REPORT

AN INITIAL EVALUATION OF "ZINGA"

by

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1. INTRODUCTION

Zinga is a proprietary zinc-rich coating which can be applied by spray, brush or similar techniques. It dries out or cures to a zinc-rich layer which retains a small amount of the other product constituents. Zinga is used to provide a protective coat for ferrous substrates to prevent corrosion of the base metal. The protection is afforded by two mechanisms:

1. Galvanic protection (sacrificial).

2. Barrier layer protection (organic paint).

BNF were asked to evaluate Zinga's performance and compare its properties with those known to be provided by galvanised zinc coatings (hot dip and electrolytic) zinc sprayed coatings and zinc-rich paints.

2. PROPERTIES OF THE COATING

2.1 Appearance of the Coating

Zinga as brush applied exhibits the properties of a standard zinc coat coupled with those expected from the organic medium present in the product. The dried out coating is porous and consists mainly of zinc grains with an organic film around each grain. An organic film exists on the surface of the coating and at the coating steel interface. The coating can be brushed or polished to a lustrous appearance and it is very easy to apply one Zinga coat to another without a visible barrier being present between the two coats.

2.2 Application of the Coating

Zinga is easily applied to a clean steel surface. The presence of light films of rust on the steel does not impair the application of Zinga because Zinga interacts with the rust to form a good bond with the substrate.

Zinga can easily be applied to Zinga so long as the top surface is not heavily corroded. If the white corrosion products are removed by brushing off, then good adhesion can be secured between the two Zinga coats.

2.3 Adhesion of Zinga to Steel

The adhesion of Zinga to steel is purely mechanical. Because steel surfaces are rough (they possess depressions and asperites), Zinga is able to key well to the surface. The coated steel can be cut with a hacksaw without detachment of Zinga from the substrate or break up within the Zinga coat itself. Preparation for microsectioning and the subsequent polishing of the samples did not cause separation of Zinga from steel. The adhesion is better than that provided by the normal zinc paint and is equivalent to that provided by sprayed coatings.

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Optical and electron microscopy on sections of Zinga prove that there is no crystallographic bonding between Zinga X-ray analysis of the interface between steel and Zinga shows no evidence of inter-metallic layers or of random diffusion of zinc into the steel. This is not surprising since Zinga is applied cold and it is worthy of note that no crystallographic bonding is provided by electroplating zinc or sprayed zinc, both of which are considered to provide adhesion appropriate for engineering coatings. This property is of great value when treating thin sections which would be destroyed by hot dip galvanising. The adhesion provided by Zinga is satisfactory for structural applications.

The formation of a single coat when Zinga is applied to Zinga means that the integrity of the coating can be guaranteed since no separation of the coatings was observed in rough cutting trials. It was not possible to detect the interface between the two coatings by optical microscopy or metallographic sectioning.

2.4 Corrosion Resistance of Zinga

Zinga shows remarkable corrosion resistance to accelerated corrosion testing. Its corrosion resistance is a function of nature of the coating and is not representative of the normal zinc coat. The organic constituents provide a resistance to the normal "white rusting" typical of a zinc coat. When zinc corrosion occurs, the pores in the coat fill up with a trapped zinc corrosion product sealing the pores and slowing down ingress of further corrodant. This effect contributes to the final corrosion resistance of the Zinga coating. If the improvement observed in accelerated testing is also shown in outdoor exposure, then Zinga is a product having unique corrosion resistant properties.

2.4.1 Resistance to Humid Atmospheres

Zinga coatings were tested in a humidity cabinet for 250 hours. During this time the coatings were continuously sprayed with an artificial hard tap water at neutral pH. After 100 hours very little white rusting had occurred. A normal zinc coat would show white rusting after as little as 16 hours test. After 250 hours test surface white rust was evident but no attack was visible on the steel. Metallographic examination showed that about 30% of the depth of the coating had been attacked and that this had resulted in the formation of plugs of corrosion product in the pores. Some corrosion product had weeped onto the surface of the coat but much of this could be easily removed by slightly brushing the surface. The unusual corrosion resistance suggested that the coating should be evaluated in a more aggressive medium - the neutral salt spray test (ASTM B117).

2.4.2 Resistance to Salt Spray

The neutral salt spray test involves subjecting the Zinga coated steel samples to a 3.5% w/v sodium chloride solution at 35°C and neutral pH at 100% relative humidity. This test is normally applied to much more corrosion resistant systems. The Zinga coatings continued to show remarkable corrosion resistance. After 76 hours the Zinga coatings were no more attacked than after 100 hours in the humidity test. After 150 salt spray hours, extensive white rusting was present as after 250 hours in the humidity test. After 200 hours salt spray some red rust attack was observed, showing that the Zinga coat had been penetrated. Metallographic examination revealed that the

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coating had been penetrated but in some areas an organic film was present on the steel surface.

Zinga coats were removed from some samples using dilute hydrochloric acid and the presence of the organic film was revealed.

The results are remarkable in that the rate of attack on Zinga by neutral salt spray was reduced as compared to the normal zinc coat. This is due both to the presence of an insulating organic film on the zinc grains and due to the pore sealing effect discussed above.

2.4.5 Galvanic Protection Afforded by Zinga

Zinc coatings are applied to steel because zinc corrodes preferentially to steel, thus sacrificial corrosion protection is provided. This effect is useful because protection of the base metal is still afforded if the protective coat is locally damaged, exposing the bare steel. Indeed, zinc blocks (anodes) are attached to offshore rigs to protect the steel structures remote from the anodes against corrosion. Zinga exhibits a corrosion protective effect to steels though to a lower extent than pure zinc. The reduced effect is due to the organic content of the Zinga coating which restricts the effective area of active zinc. Nevertheless, Zinga provided sufficient remote protection and good throwing power for use in marine salt laden atmospheres and has the advantage not possessed by other coating processes that excessive breakdown, if it were to occur, can be easily repaired.

Zinga samples were prepared on steel with a cross hatch present to 0.5mm, 1mm, 3mm, 5mm and 10mm widths of bare steel. The samples were exposed to neutral salt spray testing for 50 hours. The samples were usually examined for attack on the steel. The 0.5, 1 and 3mm were totally unaffected. Mild attack was present on the 5mm samples and more extensive attack on the 10mm samples. After 100 hours the 0.5, 1 and 3mm were still unattacked but more extensive attack was present on the 5mm and 10mm samples. No attack on any specimen had occurred on the steel close to the Zinga coat, proving that a substantial degree of remote galvanic protection had been provided.

Attempts to measure the conductivity of Zinga have been made difficult by the presence of the organic layer and because the conductivity varies with the pressure of the contact and the way in which the test block is prepared.

Zinga can be directly applied to mildly rusted steel surfaces to produce an adherent coat. The corrosion protection afforded under these conditions is not affected by the presence of thin rust films present when the samples are prepared.

3. CONCLUSIONS

Zinga exhibits the properties of a galvanic zinc coat and a zinc paint. This combination provides benefits not provided by either system alone.

Zinga can be applied to clean surfaces, mildly rusted surfaces and to Zinga to provide a coating of excellent corrosion resistance and adhesion/cohesion.

Zinga corrodes much more slowly than pure zinc and the corrosion self-stifles by blocking the natural porosity of the coat.

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Zinga· provides remote corrosion protection of bare steel (good throwing power). This is not as good as pure zinc, due to and compensated for by the slower corrosion rate.

Zinga bonds to surfaces purely by mechanical mechanisms.

Zinga provides a corrosion resistant top-surface as a result of its organic component. The organic surface slows down attack and prolongs the life of the coating.

Zinga coatings can be repaired and maintained even on corroded surfaces if the loosely attached corrosion products are first removed by abrasion.

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