MODERN SOLUTIONS TO CORROSION PROBLEMS IN COASTAL ENVIRONMENTS

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ABSTRACT

Developments in the protection of steel structures in harbours and the immediate surroundings are, as in the case of so many other developments, no longer separable from factors such as environment, health and safety. Environmental matters are in danger of becoming an over discussed subject, but a realistic and creative approach remains necessary. This paper deals with replacements for the proven coal tar epoxy systems and with the performance of "surface tolerant" maintenance systems.

ENVIRONMENTAL ASPECTS

For many years the Schelde estuary has been heavily polluted. In recent years environmental regulations have restricted industrial pollution and the results are already evident.

The following are two examples relating to paint:

* Copper containing antifouling paints (the new trend following the restrictions imposed on organotin compounds) do not show black discolouration after a period of exposure in the Schelde. That means that the concentration of sulphur containing compounds such as H_2S, SO_4 has been reduced to a great extent.

* The bottoms of harbour boats are once again being fouled by barnacles. Improved antifoulings have become necessary for these boats as a result of the cleaner environment.

Coal tar epoxy coatings

In the last 25 to 30 years many coal tar epoxy systems have been applied to jetties, dock gates and harbour walls etc.. Often four coats of coal tar epoxy were applied. When surface preparation and application were correctly carried out the degree of corrosion protection provided was good. Unfortunately, in the light of knowledge now available, a few reservations must be stated regarding this classic system.

* Coal tar is now considered to be unhealthy for long term skin contact. (Protection against inhalation of spray can easily be worn).

* When exposed in water toxic PACs and PCBs are slowly released.

* Atmospheric exposure combined with heat (from the sun) causes evaporation of low molecular tar fractions and remaining solvent. This leads to shrinkage and cracking and so to early breakdown of the system and rusting.

* Abrasive blasting to Sa 2½ is required to obtain satisfactory performance with coal tar epoxy for both new construction and maintenance.

* Coal tar epoxy polluted grit from maintenance often disappears unnoticed into the environment. Dumping this grit is often no longer possible as it is classified as chemical waste.

* The classical four coat coal tar epoxy system gives more losses during application, cleaning etc..

* Traditional paints including coal tar epoxies, particularly those with good flow characteristics, have the alarming tendency to flow away from sharp edges. For this reason four coat systems

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have been necessary to ensure adequate protection. (Recently special coatings have been developed to reduce this problem. The old fashioned, labour intensive, stripe coating is little used in the steel construction industry).

To summarise, the days of the coal tar epoxy system seem to be numbered. Not because of inadequate performance, but on the basis of environmental health and safety legislation.

WHAT REQUIREMENTS ARE IMPOSED ON MODERN COATING SYSTEMS?

Investigation of structures requiring long term protection in maritime environments has revealed that specific areas are particularly prone to corrosion. Large flat surfaces have remained in good condition for many years, but sharp edges, welds and areas around bolts and rivets are subject to premature breakdown. Excessive film thicknesses around bolts and rivets has often led to solvent retention, shrinkage and subsequent cracking of the coating.

What is required of a modern coating system to enable it to give long term, economical protection to expensive harbour facilities, while at the same time meeting the latest ecological requirements?

* Long life coating system, adapted to the expected life of the structure, including if required, a maintenance plan.
* Durability and flexibility with no shrinkage, even at excessive thicknesses.
* Ability to withstand cathodic protection where required.
* Resistance to impact and abrasion.
* High solids or solvent free.
* Coal tar free.
* Free of contents which may be toxic or environmentally damaging:
  - during application
  - during subsequent maintenance
  - and at the end of the economic life of the structure
* Good edge covering capability
* Easily applied by spray, roller or brush.
* Easily applied in a few coats with high thickness per coat.
* Suitable as a maintenance system for a still partly intact coating system.
* Easy to recoat after long service.
* Tolerance of damp surfaces for maintenance painting.
* Suitable for application following wet blasting.
* For immersion service it is advisable not to give in to a lower standard of surface preparation than dry abrasive blast cleaning to ISO Sa 2½, with wet abrasive blast cleaning as an alternative.
* For atmospheric service, systems must be suitable for application to less than perfectly prepared surfaces without too great a loss of performance.
* A product range which enables individual products to be used in several different systems - this reduces the total number of products on site.
* In the future for large projects, the products will have to be supplied in bulk containers.

Table 1 illustrates a system suitable for long term continuous and intermittent immersion with cathodic protection. Table 2 indicates some of the physical properties of the individual products.

Table 1.

Tar free system for protection of steel in coastal areas. Low solvent content, non-shrinking system, with extra edge coverage. Designed to give protection to vulnerable areas. Suitable for intermittent or continuous immersion with cathodic protection.	
1. Epoxy primer, resistant to cathodic protection.	
Sigmacover primer	75µm dft
2. Flexible solvent free epoxy for protection of sharp edges, welds, bolts and rivets.	
Sigmacover TCP Coating SF (applied only at critical areas)	to 3mm dft
3. Heavy duty epoxy topcoat	
Sigmacover TCP coating	2x150µm dft

Table 2.

PRODUCT	VOL SOL %	VOC, kg/lt	DFT,µm
7413 Sigmacover primer	57	0.42	50-125
7460 Sigmacover TCP Coating SF	100	0	500-3000
7463 Sigmacover TCP Coating	80	0.19	150-200

MAINTENANCE WITH "SURFACE TOLERANT" SYSTEMS

Epoxy mastics classified as "surface tolerant" coatings have been around now for more than ten years. That is a long enough period to enable an initial assessment to be made of their contribution to corrosion protection in coastal areas

As their name suggests they are coatings which are designed for use following a lower than ideal standard of surface preparation. They may be applied to mechanically cleaned or hand cleaned steel with traces of adherent rust remaining on the surface. The surface may also be slightly damp at the time of application.

They are ideal for maintenance where abrasive blasting is not possible. For example where environmental and health regulations forbid contamination of the soil or surrounding water with residues of used abrasive and old paint (containing toxic components). Disposal of used blasting grit may also be a problem if it is classified as hazardous waste. This may be the case if lead or chromate containing paint has been removed.

Track record

The success of surface tolerant systems has varied considerably. It has depended on the quality of the system being used and on the condition of the substrate. These coatings have occasionally been introduced as the solution to all problems. It has been suggested that they will perform well without any surface preparation and that they can improve the adhesion of existing coating systems. Practical experience has shown that these exaggerated claims have little foundation.

HOW TO OBTAIN THE BEST RESULTS

In order to gain the maximum benefit from surface tolerant coatings, these key points should be considered:

* In atmospheric exposure, some residual rust need not be a problem, but the surface to be coated should be as free as possible of millscale and heavy contamination by soluble salts.
* The adhesion of the existing coating system must be good.
* The most aggressive exposure environments such as immersion and particularly immersion with cathodic protection systems should be avoided unless suitable surface preparation can be given.
* Avoid very low dry film thicknesses. These coatings work mainly by providing a barrier and do not perform if low film thicknesses are applied.

In practice these limitations need not be a problem.

A. Substrate contamination.

Soluble salts
Always present on surfaces in and around harbours, these are a real problem for surface tolerant products. Most soluble contamination on a substrate can be easily removed by high pressure water cleaning. If this is initially combined with a detergent, much grease and oil will also be eliminated.

Millscale
Much steel fabricated in the last twenty years has been cleaned by abrasive blasting. Millscale will thus have been removed and can no longer be a problem on subsequent maintenance. Millscale remaining on hot rolled steel should be removed by at least commercial blasting to ISO Sa2.

B. Exposure conditions.

Immersion
Where steel is to be immersed continuously, particularly with cathodic protection, then a good standard of surface preparation is essential, whatever type of coating system is proposed. Dry or wet abrasive blasting are the two most effective alternatives. Surface tolerant coatings will often be suitable for use in immersion on suitably prepared surfaces.

Atmospheric exposure
Heavy scale and salt contamination should be removed before coating.

C. Surface preparation

Power tool cleaning
During the period that "surface tolerant" coatings have been introduced there has been an improvement in the level of cleanliness and profile that can be obtained with power tools and their attachments. Non-woven abrasive wheels and discs or coated abrasive disks and flap wheels are capable of cleaning previously blast cleaned and coated steel to bare metal. There may be some traces of soluble salt left in the bottom of pits, but the general standard of cleaning is high.

If no profile exists then there are power tools such as rotary impact equipment, needle guns and peening tools which clean as well as provide surface profile.

ADVANTAGES OF SURFACE TOLERANT COATINGS

These coatings provide good adhesion to most types of aged coating systems. They are easy to apply even at high dry film thicknesses. Certain products can be easily applied to 100μm dft by brush.

When correctly applied to surfaces free of millscale and not too heavily contaminated with soluble chlorides and sulphates they give excellent protection to structures in all types of atmospheric exposure conditions..

Where blasting is not allowed they may be the only alternative offering reasonable protection.

They considerably reduce the total cost of maintenance painting by reducing surface preparation costs. They will often also lower the cost of scaffolding and application by reducing the total time required for the operation. Less time spent on surface preparation and less coats per application are all factors which lower the total cost of maintenance.

The key factor regulating economical use of these systems in harbours is the removal of soluble salts from the surface. High pressure cleaning with potable water is normally sufficient to ensure a good performance in atmospheric exposure.

Tables 3 and 4 illustrate examples of a surface tolerant system suitable for application to mechanically cleaned steel.

Table 3.

Tar free system for maintenance of steel in atmospheric exposure. Surface tolerant, low solvent containing system.	
1. Surface tolerant epoxy primer.	
Sigmacover Aluprimer	100μm dft
2. Flexible epoxy	
Sigmacover CM Coating	125μm dft

Table 4.

PRODUCT	VOL SOL %	VOC, kg/lt	DFT, µm
7414 Sigmacover Aluprimer	90	0.9	75-200
7456 Sigmacover CM Coating	62	2.8	75-150

CONCLUSIONS

New coating systems capable of performing well into the 21st century can be designed using a limited number of modern products.

"Surface tolerant" products are not a magic solution to every engineer's corrosion dilemma, but properly used they can be a very useful answer to many maintenance problems.

New coal tar free systems, with differing construction and coating thicknesses from those to which we are accustomed are coming into use. They will need changes in specifications and here and there alterations in accepted guarantee and insurance procedures.

What is our experience with such systems? Several relevant case histories will be presented.

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