NACE JUBAIL
CUI Workshop
10th December 2015

AvantGuard®
Redefining anti-corrosion
Hempel introduces AvantGuard®, a brand new innovative anti-corrosion technology, based on activated zinc and locked into our new range of high performance protective coatings.

This innovation significantly reduces the effects of corrosion and offers superior protection. This increased durability has been proven in extensive tests against standard zinc rich epoxies without this new technology.
Table of contents

- Benefits of this new technology
- Where can this be you used?
- Why AvantGuard®
- What is AvantGuard®
- References
BENEFITS FROM USING AVANTGUARD®
# Benefits

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced rust creep and enhanced corrosion protection</td>
<td>Excellent protection - can contribute to reduced maintenance</td>
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<tr>
<td>Extremely good mechanical properties</td>
<td>High resistance to cracking in corners, welding seams, etc. Excellent resistance to abrasion</td>
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<tr>
<td>Self healing properties</td>
<td>Cracks are being stopped, even before they can be developed</td>
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Redefining protection: Reduced rust creep and enhanced corrosion protection

AvantGuard® technology

Zinc epoxy without AvantGuard® technology

Can contribute to reduced maintenance
Redefining protection: Reduced rust creep and enhanced corrosion protection – also on full systems

Can contribute to reduced maintenance

AvantGuard® technology

Zinc epoxy without AvantGuard® technology
Redefining durability:
Extremely good mechanical properties

High resistance to cracking in corners

AvantGuard® technology

Zinc epoxy without AvantGuard® technology

AvantGuard® redefining anti-corrosion
Redefining durability: Extremely good mechanical properties

High resistance to cracking in weldings

AvantGuard® technology
Zinc epoxy without AvantGuard® technology

AvantGuard® redefining anti-corrosion
Redefining durability: Improved self healing properties

Cracks are being stopped, even before they can be developed

Micro-crack covered by zinc corrosion sub-products
### Benefits

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<td>No special application technique or equipment needed</td>
<td>No change in production line setup</td>
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<td>Very tolerant to different climatic conditions and with high DFTs</td>
<td>Less rework due to application during high humidity, high temperature or accidental excessive film thickness</td>
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<td>Fast throughput, less need for waiting on drying</td>
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Redefining productivity: No special application technique or equipment needed

No change in production line setup
Redefining productivity: Very tolerant to different climatic conditions and with high DFTs

Less rework due to application during high humidity, high temperature or accidental excessive film thickness

AvantGuard® technology
Zinc epoxy without AvantGuard® technology
Redefining productivity: Drying properties among best in class

Fast throughput, less need for waiting on drying

Also excellent:
- stability
- spray ability
- film formation
- sag resistance
HEMPEL’S AVANTGUARD HAS BEEN TESTED
WE KNOW IT WORKS!
We know it works because we have tested it - internally and externally!

- **High Zinc Content**
  - NORSOK M 501 revision 6 (ISO 20340) – certified by COT (Netherlands)

- **Medium Zinc Content**
  - ISO 12944 C5 M/I, 2007 – certified by COT (Netherlands)

- **Other tests**
  - Water permeability test
  - Thermal Cycling Resistance test
  - NACE cracking test
  - Hempel welding test
WHERE CAN YOU USE AVANTGUARD®
## AvantGuard® product range

<table>
<thead>
<tr>
<th>Product</th>
<th>VS %</th>
<th>VOC</th>
<th>Zinc content</th>
<th>Test certificates</th>
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<tbody>
<tr>
<td>HEMPADUR AvantGuard® 770</td>
<td>66</td>
<td>328 G/L</td>
<td>Comply with the requirements in ISO 12944 Part 5, 2007, and Level 2, type II in SSPC Paint 20, 2002. Utilizes ASTM D520, type II zinc dust.</td>
<td>NORSOK M-501 Ed. 6 (ISO 20340)</td>
</tr>
<tr>
<td>HEMPADUR AvantGuard® 550</td>
<td>65</td>
<td>319G/L</td>
<td>Comply with the requirements for Level 3, type II in SSPC Paint 20, 2002. Utilizes ASTM D520, type II zinc dust.</td>
<td>ISO 12944 C5M/I, 2007</td>
</tr>
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</table>
No difference in areas of application

- Activated zinc primers can be used in the same applications as any zinc epoxy without this technology - there is no difference in areas of application

- Application equipment is the same as with zinc epoxies without this technology - no special equipment needed
Activated zinc primers are versatile and conform well with numerous different paint systems

- Typical paint system:
  - 1st coat: Activated zinc epoxy: 40 – 100 mic (1.6 – 4 mils)
  - 2nd coat: Epoxy midcoat 100 – 200 mic (4 – 8 mils)
  - 3rd coat: Polyurethane topcoat 50 – 80 mic (2 - 3.2 mils)

Other typical system combinations could be:
- Different combinations of Activated zinc primer and a PU topcoat in a two-coat system
WHY AVANTGUARD®
Nature wants it back
Nature wants it back
Three ways to provide anti-corrosion protection using coatings

**Barrier effect**

NaCl (aq), O₂

Physical barrier that reduces (or blocks) the diffusion of species that can cause corrosion

- High DFT
- Low water permeability
  - Highly cross-linked binder matrix
  - Optimal packing (often laminar fillers are used)

**Inhibition effect**

NaCl (aq), O₂

Chemical reaction that minimises or prevents corrosion

- Ensuring a stable pH in the steel interface (pH between 7-12) (steel passivation)
- Formation of an insoluble layer at the interface with steel
- Blocking movement of corrosive species (addition of environmental scavengers)

**Galvanic effect**

NaCl (aq), O₂

Altering the electro-chemical reaction forcing the oxidation of a different substance

- Addition of a substance more active than steel (typically Zn), that acts as anode, blocking the oxidation of iron

Zn → Zn²⁺ + 2 e⁻
Fe → Fe²⁺ + 2 e⁻
Not full utilisation of zinc content

Only the zinc in the closest 20-30 microns is active to provide a galvanic protection.

Galvanic effect of normal zinc epoxies is limited.

In most zinc epoxy coatings with a zinc content < 85% only a small amount of the added zinc will provide a Galvanic protection.
AvantGuard® is activated zinc and provides three types of protection:

- **Inhibitor Effect**
- **Barrier Effect**
- **Galvanic Effect**

AvantGuard® redefining anti-corrosion
AvantGuard® ingredients

Zinc

Hollow Glass Spheres

Activator

AvantGuard® redefining anti-corrosion
Redefining protection: Improved galvanic effect

- Thin layer of zinc corrosion products protects steel from corrosion
- More zinc available where needed
- Higher ability to release electrons – more efficient anode

Insoluble zinc salts have been coloured green

AvantGuard™ redefining anti-corrosion
Redefining protection: Improved barrier properties

Activated zinc on the surface creates a barrier and reduces the permeability of water.

80% Zn (in weight), SST after 950 hrs, 1 coat (only primer), same DFT, 35°C, NaCl 50 g/L. The pictures on the left shows the full panels, moving right the pictures show enlargements for of same panel.
Redefining protection: Improved barrier properties

Insoluble compounds
- Accumulate on the surface of the panel acting as a barrier to water, oxygen and ions
- Accumulate around the spheres reducing the porosity of the film and improving the barrier effect

AvantGuard® redefining anti-corrosion
Redefining protection: Enhanced inhibition effect

Chloride ions are captured by the film, inhibition effect enhanced by the hollow glass spheres

Inhibition effect: Insoluble products contain oxy-chloride zinc salts

Concentration of chloride ions next to steel is lower, due to the "chloride scavenger effect" of AvantGuard®

AvantGuard® redefining anti-corrosion
Redefining durability: Improved mechanical properties

Hollow glass spheres stop the development of cracks and reduce internal stress

Cycles of 2 hrs at +60°C and 2 hrs at -20°C during 21 days
Redefining durability: Self-healing effect towards the cracks

Zinc corrosion sub-products fill the empty space of the micro-cracks and delay their expansion into big cracks, thus **self-heal**

Micro-crack covered by zinc corrosion sub-products