COMPARISON OF PERFORMANCE 0F E-1000 AND E-2000 IN DETACHABLE ANCHOR LINKS EXPOSED TO CYCLIC TEST CONDITIONS

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INTRODUCTION

Detachable anchor links used in marine applications are periodically inspected and subjected to routine maintenance. Due to corrosion, however, the inspection and maintenance process often requires additional time and cost. Excessive corrosion can also lead to inadvisable procedures, which offer potential for injury and/or necessitate replacement of the hardware. The internal cavities of detachable anchor links have been previously filled with white lead filled beef tallow grease or more recently, greases that are not filled with heavy metals. Toxic exposure to personnel and undesirable environmental and regulatory aspects of utilizing white lead have been mitigated by utilizing greases that do not contain heavy elemental metals. However, many of the greases also contain base oils, inhibitors, or other additives that have significant aquatic toxicity or do not offer sufficient water washout resistance for extended marine use. Elisha® Mineralizing Gels have been evaluated for use in detachable anchor links. The gels prevent corrosion by excluding moisture from the cavities and crevices of the assemblies and by reacting with the surface of the substrate to form a mineralized layer. The mineralized layer reduces the tendency of the substrate surface to oxidize. The mineral layer forms by contact between components in the gel and the substrate in the presence of residual moisture.

Detachable anchor links filled with E-1000 have been subjected to Philadelphia Naval Shipyards harbor exposure as well as salt spray exposure and sea trials. In addition, E-1000 and E-2000 have been subjected to cyclic test exposure. In harbor exposure at the tidal zone, some washout of E-1000 occurred within 12 months of exposure and the majority had been washed out by 24 months of exposure. The tapered pin of the magnetic link was stuck by 19 months and difficult to remove at 24 months. Although corrosion resistance of the E-1000 was good through 12 months of exposure, extended performance can be gained by using an E-product with improved washout resistance such

as E-2000. The following cyclic testing offers a comparison of the E-1000 and E-2000 products.

CYCLIC TEST EXPERIMENTAL PROCEDURE

The cyclic test exposure included stages for immersion in 5% (weight) sodium chloride solution (15 minutes), ambient dry-off (75 minutes), and condensing humidity exposure (22.5 hours). The humidity cabinet conformed to the requirements of ASTM-D2247 with the exception that the condensing temperature was maintained at 120 F. Each test cycle required 24 hours, however on days when the stages were not completed, the anchor links remained in humidity and the cycle was not counted. Each anchor link had its own immersion tank and immersion tanks were the same size and filled with the same volume of salt solution. Evaporative losses were compensated for by addition of de-ionized water. The detachable links used for this test had previously been subjected to service conditions. The links were prepared for cyclic testing by manually cleaning out the excess grease, solvent washing with naphtha, and removal of all paint and corrosion products by blasting with glass bead media. The cleaned links were then powder coated with polyester. The respective corrosion resistant gels were applied generously to all the internal surfaces of the detachable links and the links were assembled. Excess gel pushed out through the joints was wiped off.

The links were inspected visually at 20, 50, 95, and 150 cycles. At 50 cycles, the tapered pins were removed from the links and inspected after wiping off the corrosion inhibiting gels. After inspection, the respective gels were reapplied in excess and the pins were reinserted into their respective links. At 95 cycles, the tapered pins were removed and one coupling plate was removed to inspect the internal surfaces for corrosion and condition of the gel. When exposure was completed at 150 cycles, the links were disassembled and the inside surfaces were inspected.

RESULTS

Inspection of the links at 50 cycles revealed the links had red corrosion on 40-50% of their external surfaces and localized corrosion tubules were formed. Red corrosion was visible in the joints of both links, but no significant build up or bridging occurred. Slight discoloration had occurred near the ends of the tapered pins, but no red corrosion was present. No difficulty was encountered removing the pins from the links.

At 95 cycles, the E-2000 and E-1000 links had red corrosion on 70% and 80% of their surface areas, respectively. Numerous corrosion tubules were present on each link. The polyester paint powder coating experienced cracking between areas of corrosion and no corrosion. The joints developed intermittent bridging of corrosion products. The E-1000 link had the more bridging of corrosion products than the E-2000 link. No difficulty was encountered removing the tapered pins from either detachable link assembly. A varying degree of difficulty was experienced opening the coupling plate. Only slight sticking

occurred on the E-2000 link. The E-1000 link was more difficult and required prying to break loose. Inspection of the tapered pins after cleaning revealed no significant corrosion had developed. The pin from the E-2000 link was bright and shiny. The pin from the E-1000 link had discoloration on 30% of its length from the narrow end and traces of red corrosion. The E-2000 link had the least (<0.125 inches) amount of red corrosion penetration into the interior of the link from the coupling plate joints. No red corrosion was present inside the E-2000 link away from the edges of the joints although dark discoloration was intermittent throughout. The E-1000 link had mostly bright and shiny surfaces in the interior of the assembly with corrosion around the edges of the coupling plate joints and the narrow area of the C-link interlocking lugs. Corrosion penetration was approximately 0.25 inches on the E-1000 detachable link. The corrosion products inside the E-1000 link were predominantly red.

Final inspection of the detachable links after exposure to 150 cycles of corrosion exposure revealed neither link pin was difficult to remove. The E-1000 link required prying to break loose the coupling plate as opposed to the E-2000 link, which only required a light tap. Both links had experience ingress of corrosion from the joints but the tapered pin areas were still protected. The E-1000 link had a greater buildup of corrosion products at affected areas of the internal surfaces compared to the E-2000 link (Figures 1 and 2).

CONCLUSIONS

The E-2000 product demonstrated better resistance to washout due to formulation with a tackifier and had improved performance compared to E-1000 in a cyclic corrosion test. Testing of E-1000 aboard the USS Detroit (AOE 04) demonstrated good performance with regard to the ability to disassemble detachable anchor links after approximately 2 years of service. The improved performance of E-2000 in an accelerated cyclic corrosion environment indicates the capability of increasing the performance when used in detachable anchor links in shipboard conditions.

Based upon these comparisons, the use of E-2000 instead of E-1000 in detachable anchor link applications should extend the required maintenance cycle in this application.

Figure 1: Internal Surfaces of Link Containing E-1000 After 150 Cycles Of Cyclic Test Exposure

Figure 2: Interior Surfaces of Link Containing E-2000 After 150 Cycles Of Cyclic Test Exposure