PROTECTING YOUR ASSETS in Challenging Environments

A focus on enhancing operational efficiencies galvanizes change for protective coatings.

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Global seaborne trade continues to grow despite the current economic difficulties facing many trading nations. But it has been the shipping industry that has felt the pinch most significantly. Thin margins are forcing vessel operators to search for efficiencies at every turn, which has encouraged owners and operators alike to carefully scrutinize every aspect of their operations. Using innovative hull coatings to save on fuel costs has been a major focus in recent years; the result is that owners and operators now look more strategically at the coatings they use as a tool to increase operational efficiency.

Like shipping, the offshore sector is not faring well in light of continuing low oil prices. Therefore, operators of complex steel structures in the offshore environment, such as oil and gas installations, must carefully consider their choice of protective coating as a tool to manage operating and maintenance costs and, therefore, enhance profitability.

Developing highly complex and technologically advanced protective coatings that deliver the required efficiencies to these specialized market segments raises a number of technical challenges for coatings providers.

Above the Waterline

Offshore structures are permanently exposed to highly saline and corrosive conditions along with extremes of temperature and physical stress; these factors present a unique set of challenges for the coatings industry. Traditionally, inorganic zinc-rich coatings (IOZs) such as zinc silicates have been the preferred primers for these environments because of their enhanced anti-corrosive properties, with zinc epoxy coatings taking a back seat. However, while IOZs exhibit superior anti-corrosion properties, they tend to suffer from low mechanical strength and require specific conditions for application. Because of this, an increasing number of offshore installation operators are choosing a zinc epoxy instead. But the problem here is that zinc epoxies require a more regular re-coat which usually means taking the asset out of service. Each system, therefore, has its limitations.

In both zinc silicates and zinc epoxies, the zinc acts as the sacrificial element and corrodes instead of the iron to leave the steel intact. This process - known as the galvanic effect - only works if the zinc primer is able to transfer galvanic current. In general, a normal zinc coating is around 60-80 microns thick but it is only the first 20-30 microns of a traditional zinc epoxy coating that delivers the galvanic protection. The epoxy resin insulates the zinc particles causing them to lose their galvanic properties. Even at high zinc loads, around 80% of the zinc is too far away from the point of corrosion for it to be of any use.

Activated Zinc

As a coatings specialist, our challenge has been to activate more of the zinc to improve the galvanic effect of the coating without increasing the actual zinc content itself. Doing this ensures that the zinc throughout the film is delivering anti-corrosion protection. Our solution was to introduce two new substances into the primer - hollow glass spheres and a proprietary activator. The combination of these new items, together with the optimum mix of binders, pigments, fillers and additives ensures that the zinc is activated throughout the coating.

In general, traditional zinc coatings are porous and so offer little resistance to water. But with our new coating, as well as significantly enhancing the galvanic effect, we also found that our new activated zinc primer had a lower water permeability. Once the zinc becomes activated, the resistance to water is increased as it forms a layer of insoluble salts on the surface and within the film – the barrier effect. The benefits of such a barrier within the marine environment – where an installation is permanently immersed in water – are significant and can provide additional protection over the lifespan of the installation.

It's also important to note that water is not the only destructive force for installations operating offshore. In particularly aggressive saltwater environments, chloride ions will penetrate a protective coating to cause pitting corrosion. Our coating effectively captures these chloride ions by forming chloride-containing salts around the hollow glass spheres. This significantly delays the corrosive process as the chloride ions are trapped within the coating and prevented from reaching the steel surface – the inhibitor effect.

Avantguard Technology

These innovations have been captured in a new Hempel coating technology called Avantguard. This has, in our view, redefined anti-corrosion coatings as Avantguard delivers a triple protection. It exhibits greater galvanic activity by increasing the activation of the zinc; it creates an inorganic salt barrier against water and other corrosive species; and it acts as a chloride scavenger by capturing chloride ions.

Offshore structures are often exposed to severe mechanical stress and fluctuations in temperature which can cause a zinc primer to crack as the steel contracts and expands. The new Avantguard technology compensates for this through its unique self-healing properties. The hollow glass spheres within the primer absorb much of the energy from the cracking process to prevent initial cracks from widening and developing. In addition, the sub products formed by the zinc activation process will occupy the space left by micro-cracks and prevent them from developing into something more serious. This significantly reduces rust creep and ensures that the coating maintains its anti-corrosive performance for much longer.

In terms of the application process, an Avantguard coating may be applied at high temperatures and levels of humidity without blistering. And, with a re-coat interval of one hour at 20 °C, it is 50 percent quicker to dry than most zinc-rich epoxy primers at similar temperatures. Its high dry film thickness is not susceptible to cracking which means that operators needn't be overly concerned when applying to welds or in corners where over-application tends to occur.

Efficiency Gains

The advantages of utilizing this innovative technology in aggressive environments are significant. Owners of offshore structures can increase the lifetime of their assets and reduce maintenance requirements and costs. This is particularly relevant for hard-to-access areas that require a shut-down to maintain. For contractors, having confidence in their choice of coating allows them to offer enhanced warranties for the equipment and structures they supply. Avantguard's wide tolerance allows contactors to touch-up and repair a coating on site. For fabricators, Avantguard is easier to apply than other similar primers and enjoys a shorter re-coat interval which improves speed and efficiency. All in all, this new technology has redefined anti-corrosion coatings by reducing rust creep, enhancing resistance to corrosion, improving crack resistance and heightening tolerance to varying climatic conditions.

Below the Waterline

Ship owners are keen for their vessels to maintain a smooth and foul-free hull. Fouling increases the drag of the hull which, in turn, increases the fuel consumption and associated harmful emission. The right coating keeps the hull smooth thus minimizing the need for cleaning operations or premature docking of the ship.

The antifouling market is dominated by conventional antifouling coatings that rely on biocides to control hull fouling. This is traditionally achieved by the addition of cuprous oxide as a pigment, combined with organic co-biocides, in order to deliver the required biocide activity to fight off the entire

span of marine-based biofouling organisms. Conversely, fouling release systems are generally biocide-free. They are based on polydimethylsiloxane, known as PDMS or silicone, that minimizes the strength of adhesion of the fouling organism, allowing for release during the operation of the vessel. The problem here is that PDMS coatings have limited effect at low operating speeds. This is particularly relevant in today's market where ships can be idle for longer periods or are steaming more slowly to save on fuel costs.

Resistance to Fouling

The way around this is to combine a PDMS coating with a hydrogel to deliver improved resistance at slower speeds or when the vessel is idle. A hydrogel is a layer of water trapped in or around a network of hydrophilic polymers. An organism wanting to attach to a hydrogel-covered hull will first need to recognize if the surface is suitable for settlement. As the hull is covered in bound water, most organisms will simply not recognize it as a suitable surface and find a home elsewhere. A water bound surface will also require the organism to expel the water before it can apply its own adhesive direct to the hull, and most organisms don't have the energy to do this.

Actiguard Technology

Moving the concept on, we are now combining the hydrogel layer with biocide to form a biocide-activated hydrogel layer – a technology called Actiguard®. Here, the hydrogel traps the biocide during its diffusion out of the film and this increases the surface concentration of biocide. It thereby prolongs the retention of biocide on the surface enabling Actiguard to remain extremely effective with lower amounts of biocide. Because of this, an Actiguard coating is able to release biocide in a stable and controlled manner for vessel speeds (or currents) exceeding 0.1 knot and upwards. This is significant for a ship owner as it means the hull remains protected even when the vessel is idle, or is slow steaming. From an environmental perspective, the stable release of biocide irrespective of speed means that less biocide is released into the oceans when travelling at higher speeds.

The efficient use of biocides allows for a very low pigment and filler volume concentration; they also enjoy a low VOC content. Low biocide content also ensures the coating is smooth after application, which is important for a vessel to maximize its fuel efficiency and, therefore, reduce operating costs. Even if the hull suffers scratching, Actiguard offers a window of defense and tests have shown that Actiguard coatings will retain their protection levels for at least 22 months when scratched.

Performance Consistency

Efficiency is paramount in the current shipping markets and tests of Actiguard technology show that its fouling defense properties remain effective for vessels that switch from slow to fast steaming and that remain idle for periods up to 120 days. This is particularly interesting for larger container vessels and tankers that, for example, may wish to increase speed on one route to meet schedules and slow steam on the other to achieve extra fuel savings. It also means an operator can lay up a vessel for up to four months without having to clean the hull. Additionally, fuel savings of 6 percent on average, across the entire docking interval, have been achieved which is significantly higher than conventional self-polishing technologies. Further efficiencies are gained due to the extended re-coating interval which reduces the time a vessel spends in dry-dock.

Galvanizing Change

Tough markets and challenging physical conditions are encouraging those who operate in such environments to demand more from their coatings provider. This provides an opportunity to push harder and develop ever more sophisticated coatings solutions for the benefit of our customers, and the environments in which they operate. Contemporary coatings must offer the highest levels of protection as well as opportunities to enhance efficiencies and control costs. In turn, as coatings providers, we can play a significant role in helping our customers develop their operational capabilities. A heavy investment in continued R&D will pay dividends in both quarters, and we will all benefit from the ripples of change. *CW*