The increasing demands placed on offshore operators means that exploration and production assets are being pushed harder and harder to maximise financial returns. This inevitably means prolonging of the working lifetime of an offshore structure whilst operating in some of the harshest, most corrosive environments in the world.

The past 10 to 15 years has seen many significant changes in the coatings industry, particularly in the areas of health, safety and environmental controls. Many of the ‘traditional’ anti-corrosive coatings are now no longer acceptable due to their potentially hazardous nature, e.g. red lead, coal tar pitch, isocyanates, etc. In addition, requirements to reduce emissions to the atmosphere of potential ozone depleting materials have resulted in a reduction in volatile organic content (VOC) of paints and coatings.

As the protective coatings industry moves into the 21st century, coating manufacturers can no longer rely on the extensive track records of their time-served product ranges to convince customers of their suitability for use. As each day goes by, these products are increasingly phased out due to the various strict global VOC and raw material legislations, and there is nothing more certain than legislation becoming even stricter as time progresses.

Whether it is a drilling rig, fixed platform, subsea wellhead, or a floating production storage and offload (FPSO) vessel, the ravages of corrosion pose a threat to the longevity of the structure. The coatings materials being used today are much changed from their counterparts of 25 years ago and, as a consequence, owners and operators need to understand the potential benefits of selecting the correct protective coatings materials, specifications and procedures in order to ensure appropriate protection of their assets.

Protective Coatings – Short-term Cost or Long-term Benefit?

The application of coatings to protect offshore structures is an essential component of ensuring a structure can survive for its intended design life. While the overall value of coatings applied to an offshore structure are relatively small in terms of the overall cost of the project, all too often their use is minimised in order to reduce costs during new construction. While this may recoup some financial gain in terms of the delivery of a new structure, there is likely to be a more significant negative impact to the owner/operator in terms of cost of on-going maintenance and repairs over the lifetime of the structure. However, correct selection of coating materials and their specification at the design stage can yield financial benefits in the longer term.

New Coatings Technologies – Designed for Longer Life

As coatings technology has evolved to accommodate the need for safer, higher solids, lower solvent content materials, research and development work has yielded new materials that can provide performance benefits compared to traditional materials, for example:

High-performance Topcoats

Organic coatings such as epoxies and polyurethanes degrade as a result of exposure to ultraviolet radiation, or by chemical attack. Silicon-based inorganic coatings are much more resistant to these degradation mechanisms, and polysiloxane coatings offer significantly enhanced durability when compared with conventional polyurethane coatings. Polysiloxane coatings must, however, be modified to the right extent with organic resins to enable other coating performance properties such as flexibility, toughness, adhesion to primers and cost to be obtained while, at the same time, not detracting from the polysiloxane properties. By carefully choosing the organic modification of the polysiloxane polymer, e.g. acrylic, these materials can provide an inorganic backbone that provides not only enhanced finish coat aesthetics but also the long-term durability against coating breakdown caused by weathering and exposure to aggressive environments.
Correctly formulated polysiloxane coatings offer excellent short, medium and long-term gloss and colour retention (see Figure 1). Good abrasion and impact resistance means reduced damage during service and long-term film flexibility allows application to structures where some flexing movement is expected.

**Abrasion-resistant Splash-zone Coatings**

The incorporation of glass flake in high-solids epoxy coatings is a recognised solution for long-term protection in the most corrosive environments, such as those used in splash-zone coatings for offshore, underwater steelwork, and hull structures on FPSO vessels, floating storage and offload vessels, etc.

Epoxy-based glass-flake coatings are the most commonly used protective coatings in these extremely aggressive areas and are hard, tough materials with good chemical, solvent and abrasion resistance. They can also be used in association with cathodic protection systems.

**Fire Protection**

The provision of appropriate fire protection on offshore structures is now a mandatory requirement. Intumescent materials are thin coatings – 5mm to 15mm – that, when exposed to fire, form a thick char preventing heat transfer. These materials provide the necessary levels of protection against hydrocarbon pool and jet fires, and retain their fire performance throughout the life of a structure, subject to correct surface preparation and application (see Figure 2).

For many years Underwriters Laboratories, Inc. (UL) in the US have provided the service to test and evaluate intumescent materials and provide a listing confirming suitability for exterior use. Products that cannot demonstrate the ability to maintain a specific level of fire performance after accelerated ageing exposure are not deemed suitable for exterior listing.

Correctly formulated epoxy intumescent materials are hard and durable, providing exceptional protection from corrosion. This is due to their very high adhesion to the substrate and resistance to impact, abrasion and vibration damage. High tensile and compressive strengths can be obtained and weather resistance is excellent. The relative ease of application and their durability far outweigh any cost advantages of other systems. This is one of the primary reasons why epoxy intumescent materials have almost totally displaced cement-based fire protection products for the offshore oil and gas exploration and production industry.

**Fouling Control**

Worldwide, offshore platforms are being set in deeper and deeper water and, whether a production structure is situated in relatively cool waters, such as the North Sea or in more tropical waters such as the Gulf of Mexico, significant marine growth on the underwater portion exposed to sunlight is inevitable.

On the subsea areas of a production structure, barnacle growth can add a huge amount of weight, making it necessary for design engineers to increase the amount of steel-stiffeners required. In addition, any type of fouling growth masks the surface, making it difficult to inspect the underwater structure with remotely controlled vehicles or divers without the need for extensive surface cleaning.

In particular, protecting vulnerable offshore riser piping from marine growth is a high priority for the oil and gas industries. Just the weight of the riser pipe string and its contents puts tremendous stress on the riser pipe, which can be compounded by wave and current action, and the potential for storm damage. Vibration is one of the greatest threats to riser piping, since continuous vibration can weaken and eventually break weld joints.
Previously, toxic antifouling coatings were effective for controlling the growth of marine organisms. However, the worldwide ban on the use of tin-based antifouling coatings and further proposed environmental restrictions concerning discharge of leachable toxic materials limits – and in many countries prohibits – the future use of these coatings. The gap between the efficiency life of traditional biocide antifouling and structure service life is therefore likely to become even wider.

Non-toxic, biocide-free, silicone elastomer, fouling control systems are durable, surface-effect coatings with low surface energy, which prevents the adhesion of mussels, barnacles, etc. They provide an environmentally friendly solution to the problem, with equivalent fouling control performance compared with tributyltin-based self-polishing copolymer systems. The surface of the coating allows easy cleaning by either moderate tidal-wave action or low-pressure water washing, and fouling control properties have been proven in service for over 15 years in severe fouling environments. The inherent flexibility of the coating also allows their use on flexible substrates and lightweight composite materials, allowing their use on riser pipes and subsea structures (see Figure 3).

Correct Coating Selection and Specification

In many instances, selection of the correct coating system at the time of construction undoubtedly comes down to an issue of cost. However, in what is a very competitive supply environment, the value saved during the fabrication stage is insignificant compared with the overall cost of the application itself and, in particular, the exceptionally high cost of replacing materials offshore in a complicated and hazardous operating environment. Correct surface preparation, using appropriately tested coating systems and observing good coatings practice, is critical to the success of any coating application.

Due to the rapidly changing requirements of the industry and the lack of track record for new materials, laboratory prequalification testing of candidate coating systems has become increasingly important in the offshore industry due mainly to the seriousness of the requirement for asset protection. A number of internationally recognised standards have been established to assist owners and operators in the selection of the correct coatings systems for use in the offshore industry.

NORSOK M501, ISO 20340 and NACE TG 260/263/264 have all been developed to meet the demands of the industry and detail the performance requirements for protective paint systems for structures operating in offshore environments. All of these standards aim for high durability to minimise the future maintenance and consequential safety and environmental aspects.

The key to successful laboratory performance testing is being able to obtain correlation with field exposure. Cyclic corrosion tests provide information on the anti-corrosive ability of a coating system in terms of blister, rusting, chalking and corrosion under-creep from a defect area or scribe. The tests can provide valuable information relating to the effect of over-application, surface preparation and overall ranking of protective coating systems with regard to preventing corrosion onset at a defect. These test methods are superior to the traditional salt fog tests in all aspects. However, a significant number of control coating systems of known field performance need to be evaluated in order to obtain correlation.

Over the coming years, it is predicted that customers will increasingly demand anti-corrosive data and prequalification testing for new coating systems as an effective replacement for field track record. This could well become a common feature in all performance-based specifications, particularly for those end-users who have experienced early corrosion problems in the field.

Maintenance – A Necessary Evil or a Plan for Longer Life?

Every offshore structure will require maintenance over its working life. Plant and equipment maintenance painting are essential to efficiency, extended life of the facility and safety in the work environment. They can, however, be low-priority items that do not receive the time and attention they deserve. By prioritising the coating work required, an operator can gain the maximum benefits from the existing coatings. Regular corrosion inspection surveys and the use of specially...
formulated surface-tolerant coating systems is the key to success in this area.

The use of structured, organised maintenance painting services can provide in-depth analysis, assessment and recommendations for maintenance painting. Within large facilities, maintenance of specific areas can be prioritised so expenditure can be made where it is most needed. Planned maintenance minimises operating problems and costly production interference, enhances cost-effectiveness by optimising maintenance intervals and delivering long-term savings. Plant managers find that this approach provides the greatest return on monies spent for maintenance painting.

Conclusion

The demands of the offshore industry are constantly changing, however, owners and operators need to recognise the need for cost-effective corrosion and fire protection of their primary assets. When correctly specified and maintained, use of an appropriate protective coating system can go a long way in helping to reduce operating costs and extending the overall life expectancy of the many different structures used in the field of oil and gas exploration and production.

References

ISO 20340, “Paints and Varnishes: Performance requirements for protective paint systems for offshore and related structures”.

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