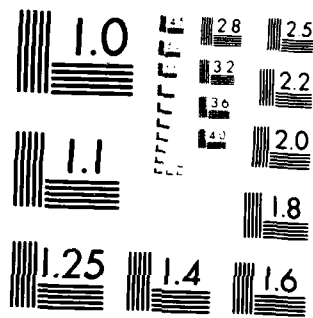


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MATERIALS NOTE 132

**THE EFFECT OF WATER DISPLACING CORROSION
PREVENTIVES ON STRESS CORROSION CRACKING
OF ALUMINIUM ALLOY 7075-T651**

by

L. WILSON

and

R. S. G. DEVEREUX



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✓
SUMMARY

The effectiveness of some commercial water-displacing corrosion-preventive formulations with respect to the inhibition of stress-corrosion cracking of 7075-T651 aluminium alloy has been investigated. The formulations consisted of examples of three types of protective agents, viz. oily films, soft (grease-like) films, and hard (resin-like) films. All three types of formulation used were effective in reducing rates of stress-corrosion crack growth in laboratory tests. *↑*



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1. INTRODUCTION

Water-displacing corrosion-preventive (WDCP) formulations are being used by aircraft operators to protect aircraft structures from deterioration by corrosion. Earlier work by Lewis and Hinton (1) at ARL assessed the effectiveness of three of these formulations-- LPS3, PX112 and WD40--in controlling: (i) corrosion of mild steel specimens exposed to (a) an outdoor industrial environment, and (b) an operational aircraft environment, and (ii) the rate of propagation of stress-corrosion cracks in aluminium alloy 7075-T651 double cantilever beam (DCB) specimens exposed to an operational aircraft environment. They concluded that the film produced by a single application of the WDCP "is of limited protective value on steel" and "has no significant effect on the rate of growth of stress-corrosion cracks in 7075 T651 aluminium alloy". Since their work was reported, many new WDCP formulations have been approved as meeting the requirements of various national military specifications. Approved formulations include

- (1) Ardrox 3961; DEF. STAN. 68 10-- PX24.
- (2) Preservac Wetproof; DEF. AUST. 1002-- PX112.
- (3) Amguard; MIL-C-85054 (AS)
- (4) Boeshield T9; BMS-3-23.
- (5) Tectyl 472 B; MIL C-23411 A (YD) Type 2.
- (6) WD40; DEF. STAN. 68 10-- PX24.

None of the above-mentioned specifications prescribes tests for assessing the effectiveness of WDCP formulations in controlling stress-corrosion cracking in aluminium alloys.

This report describes work carried out to determine the effect of periodic applications of each of these six WDCP formulations on the growth of stress-corrosion cracks in a laboratory test programme where 7075-T651 aluminium alloy DCB specimens were periodically immersed in 3.5% sodium chloride solution.

Another report (2) will describe experiments testing the relative effectiveness of these WDCP formulations in controlling surface corrosion and exfoliation corrosion of aluminium alloys.

2. EXPERIMENTAL

Seven DCB specimens, one to test each of the WDCP formulations plus one for a control specimen, were manufactured from 7075-T651 aluminium alloy plate. The specimen size and method of testing is given in Reference 3.

After the lengths and opening displacements of cracks introduced into them were measured, each specimen was immersed in a separate solution of 3.5% sodium chloride for 30 seconds. The specimens were then allowed to stand in the laboratory air for 24 hours, after which the lengths of the cracks were again measured. Immersion of the specimens in their respective solutions for 30 seconds was then repeated and the crack lengths again measured after another 24 hours in the laboratory air. This sequence was continued for 72 hours by which time stress-corrosion cracks were obviously growing in each specimen. At this stage, the test procedure was varied for six of the specimens. After removal from the salt solution each of the six was immersed in a particular WDCP formulation for 30 seconds before being left in the laboratory air. This procedure was repeated on most working days for a total of 90 days to assess the effect of the WDCP formulations on the crack growth rate and to compare the rates with that in the control specimen.

The routine was chosen to simulate (crudely) an aircraft with a stress-corrosion crack flying in a marine atmosphere and being treated with a WDCP after each flight.

3. RESULTS

Figure 1 shows the increase in crack length with time for the specimen treated with 3-5% sodium chloride solution and for the six specimens treated with both sodium chloride solution and a WDCP. All of the WDCP formulations investigated significantly decreased the rate of growth of the stress-corrosion cracks compared to that in the control specimen. Treatment with Amlguard, Boeshield T9, Ardrox 3961, Tectyl 472 B and WD40 produced cessation of stress-corrosion cracking within 24 hours after application, while the PX112 treated specimen took 8-10 days to exhibit the full effect. In all cases the crack length/time curves showed alternate periods of crack growth and crack growth inhibition. It is postulated that the sudden increases in crack growth rate are caused by the wedging action of corrosion products, formed at the crack tip, increasing the crack tip stress intensity.

Of the six WDCP formulations tested Amlguard and Boeshield T9 appeared to be the most effective stress-corrosion inhibitors. All of the WDCP's tested except Amlguard leave oily or, in the case of Boeshield T9, a grease-like film on the surface to which they have been applied. These tacky surfaces are likely to accumulate dust, grit, and fluff which make inspections difficult. Amlguard leaves a hard dry-to-touch film.

4. CONCLUSIONS

- (i) WDCP formulations have an inhibiting effect on stress-corrosion cracking in 7075-T651 aluminium alloy under laboratory test conditions.
- (ii) The corrosion-inhibiting properties of WDCP formulations are due to the deposition of an impervious moisture barrier on the surfaces being protected. These barriers may be oily, grease-like, or 'dry-to-touch' films. The latter type is to be preferred.

REFERENCES

- (1) F. G. Lewis and B. R. W. Hinton The effectiveness of the inhibited water displacing fluids LPS-3, PX112, and WD-40 in controlling corrosion, and in slowing the rate of stress corrosion crack propagation.
Department of Defence ARL Mat Note 116 Oct. 1976.
- (2) L. Wilson, and R. S. G. Devereux To be published.
- (3) M. V. Hyatt Use of precracked specimens in stress-corrosion testing of high strength aluminium alloys.
Corrosion—NACE Vol. 26, 487, 1970.

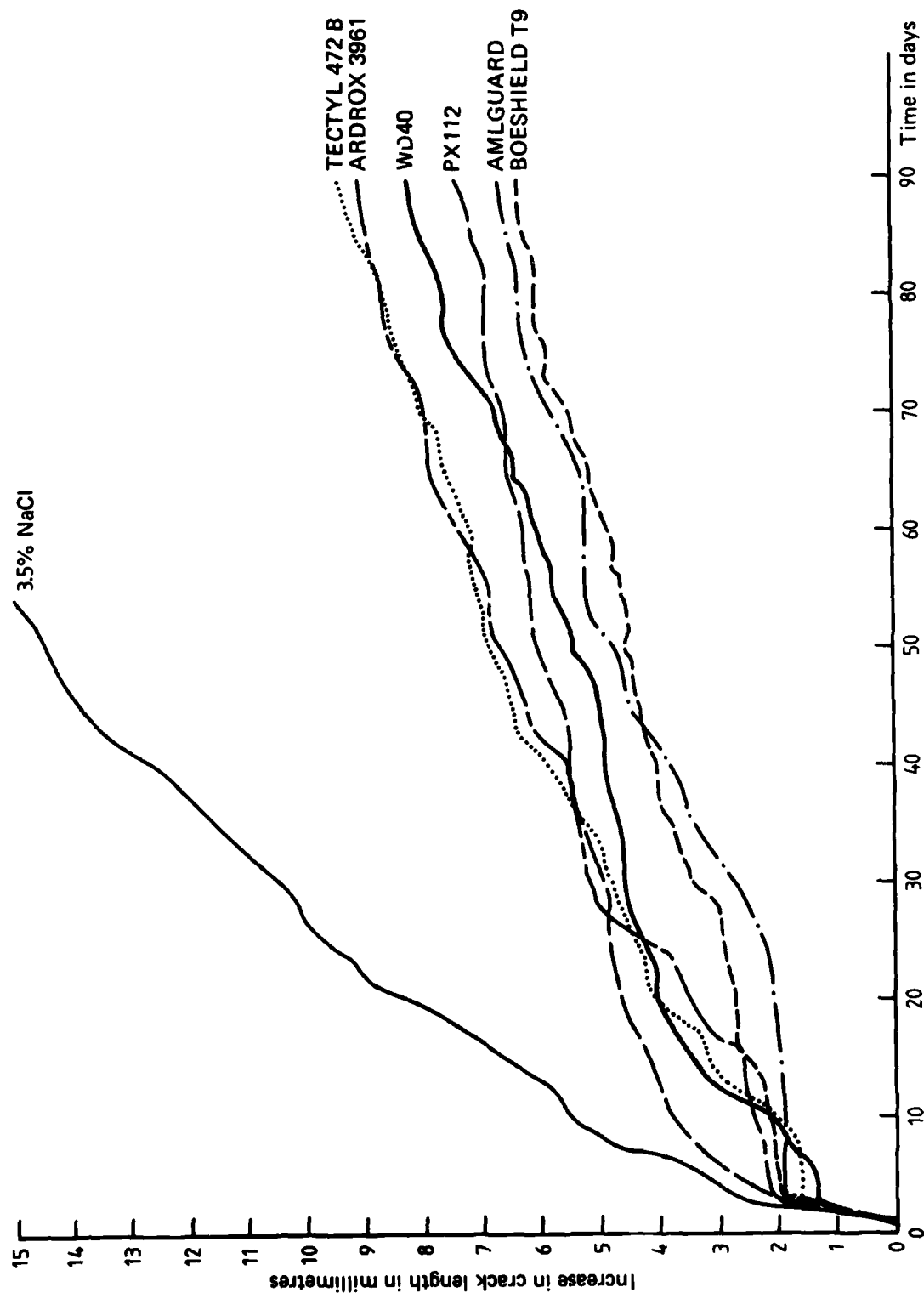


FIG. 1 THE VARIATION OF CRACK LENGTH WITH TIME FOR ALUMINIUM ALLOY 7075 - T651 SPECIMENS TREATED WITH VARIOUS WDCP'S

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16. ABSTRACT <i>The effectiveness of some commercial water-displacing corrosion-preventive formulations with respect to the inhibition of stress-corrosion cracking of 7075-T651 aluminium alloy has been investigated. The formulations consisted of examples of three types of protective agents, viz. oily films, soft (grease-like) films, and hard (resin-like) films. All three types of formulation used were effective in reducing rates of stress-corrosion crack growth in laboratory tests.</i>			
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