Alternative for long-term corrosion protection

Surprising, but consequential on second thought ...

The paint and coatings specialist Mol Coatings B.V. presents a new anti-corrosion base coat offering surprising properties.

Manufacturers of Containers, Trailers, vehicle chassis and other steel constructions commonly count on zinc for long-term corrosion protection. This is commonly based on three alternative processes: hot-dip metallisation, zinc spray metallisation, and the use of a zinc-rich primer. Generally speaking, the industry regards hot-dip and zinc spray metallisation to be the superior processes.

In several years of R&D work the specialists at Mol Coatings B.V. took up a series of systematic, in-depth investigations into these methods and can offer now intriguing results on zinc-rich primers, which – against all expectations – outshine the known results of zinc spray metallisation and hot-dip metallisation.

Overview of the test results.

Since 1932 the Dutch company MOL Coatings B.V. develops and produces professional paint systems. MOL's latest product is called „Armour Zinc 786 System" and proves to be a true wet-paint alternative to zinc spray metallisation and hot-dip metallisation. The coating achieves indeed a level of 86% zinc in the dry film and hence complies with the highest level (Level 1) of the SSPC Paint-20 Norm and the DIN/EN/ISO 12944, part 5. The material can be applied in a very thin layer, whilst offering exquisite filling properties. Additionally, „Armour Zinc 786" convinces with high mechanical impact resistance, very good adhesion properties and - due to its very short drying time - with a significantly shorter „ready for assembly" time.

Working with this new zinc-rich primer produces hardly any overspray, resulting in especially low spray losses and a smooth and dense surface. The top coat can be applied directly onto the base coat, without any further treatment or application of fillers and primers. In combination with one of MOL's 2K paint systems this paint system complies with the European Environmental Regulations with respect to reduction of VOCs.

Advantage number seven: the corrosion protection system "Armour Zinc 786" is of course compatible with MOL's water based paint systems.

Over the years MOL Coatings has conducted extensive tests in both, lab conditions and practical applications, comparing „Armour Zinc 786" and alternative metallisation methods and products. The following table summarises the results of these tests:

	Armour Zinc 786	**Standard zinc dust primer**	**Zinc spray metallisation**
Complexity and expense of overall painting process	mid-level (sand blasting 2 ½ Paint system 2 layers)	high (sand blasting 3 paint system min. 3 layers)	very labour intensive, risk of faults, porosity, and blistering
Corrosion protection (Brown rust)	very good protection	less protection	very good protection
Blistering / Undercutting	Very advantageous	satisfactory	satisfactory
Mechanical resistance	Very advantageous	satisfactory	satisfactory
Costs (labour and material)	low	higher	high

Logical

As astounding as the results might seem at first, as logically deductible they are when understanding the underlying phenomena.
The experts at MOL Coatings explain: The protective properties of zinc on steel are based on two principles:
(A) Cathodic corrosion protection: Zinc is less noble that iron. In a corrosive environment, the zinc will dissolve (corrode). This process releases electrons, which prevent the iron from dissolving.
(B) Formation of insoluble zinc salts: the corrosion products of iron have an open structure (chips), so the corrosion will propagate. The corrosion products of zinc in contrast form a closed layer (zinc patina), which prevents further corrosion.

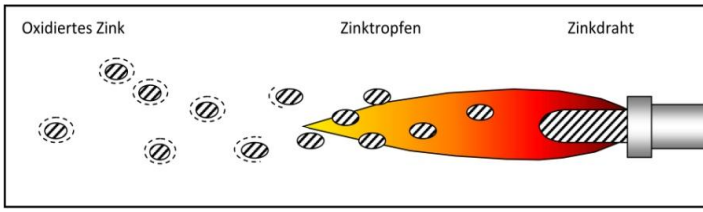
These two working principles are equally valid for all of the compared methods of zinc spray metallisation, hot-dip metallisation and zinc-rich primers. However, the different application methods lead to huge differences in how the zinc metal comes into contact with the iron surface, which in turn has an immense influence the total micro-structure of the zinc layer.
The micro-structure however is highly relevant for properties such as material consumption, as well as smoothness and mechanical impact resistance of the metalized surface and will last but not least determine the necessity of further steps in the build-up of the paint system.

Zinc spray metallisation in practice

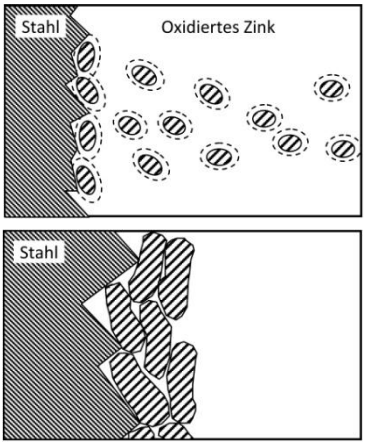
Zinc spray metallisation

The first step in the zinc spray metallisation process is the sound cleaning of the surface. Sand blasting at level Sa 2½ can leave contaminants or impurities on the surface, which will negatively affect adhesion. Therefore it is always recommended to sandblast at level Sa 3 and use a sharp blasting medium.

In the actual zinc coating process a zinc filament is brought to melting point in a spray gun. With the help of pressurised gas the liquidized zinc is blasted



onto the metal surface in the form of minute droplets. On their way the zinc droplets start oxidizing. The zinc oxide droplets then stick to the sand blasted (rough) surface. The usual film thickness of the zinc layer varies from 50 to 300 µm, and can in places even reach up to 400 µm.
In general, the zinc layers applied in a zinc spray metallisation process are comparatively rough and porous, and hence corrode faster as with hot dip zinc metallisation. The porosity rises with the size of the zinc droplets. If the metallizing process is run too fast, the process bares a high risk of insufficient surface density, which will foil a sufficient coating in the following steps.



After the zinc spray metallisation process the surface needs to be treated as quick as possible with the paint system.
Zinc spray metallisation achieves good corrosion protection. The protective layers are however less resistant to chlorides, so they will corrode faster in the presence of salt.

Armour Zinc 786

Armour Zinc 786 is a two-component zinc dust primer with zinc content higher than 85% in the dry film. For real effectiveness of zinc dust primers, a zinc content as high as this is absolutely paramount, as the zinc must have direct contact with the iron and the (corrosive) environment.
Because of their extremely high zinc content, zinc coatings of this type are often difficult to apply: during spraying a dry particle-mist is quickly formed, which results in lots of over-spray, a coarse structure of the primer film and possible cracking of the film.
Thanks to a mixture of special binding agents MOL Coatings has succeeded to achieve more than 85% zinc in the dry film, without the disadvantages just mentioned.

"Armour Zinc 786" forms a uniform and smooth paint film, without cracks or overspray. "Armour Zinc 786" can directly be coated with the top coat, without the need for any filler or sealer. The picture below shows an example of the resulting surface of the base coat.

ARMOUR ZINC 786 fulfils the highest level of the DIN/EN/ISO 12944: Corrosion protection level C5-M with a protection period of over 15 years.

ARMOUR ZINC 786: Easy to apply even on highly complex constructions. Smooth and dense surface. Can directly be coated with top coat without need for any filler or sealer.

Salt spray tests, condensation tests and long-term outdoor exposure

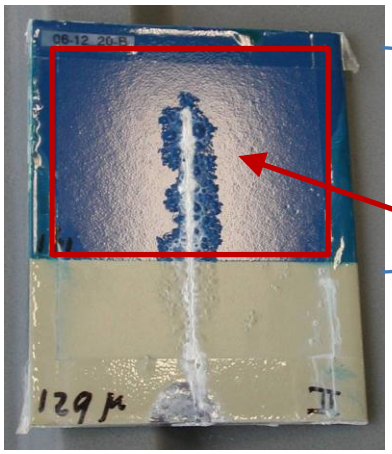
In order to obtain exact and impartial data on the corrosion protection properties of „Armour Zinc 786", MOL Coatings B.V. conducted extensive tests with both, standard lab tests and long-term outdoor exposure tests under especially harsh conditions.

Test series 1: Salt spray tests have been performed comparing both, zinc-spray metallized panels (see right column, test panel (A)) and panels treated with „Armour zinc 786" (test panel (B)). The panels were analysed with respect to blistering (ISO 4628-2), undercutting and adhesion (ISO 2409).
The results after ***1020 hours salt spray test*** were striking:

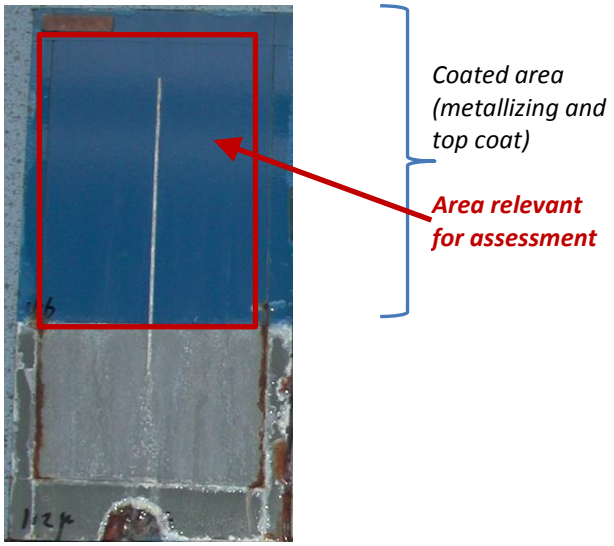
- Whilst the zinc-spray metallised panels showed considerable blistering (S4) near the scratch, the Armour zinc system showed no blistering at all.
- The zinc-spray metallised panels also showed articulate undercutting (up to 8 mm) and adhesion at only classification level 3. The Armour Zinc System in contrast showed no undercutting and convinced with adhesion at classification level 0.

Encouraged by these results, MOL Coatings extended the tests to amazing ***2096 hours salt pray test*** – which only spelled out the protective properties even more clearly.

(A) Test panel ZINC SPRAY METALLISING at 1020 hours salt spray test

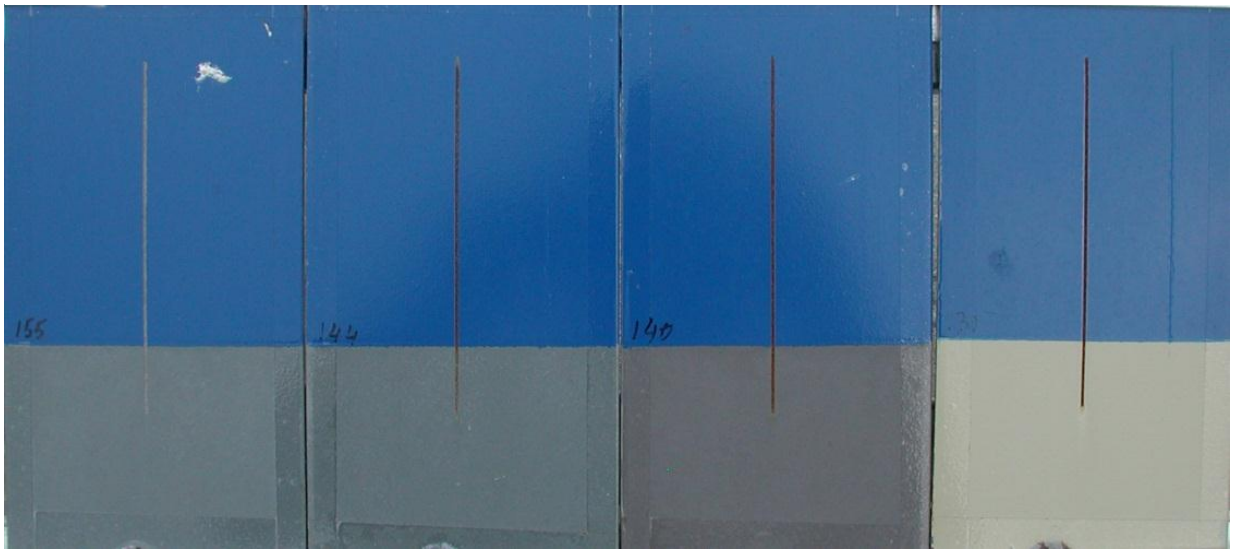


(B) Test panel ARMOUR ZINC 786 at 1020 hours salt spray test



Test series 2: In parallel to the lab tests, long-term outdoor exposure tests were run. Several zinc-dust primers of different manufacturers, MOL's own expoyd-based zinc-dust primer (E.P.M. Hechtprimer 721) and Armour Zinc 786 were compared. In all cases, MOL's top coat „Pantser 2K Coating Gloss" was applied.
The test panels were installed at a location directly at the north sea shore and openly exposed to the elements. The condition of the panels was documented at defined points of time. Following a showcase of the results after ***4 ½ years exposure*** :

- The conventional zinc-dust primer (E.P.M. Hechtprimer) as expected showed blistering and undercutting at the scratch; with "Armour Zinc 786" and some of the other zinc-dust primers in contrast, no blistering or undercutting was observed.
- The difference between "Armour Zinc" and the alternative zinc-dust primers however came very apparent with respect to brown rust: Whilst Armour Zinc had developed the



Results after 1645 days outdoor exposure at a location in Zandvoort at the North Sea shore

so-called "zinc-patina", which sealed the scratch off with white zinc salts, MOL's conventional primer and the alternative zinc-dust primers in contrast showed brown rust at 95-100% of the scratch.

- A further result of the investigations: Even small changes to the amount of zinc-dust in the coatings recipe result in dramatic changes to the protective properties. A 2K zinc-dust primer containing e.g. only 80% zinc in the dry film (equals about 75% zinc in the wet product), shows a considerable loss of corrosion protection.

In summary the tests proved, that only zinc base coats, which strictly adhere to the definitions of SSPC-Norm Level 1 and DIN/EN/ISO 12944 part5, i.e. coatings achieving at least 85% zinc in the dry film, offer a corrosive protection comparative to hot-dip metallizing; Coatings with zinc levels below this thresholds offer hardly any advantage over standard protective coatings.

Cost savings included

On top of the established advantages in the material's functionality (corrosion protection, blistering, undercutting and very high mechanical strength) the new zinc-dust primer convinces in the analysis of labour costs and material costs.

Whilst in the zinc-spray metallizing process labour costs add up for up to eight process steps (including sand blasting Sa 3, zinc-spray metallizing, pre-treatment with base coat, application of base coat, sanding, application of filler/sealer, caulking, application of top coat) the Armour Zinc System can reduce this to only four steps. The highest cost saving potential is clearly connected to the fact, that „Armour Zinc 786" can be applied in a thin layer (50 µm) and that – due to the high weight of the material – only very little spray losses are observed. This zinc-layer dries very quickly. Also – in sharp contrast to zinc-spray metallisation – „Armour Zinc 786" has very good filling properties and forms a dense and closed surface. Hence labour- and material-intensive post-treatment of the metallized surface is not necessary, and – after potential caulking – the top coat can be applied directly on top of the zinc-layer with very good results.
Users of this new system are often able, to translate the demonstrated advantages into distinct savings in the overall production costs.

In summary it has been established: Lab tests and long-term outdoor exposure tests proved, that the „Armour Zinc 786" offers clear advantages in functionality and commercial aspects compared with zinc-spray metallizing, and hence offer a true alternative to zinc-spray metallizing for the Container- und Trailer-Industry. Thanks to its easy and low-effort application method, the process can be used in any conventional spraying booth common in the body-building industry.

Contact:

Sander Jansen
Phone: +31 651 81 6510

MOL Coatings B.V.
Utrechtsestraatweg 224
3911 TX Rhenen, The Netherlands
Phone +31 318 472 020