Increasing protection and productivity in challenging environments with patented Avantguard® technology

How activated zinc primers are enhancing application efficiencies and reducing maintenance on industrial assets in very high corrosive environments.

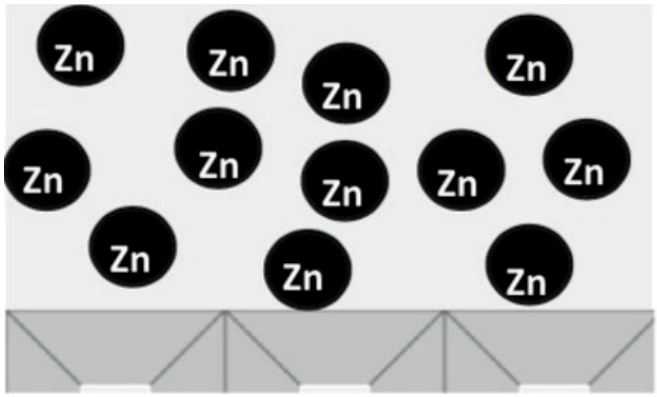
From offshore wind turbines and oil platforms to mines and power stations, industrial assets are exposed to some of the most corrosive environments on our planet. Permanently corrosive saline and chemical atmospheres, extreme temperature and humidity swings, and impact and abrasion make corrosion a major challenge. Maintaining these assets can be costly, especially structures in hard-to-access locations or facilities that require shutdown during repair work. The correct choice of anti-corrosive coating system can significantly increase asset lifetime, reduce maintenance costs, lower application costs and improve sustainability.

This paper examines the performance of Avantguard zinc epoxy primers, a new type of zinc coating that uses unique activated zinc technology to increase performance and overcome the limitations of current coating technologies. Activated zinc technology activates more of the zinc in a coating in the fight against corrosion. This increases the galvanic, barrier and inhibition protection of the coating, as well as its mechanical properties, without increasing zinc content. The result is a coating that provides the same or better corrosion protection than traditional zinc epoxies and inorganic zinc primers, but is significantly easier to apply and requires fewer coats or dry film thicknesses.

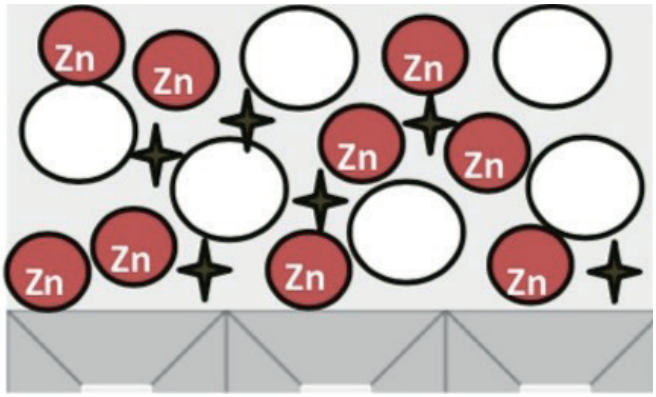
The advantages of utilising Avantguard primers in corrosively aggressive environments are many. The superior anti-corrosion performance of activated zinc coatings can increase system longevity by up to 50%, extending asset lifetime and reducing maintenance requirements. Also, as the coatings are easy to apply and dry quickly, productivity is higher and application more reliable, lowering both maintenance and construction costs. In addition, lower dry film thicknesses are required to deliver the same or higher protection. This means less paint is used, which can reduce VOC emissions by up to 30%.

Improving protection in harsh environments

In traditional zinc-rich coatings, the zinc acts as a sacrificial element. As zinc is less noble than iron, when the coating is exposed to corrosive elements such as water or oxygen, the zinc corrodes instead of the iron to leave the steel intact. This process, known as the galvanic effect, is dependent on the transfer of galvanic current by the zinc primer. In conventional zinc epoxies, however, this current transfer can be an issue. A normal zinc epoxy coating is around 60-80 microns thick. However, research shows that only the zinc in the first 20-30 microns of a conventional zinc epoxy provides galvanic protection. This is only 1/3 of the total coating thickness. Even at relatively high zinc loads (80% or greater) a large portion of the zinc is left unused. Avantguard is different. Its patented activated zinc technology fully utilises zinc content, providing better corrosion protection. This is achieved by combining the elements used in conventional zinc epoxies with two new substances – glass spheres and a Hempel proprietary activator.



Zinc epoxy without activated zinc technology



Avantguard: Zinc epoxy with activated zinc technology

The combination of these key elements and the right choice of binders, pigments, fillers and additives in Avantguard products ensures more zinc is activated throughout the coating. As a result, Avantguard provides significantly more efficient galvanic protection, as well as enhanced inhibition and barrier effect.

Galvanic protection

All of the zinc is activated through the lifetime of the coating. This stops steel corrosion more effectively and reduces creep corrosion if the coating suffers mechanical damage during service.

Barrier effect (low water permeability)

If mechanical damage occurs, the compounds produced by the unique zinc activation process in Avantguard fill any space within the film, sealing it and enhancing the coating's water barrier properties.

Inhibition effect

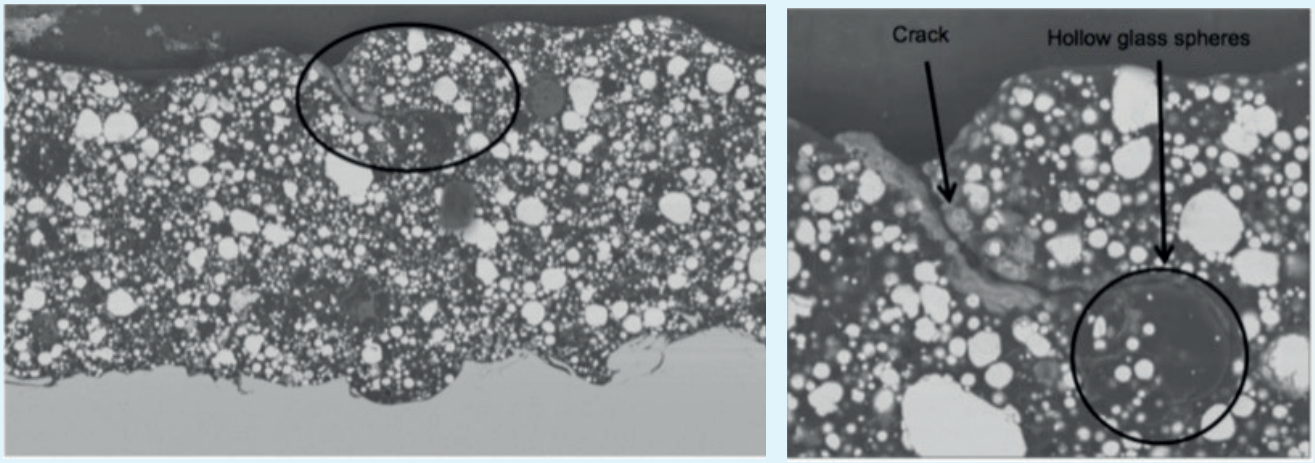
The zinc salts contain high levels of ions. These are captured within the coating as they diffuse from the environment through the film, reducing the concentration of corrosive agents that can reach the surface of the steel.

As a result of these enhancements, Avantguard zinc epoxies outperform conventional zinc epoxies in the protection of steel against corrosion. When Avantguard systems are tested under corrosion protection test methods – including salt spray tests (ISO 12944 part 6), cyclic corrosion tests (ISO 20340 - NORSOK M-501 revision 6), water permeability tests (SSPC paint 20 type II) and thermal cycling resistance tests (NACE cracking test) – they outperform conventional zinc epoxies, either by meeting test requirements for a longer test time, or by meeting the test requirements at lower film thicknesses.

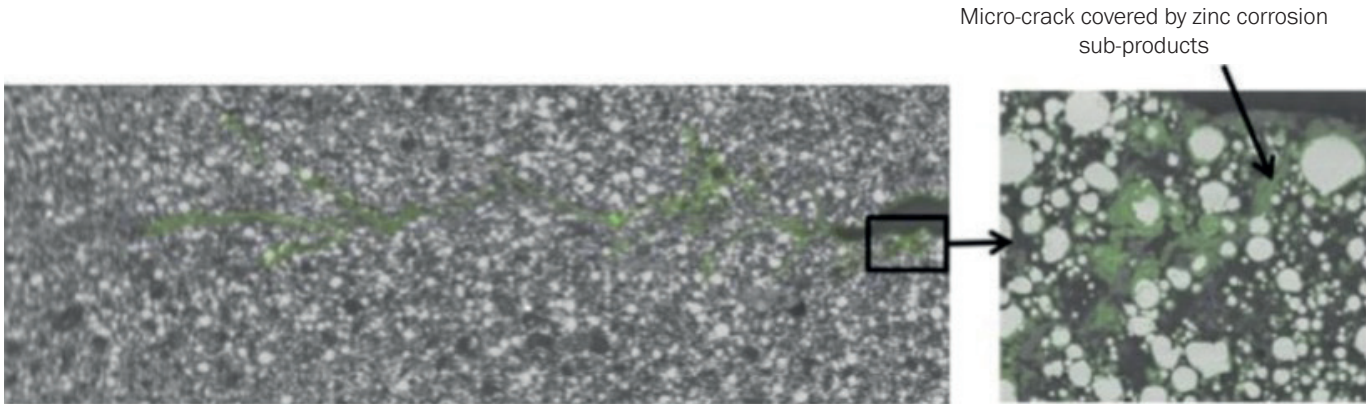
Increased mechanical strength

Industrial steel structures are often exposed to severe mechanical stress, such as extreme temperature fluctuations or mechanical damage from impact and abrasion. Traditionally, zinc-rich primers have been the weakest mechanical point in a zinc protective coating system. This mechanical stress and damage can result in the formation of micro-cracks, which will eventually lead to real cracks and subsequent corrosion. This is a common issue in both zinc epoxies and inorganic zinc primers.

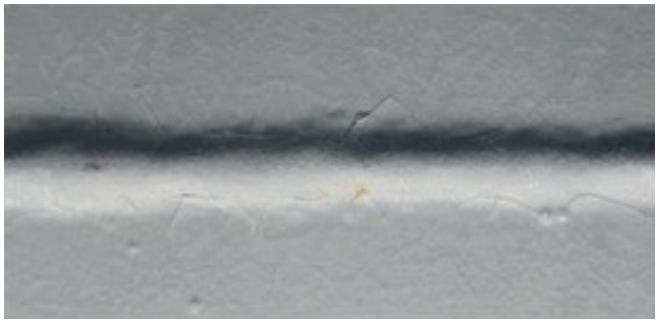
In Avantguard-based systems, the unique combination of hollow glass spheres and the zinc activation process overcomes this issue. If a crack forms, the glass spheres absorb most of the impact from the initial crack and stop it from developing. In addition, the sub-products formed during the zinc activation process occupy the space left by the micro-crack, preventing it from developing into a more serious crack. This significantly reduces rust creep and ensures that the coating maintains its anti-corrosive performance for longer.



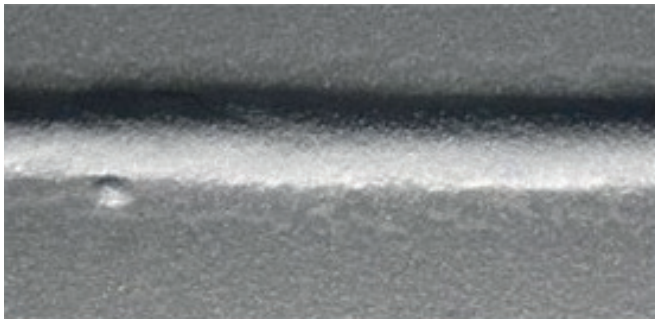
The glass spheres in the coating absorb the impact of the initial crack and stop it from propagating. (The picture on the right shows an enlargement of the crack seen on the left).



The hollow glass spheres form at the base of a crack and stop it from becoming larger. (The picture on the right shows an enlargement of the crack seen on the left).

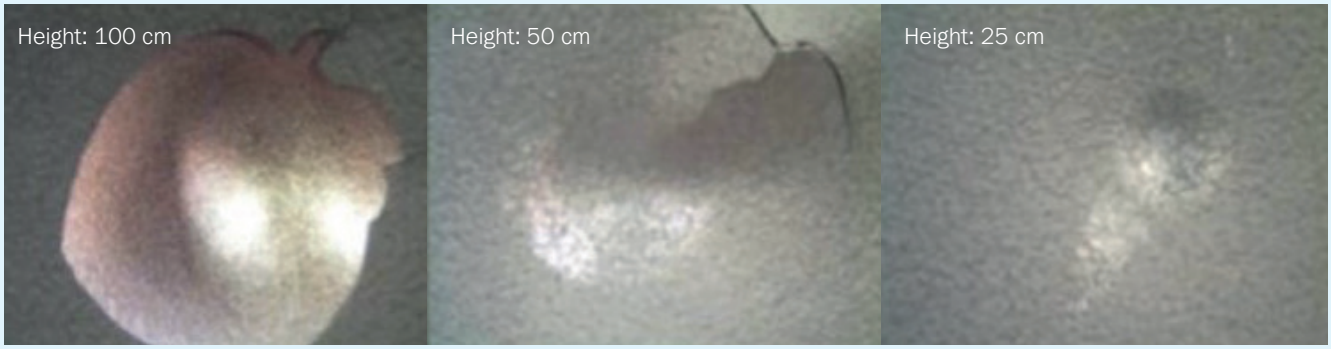


Zinc epoxy without activated zinc technology

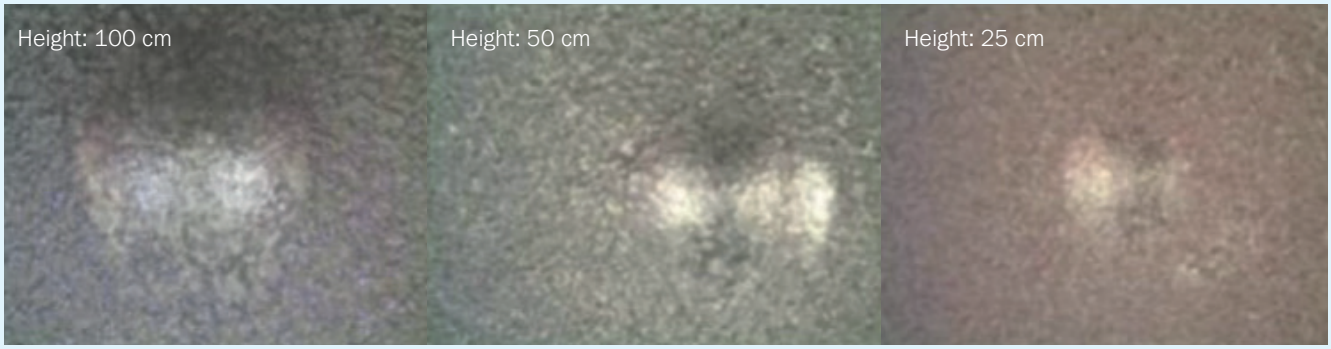


Avantguard: Zinc epoxy with activated zinc technology

In order to assess mechanical strength, steel panels with a centred weld were applied with a single coat system. After curing, the panels were exposed to the NACE TM0304 thermal cycling test for 150 cycles (2 hours of exposure at 60°C and 2 hours of exposure at -20°C).



Zinc epoxy without activated zinc technology



In the impact test, steel panels were applied with a single coat system. After curing, the panels were exposed to the impact test at heights of 25 cm, 50 cm and 100 cm.

Increasing productivity during application

In order to ensure strong galvanic protection, zinc primers are typically formulated with a high concentration of zinc pigments (80% or higher). However, this leads to very poor film characteristics, such as low adhesion values, high potential for mud-cracking and high viscosity. As a result, surface preparation is extensive and conditions must be ideal during application to ensure a high quality and reliable finished coating. If these criteria are not met, the performance of the coating can be severely compromised. Additionally, conventional zinc-rich coatings are slow to dry, delaying application of the next coat in the system. This makes conventional zinc-rich coatings difficult and time-consuming to apply, which can lead to project delays and often results in unreliable performance of the finished coating system.

Avantguard products do not suffer from these issues. They ensure good coating stability, edge retention and film formation, even in high temperatures and humidity, and can tolerate up to 25% higher dry film thicknesses, which significantly reduces the likelihood of cracking and improves final coating quality.

Avantguard can also be formulated with a recoat interval of just 45 minutes at 20 °C, 50% quicker than most standard zinc primers at the same temperature. This makes them ideal for high productivity systems: when used with other fast-curing products, they enable applicators to coat more sections in one shift, for higher productivity in both new building and maintenance situations.

Challenging the standards of corrosion protection

The industry standards that define the design, testing and durability of anti-corrosive coating systems are usually based on the performance of conventional coating technology. The activated zinc technology in Avantguard is redefining corrosion protection by combining and enhancing the three protection methods of galvanic protection, barrier effect and inhibition effect. With this unique blend of protection methods, coating systems based on Avantguard have been proven to exceed the test requirements of well-known standards, such as ISO 12944 and NORSOK. This has been demonstrated by passing the test requirements for an extended duration (indicating an extension of service of the system) or by passing the test requirements with reduced system requirements (e.g. with a lower film thickness or fewer coats).

This can be useful in multiple ways. By extending the protection of assets, operational costs related to maintenance are lowered by up to 30% across the lifetime of an asset. In addition, by reducing system requirements, capital investment and environmental impact can be lowered. Material costs can be up to 15% lower, for example, and VOC emissions can be reduced by 30%. At the same time, application time can be reduced by as much as 30%, leading to faster project completion times.

Conclusion: Benefits for asset owners, contractors and applicators

Thanks to activated zinc technology and its novel combination of zinc dust, hollow glass spheres and proprietary activator, Hempel's Avantguard primers demonstrate improved corrosion performance, mechanical robustness and application properties compared to conventional zinc epoxies and inorganic zinc primers. This has significant benefits for owners, operators and applicators.

In corrosively aggressive environments, the use of an Avantguard primer can increase the lifetime of an anti-corrosive coating system and reduce maintenance requirements. In terms of general operating costs, this can mean significant savings, especially on assets that are hard to access or facilities that must be shutdown when maintenance is performed. For contractors, the documented performance of Avantguard coatings enables them to offer better warranties for the equipment and structures they supply. For applicators, the easier application and faster drying speeds of activated zinc coatings enable them to increase productivity – and so profitability – in both newbuild and maintenance situations.

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