passivation) in a way similar to that of stainless steel. The thicker and denser the layer the better protection. The rather high resistance to general corrosion of aluminium is mainly due to this passivation provided by aluminium oxides. It is based on a constant availability of ample supply of oxygen; and in case of damage of the thin layer or part of it, new oxide will immediately be formed. Compared with the corrosion products of ordinary construction steel the layer of aluminium oxides is much denser, non-porous, non-absorbent, smooth – and colourless.

However most aluminium is vulnerable to chloride attack in immersed conditions, typically resulting in severe pit-corrosion i.e., the seawater resistance is generally poor. Aluminium consequently needs a strong barrier coating system for protection in marine environments. Certain magnesium-alloyed versions are nevertheless considered sufficiently resistant for marine purposes although they do corrode little by little.

Anodised Aluminium
Aluminium may be given a special electrolytic treatment (anodic oxidation or anodizing) in a bath of diluted sulphuric acid, resulting in a more dense, much thicker (20 µm/0.8 mils or more) protective layer of oxides.
Since anodised coatings can be dyed/absorb pigments, a complete range of colours can be made available - known from for instance, yacht's masts and kitchen utensils.
However, anodised coatings vary considerably in quality; mechanical and cohesive properties of the oxide layer which may be rather weak due to variations especially in its density and thickness.
Consequently, the recommendation is always to completely remove anodising by abrasive grit blasting or another suitable method before paint application of any kind. In other words:
The aluminium oxide layer itself is not a reliable substrate for a paint system.

Antifouling coating
Antifouling coatings containing cuprous oxide (e.g. Hempel's brands Dynamic, Globic, Oceanic, Olympic, Hard Racing, Mille, Bravo, Tiger") present a special problem on aluminium hulls. In contact with aluminium and seawater the cuprous oxide may be converted into metallic Cu resulting in bimetallic galvanic corrosion of the aluminium. Premature failure of aluminium hulls have happened due to this mechanism when cuprous oxide containing coating was applied directly onto the aluminium without a primer.

Nevertheless, it is believed that a thick, pinhole free, epoxy coating will provide adequate insulation between the copper biocides and the aluminium substrate. The recommended minimum dry film thickness of the epoxy is 300 µm/12 mils.

However, physical damage to the anticorrosive coating may cause smearing/squeezing of copper biocide from the antifouling onto the alu. This may cause pit corrosion. This galvanic attack can hardly be prevented by cathodic protection. Thus copper-free antifouling solutions are most safe regarding the risk of pit corrosion. Fouling release coatings will normally be copper-free and offers a safe alternative to copper containing antifouling.