

## Designing Protective Coatings Systems for Offshore Oil and Gas Platforms

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Coatings systems for offshore structures must be designed to protect hyper-expensive assets from the ravishes of one of, if not the most corrosive and hostile environments known. Huge investments are made in the exploration and production of offshore oil & gas fields in remote areas that will provide energy products for a great many years; and, the costs of protecting capital infrastructure cannot be compromised by poorly designed, selected or applied protective coatings systems.

Offshore oil & gas fields provide a challenge to not only the engineers who must design structures that will operate in and withstand these hostile environments; but, also the coatings manufacturers to assist in protecting those structures from the ambient conditions that are most destructive to coatings systems;

- Continuous exposure to salt spray in atmospheric zones
- Continuous wet/dry conditions from wave action
- Severe exposure to ultra violet sunlight
- Constant movement and flexing of substrates
- Severe abrasion from drill pipe and casings, boat landings, etc.
- Chemical spills

The lack of availability for routine maintenance also mandates that the coatings systems be engineered for a very high level of performance and maximum service life. Coatings designed to enhance personnel safety, such as non-skid deck coatings, high visibility color markings, fire and high heat resistant and other specialty coatings are necessary to further protect personnel as well as capital assets.

### Coatings Systems

Individual coatings are formulated to perform specific functions and must be selected to become components of a total system designed for optimum results considering the environment and service expectations. In the case of offshore environments, and considering all of the factors previously mentioned, the best that technology has to offer that can be applied in a practical and cost effective manner is warranted. This is a particular area of the heavy duty marine and industrial coatings fields that has little room for compromises.

# Designing Protective Coatings Systems for Offshore Oil and Gas Platforms

January, 2004

Page 2

Additional coats and higher cost materials are used in many cases as the system must outlast those used for other types of marine vessels, such as workboats, that receive scheduled routine maintenance. The higher cost of some of these materials becomes a secondary concern when the purpose that they will serve is considered.

## Inorganic Zinc Silicate Primers

Steel structures that are permanently immersed in sea water, such as jackets in the area below the Splash Zone, are typically not coated for various reasons and protected solely by cathodic protection systems consisting of sacrificial anodes or impressed current arrays, which can be maintained as required by underwater contractors. A coatings system in this area for large, deep water jackets would be cost prohibitive and cannot be maintained. However, when design engineers determine that a jacket below the splash zone does require coatings, hydrophobic barrier epoxies are normally specified.

The structure in the atmospheric zones and production decks on the other hand require a high performance protective coatings system that can be maintained. However, considering the lack of availability for maintenance due to weather conditions or production schedules, cathodic protection is also desirable to work in conjunctions with the coatings system and this can only be accomplished by the use of anticorrosive pigmentation of the primer coat.

Various anticorrosive pigmented primers are available, some that passivate the steel but the most effective are inorganic zinc silicate primers which essentially become anodic to the steel in a corrosion cycle. The primary advantage of this type of coating is that it will arrest rust creep, or undercutting of the coatings surrounding the damaged area, and confine corrosion to the point of the damage. These coatings also provide a high degree of resistance to heat and chemical spills.

Sacrificial zinc rich coatings are passive until damage to the coatings system occurs and the substrate becomes exposed to the environment. Therefore it becomes important to protect the primer from those elements.

## High Build Epoxy Coatings

Epoxy coatings generally provide protection to substrates by forming a barrier to the environment and essentially keeping the electrolyte necessary for corrosion at bay. Minimum film thicknesses are normally obtained in one or two coats, but two coats are typical in offshore applications to ensure a high level of protection and a minimum amount of film defects such as pin holes, "holidays", etc.

Epoxies are generally more abrasion and chemical resistant than primers and topcoats and in this case protect not only the substrate itself, but the zinc primer as well from all of these detrimental factors. Although epoxies are widely used in direct-to-metal

## **Designing Protective Coatings Systems for Offshore Oil and Gas Platforms**

January, 2004

Page 3

applications, combined with a zinc rich primer they will provide the best possible long life anticorrosive protection available for atmospheric exposure.

However, one drawback with epoxy coatings is very poor resistance to ultra violet from sunlight and most will chalk and fade rapidly. This leads to an erosion of the coatings' film thickness, reducing the barrier protection of the system. Topcoats are generally required that have a high resistance to UV in addition to all of the other elements of the environment.

### Aliphatic Polyurethane Topcoats

Polyurethane finish coats are generally acknowledged as providing optimum resistance to UV and high degrees of flexibility and chemical resistance. They also help to maintain a very high level of cosmetic gloss and color retention and can be cleaned very easily, generally with low pH detergents and fresh water pressure washing. Although polyurethane finishes offer no real anticorrosive or barrier protection to the substrate they do provide a high level of protection to the integrity of the coatings system.

### Epoxy/Polysiloxane Finish Coats

Polysiloxane coatings technology permits the availability of ultra high performance by the combination of the barrier protection and durability properties of high build epoxy with UV resistance, color and gloss retention greater than that achieved with a polyurethane topcoat, and without the use of isocyanate. This unique technology not only provides superior performance but eliminates the need for polyurethane topcoats that may raise health and safety concerns, as well as reducing application costs at new construction. A three coat system consisting of zinc/epoxy/epoxy-polysiloxane rivals the performance achieved with a typical four coat zinc/epoxy/epoxy/polyurethane system.

Acrylic modified siloxane finish coats are also available that will provide UV resistance, color and gloss retention similar to that achieved with polyurethane topcoats but the anticorrosive advantages of a high build epoxy-polysiloxane are not possible with these modified products. These are available as single component materials and are well suited for routine maintenance of the high build epoxy-polysiloxane coatings. High build, two component acrylic polysiloxane coatings have been recently introduced as "next generation" in siloxane technology, however, they cannot provide the long term durability and chemical resistance of the epoxy-polysiloxane benchmark standard and claims of superior performance are simply marketing spin.

### Zinc Rich Epoxy Primers

As previously mentioned, inorganic zinc silicate primers provide optimum galvanic protection for steel substrates in atmospheric areas but in some cases may not be practical or possible as they require a high degree of abrasive blast surface preparation and favorable ambient conditions for proper application. Zinc modified epoxy anticorrosives

## **Designing Protective Coatings Systems for Offshore Oil and Gas Platforms**

January, 2004

Page 4

will provide a high level of service and are more tolerant to compromised surface preparation and ambient weather conditions providing the zinc loading of the formula is sufficient. A zinc pigment loading of greater than 80% by weight in the dried film would be considered as a minimum for good cathodic protection properties.

Zinc rich epoxy is also most effective in maintaining damaged areas and breakdown of the coatings systems applied at new construction as it is compatible with alternate methods of surface preparation such as power tool cleaning and UHP Hydro Blasting. It is the recommended primer for touch-up of erection welds and damaged areas of the principle coatings system during fabrication of sub-assemble units and installations.

### Splash Zone and Boat Landing Barrier Coatings

These areas of offshore structures are subjected to an extreme corrosive environment due to constant wet/dry conditions, being an area most difficult to maintain and high abrasion from service craft unloading crews and supplies. Special coatings are designed to form a highly abrasive resistant barrier, or cladding, and in many cases incorporate the use of glass beads, quartz, aluminum flake and other inert pigmentation that enhance impermeability and abrasion resistance.

These barrier coatings are applied in ultra high film thicknesses, direct-to-metal, without any topcoats and require specialized application equipment in many cases. They are also formulated to cure very quickly, be compatible with damp or wet conditions and in some cases cure underwater. This enables maintenance applications offshore and without interference from wave action.

### Non-Skid Deck Coatings

Maintaining safe working conditions is paramount offshore due not only to the harsh environment but the dangerous nature of the work and specialized coatings assist in reducing risk to personnel. Anti-slip deck coatings are essential in walkways, exterior work areas, helidecks and boat landing platforms and must be highly durable. Splash zone barrier coatings may be used in many cases for deck coverings but normally cannot provide the chemical resistance to fuels, hydraulic fluids and other chemicals normally found on helidecks, nor do they provide high degrees of slip coefficient that may be desired in very harsh environments such as the North Sea where decks are awash frequently.

Coatings specifically designed with anti-slip properties normally incorporate very course aggregates for an exaggerated profile. They are applied in very high film builds and normally without a zinc rich primer. When primers are required they are usually epoxy types.

Alternate materials are available for anti-slip deck coverings that many be applied directly over old and intact traditional coatings, with very minimum preparation, can be

## **Designing Protective Coatings Systems for Offshore Oil and Gas Platforms**

January, 2004

Page 5

returned to service instantly and with relative ease. The Epok Tread Tile system is one such alternate, can be applied easily and quickly with the deck being returned to service immediately after application. Epok Tread Tiles will provide a high level of service when complete refurbishment of deck coatings by blasting and coating of is not practical or possible.

### Summary

Protective coatings systems are somewhat of a partnership in that each component is dependent upon the performance of it's counterparts. In very simplistic terms, the zinc provides galvanic protection for the steel, the epoxy protects the zinc, the topcoat protects the epoxy and the whole system's overall performance is the sum of the proper selection of the components.

Much like the protective coatings system, successful design results are dependent upon the sum of all parties involved working together to achieve the Customer's objectives of the proper protection of their personnel and assets.

Beginning with close attention to important details of coatings function and selection by the design engineers, the coatings manufacturer's must provide advanced technology and product quality that is practical for application by accepted industry standards, the contractor must ensure a high quality application by following the Customer and manufacturer's precise recommendations, the QC inspector must ensure proper application by being fully educated in the fundamentals of coatings characteristics and application methods with all parties having a vested interest in the success of the overall project.