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EVALUATION OF CORROSION PREVENTIVES
FOR USE ON PHOSPHATED MACHINE GUN LINKS

Project Title: Rust Preventive Oils and Compounds

Sub-Task Title: Rust Preventives, Development of
Improved Test Methods

Project No: TB5-6010A

Report No.: 20

RIA Lab. No.: 52-4447

Date: 15 October 1952

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ROCK ISLAND ARSENAL LABORATORY

Authorized by: Research and Materials Branch,
Fuels and Lubricants Section

Project No.: TB5-6010A

Project Title: Rust Preventive Oils and Compounds

Sub-Task Title: Rust Preventives, Development of
Improved Test Methods

Report No.: 20

RIA Lab. No.: 52-4447

Priority: DA-2A

EVALUATION OF CORROSION PREVENTIVES
FOR USE ON PHOSPHATED MACHINE GUN LINKS

Object

To evaluate comparatively materials meeting USA Tentative Specification AXS-1759 Grade 1, USA Tentative Specification AXS-1759 Grade 2, and Miscellaneous compounds for their efficiency as corrosion preventives for phosphated surfaces by:

A. Determining the effect of coating weights on salt fog life of links.

B. Determining the influence of quality of phosphate finish on protective efficiency of corrosion preventives.

C. Determining the advisability of a water displacement requirement.

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Summary

Phosphated machine gun links, .50 caliber M9, were tested in the 20% salt fog cabinet by:

- (1) Using various coating weights of the rust preventive compounds (between 0.6 - 129 mg per link).
- (2) Using different grades of phosphate finishes (the grade depending upon the quality and type of phosphate coating).
- (3) Using a water-dip prior to dipping into the rust preventive compound.

Conclusions

Some rust preventive compounds give efficient salt fog protection at very low coating weights (as low as 5 mg per link).

The phosphate finish apparently has to be a satisfactory zinc phosphate finish in order for the rust preventive compounds to pass the salt spray requirements. Without the satisfactory zinc phosphate finish, even the best rust preventive compounds tested will not pass the salt fog requirement.

It seems advisable that there be a water displacement requirement in a specification for link finish rust preventive compounds.

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Tables 1 through 7

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Introduction

1. In the manufacture of phosphated machine gun links, it is essential that a supplementary preservative be applied to the links to provide adequate protection since the phosphate coating itself is porous and provides very limited protection to the base metal. In conjunction with a preservative, extensive and satisfactory performance is obtained.

2. The specifications concerned with the supply of links do not clearly define the type of preservative to be employed. Specification USA 57-0-2C, Finishes, Protective, for Iron and Steel Parts, is vague, and Specification MIL-L-3077, Links, Metallic Belt, for Small Arms Ammunition, is in error in the designation of the grade of rust preventive compound to be used on phosphated surfaces. As a result, there has never been any agreement as to what constitutes an acceptable material, each manufacturer using the material he prefers.

3. It seemed advisable to survey materials currently used as well as applicable materials in order to determine which of the available products would be most satisfactory.

This would permit this laboratory to recommend suitable materials until a new specification could be developed, which would clearly define the type of product desired.

4. The work reported here was set up to evaluate comparatively three groups of compounds:

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(1) Materials meeting USA Tentative Specification
AXS-1759 Grade 1.

(2) Materials meeting USA Tentative Specification
AXS-1759 Grade 2.

(3) Miscellaneous materials; for their efficiency
as corrosion preventives for phosphated surfaces, by three
methods:

(a) Determining the effect of coating
weights on salt fog life.

(b) Determining the influence of quality of
phosphate finish on protective efficiency of corrosion pre-
ventives.

(c) Determining the advisability of a water
displacement requirement.

5. The above investigative work was initiated since
the following factors are important in selecting a satis-
factory corrosion preventive for use on phosphated machine
gun links:

(1) The importance of low coating weight in
relation to protection and being dry to touch.

(2) Significance of the quality of the phosphate
coating in relation to protection offered by various pre-
servatives.

(3) The need for a water displacement property
in the preservative, if the links are wet when coated with
preservative compound.

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Procedure and Results

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6. The materials employed are listed in Table 1, and are coded by letter to simplify any reference made to an individual product.

7. In addition, all the links employed (.50 caliber, M9) were treated similarly in that the average weight of rust preventive compound coating per link was determined by weighing each group of links before and after being dipped into the compounds. The different weight coatings were made by diluting the original samples with either Stoddard Solvent or naphtha. All links were drained and dried on absorbent paper, and weighed after they had reached constant weight. The draining period was determined by weighing the links after draining fifteen minutes, then every hour until the weight was constant.

A. Coating Weight versus Salt Fog Protection

8. Groups of links were coated with varying weights of each compound, from 0.6 to 129.0 mg per link, then subjected to salt fog. The coating weights given in the tables are the average coating weights of each group of links. The days of protection given in the tables are similarly the average days for each group of links.

9. Tables 2, 3 and 4 list the results of the evaluation of the compounds by groups, i.e., AXS-1759 Grade 1, AXS-1759 Grade 2, and Miscellaneous, respectively.

10. Table 2 shows compound A to be more efficient than

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the others in its group, considering the increase in protection with increase in coating weight.

11. Similarly, Table 3 shows compounds E, F and G to be more efficient than the others in their group, considering, also, longer protection at low coating weights.

12. Similarly, Table 4 shows compounds K and L to be more efficient than the others in their group.

13. Table 5 lists the best compounds selected from Tables 2, 3 and 4. The table shows that the two groups of compounds, AXS-1759 Grade 2, and Miscellaneous are more satisfactory than the third group, AXS-1759 Grade 1, in protection at low coating weights.

B. Phosphate Finish versus Salt Fog Protection

14. Phosphate finishes are made with zinc, manganese, or iron phosphate. The criterion for a satisfactory or unsatisfactory finish is a two-hour salt spray test on the dry phosphated link. The only phosphate finish to pass the two-hour salt spray test was the thirty-minute-zinc finish, hence, designated as "satisfactory". The other finishes, manganese, iron, and less-than-thirty-minute-zinc, did not pass the test, hence, designated as "unsatisfactory".

15. Groups of links with satisfactory, unsatisfactory, and no phosphate finish, were coated with varying weights of the compounds, and then subjected to salt fog.

16. Table 6 shows that even the most efficient rust preventive compounds will not protect a non-phosphated link

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nor an unsatisfactory phosphated link for more than 0.9 day. For a rust preventive compound to protect a link for the minimum of 1.0 day (24 hours) in the salt spray test, the link must have a satisfactory zinc phosphate finish.

C. Wet and Dry Links versus Salt Fog Protection

17. This test was to determine the advisability of a water displacement requirement. It was to be determined by the difference shown in the length of salt fog protection between the regular salt fog test - whereby, links are coated with the compounds and subjected to salt fog test, and a water-dip salt fog test - whereby, links are dipped into water, then coated with the compounds and subjected to salt fog test.

18. The only links available at the time were of the unsatisfactory zinc phosphate finish type, but since the test was primarily for the relative lengths of protection, they were employed, cognizant of this condition.

19. Being cognizant of the fact that AXS 1759 Grade 2 materials are water displacing, they were expected to protect more efficiently than the other materials. This was confirmed by the experimental data obtained. Table 7 shows the difference in length of protection between the two tests for the three types of compounds. The compounds which gave over 0.2 day protection in the regular salt spray test fall into two groups: one, whose protection differential between the two tests is high, and the other, whose differential is low.

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20. The characteristic difference between these groups is that the high differential group is not water displacing, while the low differential group is water displacing. The two types of compounds, AXS-1759 Grade 1, and Miscellaneous give the high differential; the AXS-1759 Grade 2 type gives the low differential.

Discussion

21. The result of the foregoing work indicated that there are corrosion preventives available which will give 24 hour salt spray protection to phosphated links when very low coating weights are employed. This would provide a dry to touch film which is, of course, one of the desirable characteristics.

22. It was further shown, however, that a satisfactory corrosion preventive would not necessarily protect any quality and type of phosphate used. It is mandatory that the phosphate coating be a thirty-minute-zinc phosphate coating, to supply a minimum of two hours salt spray protection to the base metal when dry links are tested.

23. Finally, a water displacement property should be one of the characteristics of the preventive used, to insure adequate protection, if the links are wet when coated with preservative compound.

24. It should be mentioned, however, that the data indicated that several compounds gave very inconsistent

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results in that coatings obtained were grainy and non-uniform. (In diluting the compounds the method which would be used in the shops was followed - that of simply pouring solvent into the cold compound and stirring, no special consideration given to any compound, although some were grainy.) Furthermore, consideration must be given to the non-uniformity in the phosphate finish of various batches as a contributing factor towards inconsistency.

25. In order to alleviate the confusion existing in the choice of a preservative to be used on phosphated machine gun links, the link specification MIL-L-3077, Links, Metallic Belt, for Small Arms Ammunition, is being revised from stating that an AXS-1759 Grade 1 rust preventive compound should be used, to specifying that an AXS-1759 Grade 2 compound be used. It was the Grade 2 which was originally intended when the specification was written, but through an error the Grade 1 was designated. Although this will reduce the difficulties by the inclusion of a water displacement requirement, it is not a "cure-all". It is known that not all AXS-1759 Grade 2 compounds are satisfactory on phosphated surfaces⁽¹⁾.

26. It is believed that not all tests in the AXS-1759 Grade 2 Specification are necessary for the machine gun link rust preventive compound. Some of them are not applicable. To alleviate this situation, Rock Island Arsenal Purchase Description 505 for Metallic Belt Links has been issued by

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Rock Island Arsenal with a supplementary preservative alternate compound stipulation, whereby, if a manufacturer is processing links that are dry before being dipped into the rust preventive compound, a compound may be used which does not have water displacing properties, but which has been approved by Rock Island Arsenal.

27. The alternate compound must conform to the following requirements:

<u>Test</u>	<u>Requirement</u>
Abrasives	None
Flash Point, °F. (Min.)	100
Flow Point @ 130°F. (Film thickness 0.2 - 0.5 mil)	Pass
pH (Min.)	5
Salt Spray Protection on M9 .50 Cal. phosphated machine gun links, coating weight 6.0 to 7.0 mg per link (Min.)*	24 hours

* The finished dry phosphated links used for the salt spray test must be from a batch previously tested and found to satisfactorily meet a two hour salt spray test.

Recommendations

28. It is recommended, since no specification exists which defines the particular preservative required, that work be done to establish criteria for the requirements of a proposed specification which includes the following tests: penetration of base material, water displacement, salt spray on dry phosphated links, salt spray on rust preventive

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coated phosphated links, and the other tests which are usually considered in the development of a specification for rust preventive compounds.

29. It is anticipated that when completed, the proposed specification will provide satisfactory materials which will include the best of those currently used.

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References

- (1) Eisler, S. L. "Efficiency of Water Displacement from Sandblasted and Phosphated Surfaces Determined Radiometrically", Rock Island Arsenal Laboratory Report No. 51-4457.

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List of Prior Reports

No.	R.I.A. Lab.No.	Date Issued	Title
1	46-761	1-23-47	A Visual Rating System for Rusted Steel Specimens
2	46-731B	5-9-47	Thickness Measurement of Soft Rust Preventive Films
3	46-731A	1-27-47	Rust Preventive Coating Remov- ability Tester
4	47-375	6-25-47	Addendum to 46-731A
5	47-642	11-17-47	Tack Measurement of Rock Island Arsenal Coatings
6	47-782	12-5-47	Salt Spray Tests on U.S.A.2-82C Coatings
7	48-68	2-16-48	Determination of Specimen Surface Cleanliness by use of a "Falling Drop Method"
8	48-69	3-5-48	Comparative Evaluation of Cut- back Soft Film Rust Preventives by Means of Service and Acceler- ated Tests
9	48-1003	9-17-48	Investigation of the Water Dis- placement Test and Compounds
10	49-320	6-14-49	Water Displacing Rust Preventives II: Surface Active Agents in Relation to Water Displacement
11	49-1640	12-21-49	Study of Cutback Rust Preventives in Storage Tests
12	50-79	1-25-50	Water Displacing Rust Preventives III: Water Stability, Dilution and Displacement from Rusted Surfaces
13	50-2557	10-31-50	Radioactive Tracer Method for Evaluating Water Displacing Com- pounds

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List of Prior Reports (Cont'd.)

No.	R.I.A. Lab. No.	Date Issued	Title
14	50-2988	11-15-50	Coating Removability Tester for Corrosion Preventive Compounds
15	51-4457	11-16-51	Efficiency of Water Displacement from Sandblasted and Phosphated Surfaces Determined Radiometrically
16	51-4542	11-15-51	The Effect of Prolonged and Excessive Heating on Petrolatum Type Rust Preventives
17	52-162	1-16-52	Evaluation of Common Steel Test Panels for Laboratory Use
18	52-2039	6-20-52	Radiometric Study of the Adsorption Characteristics of Stearic Acid
19	52-3790	10-14-52	Radiometric Evaluation of the Water Displacing Efficiencies of Various Surfactants

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FOR USE ON PHOSPHATED MACHINE GUN LINKS**

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Sub-Task Title: Rust Preventives, Development of
Improved Test Methods

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RIA Lab. No.: 52-4447

Date: 15 October 1952

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Table 1
CODE TO IDENTIFY COMMERCIAL PRODUCTS

Material	Product Designation	Supplier	Type
A	Inco S-1423	Intercoastal Paint Corp.	AXS-1759 Gr. 1
B	T-580	Shell Oil Co.	AXS-1759 Gr. 1
C	Rustavoid 9215A	F. E. Anderson Oil Co.	AXS-1759 Gr. 1
D	No-Ox-Id 521	Dearborn Chemical Co.	AXS-1759 Gr. 1
E	L-492	Franklin Oil & Gas Co.	AXS-1759 Gr. 2
F	Cosmoline 377	E. F. Houghton & Co.	AXS-1759 Gr. 2
G	No-Ox-Id 520	Dearborn Chemical Co.	AXS-1759 Gr. 2
H	Nox Rust 109	Nox Rust Chemical Corp.	AXS-1759 Gr. 2
M	Rex 101	Rex Oil & Chemical Co.	AXS-1759 Gr. 2
I	Alox L-1279	Alox Corporation	Miscellaneous
J	Ensis 211	Shell Oil Co.	Miscellaneous
K	Parcolac 2B	Parker Rust Proof Co.	Miscellaneous
L	Rust Veto 850	E. F. Houghton & Co.	Miscellaneous
N	Poco 5 (Dark)	Pure Oil Co.	Miscellaneous
O	Non Toxic 17	Rock Island Arsenal	Miscellaneous
P	Rustbuster 7	Cannon Chemical Co.	Miscellaneous
Q	Poco 5 (Light)	Pure Oil Co.	Miscellaneous
R	Ircolene 19	International Rust-proof Corp.	Miscellaneous
S	Rust Ban 334	Penola, Inc.	Miscellaneous

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Table 2
RUST PREVENTIVE COATING WEIGHT
Versus
SALT SPRAY PROTECTION USING AXS-1759 GRADE 1 COMPOUNDS

Coating Wt. (mg/link)	Protection (Days)			
	A	B	C	D
5.0	0.5			
6.5		0.7		
7.5	4.5		0.3	
8.5				0.3
22.5		2.1		
24.0		2.3		
25				1.3
27			2.3	
28	8.7	1.3		0.3
34	9.6			
36	5.9			
75	6.8			
91		8.9		
111			7.0	
129				3.9

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Table 3
RUST PREVENTIVE COATING WEIGHT
Versus
SALT SPRAY PROTECTION USING AXS-1759 GRADE 2 COMPOUNDS

Coating Wt. (mg/link)	Protection (Days)				
	E	F	G	H	M
4.0		1.3			
5.0			1.0	0.3	
6.0	2.1				
6.5					0.8
9.5			1.3		
10.0			3.7		
10.5			1.1		1.2
14.5					1.3
16.5	3.2				
21.5		5.7			
22.5				1.8	
24.5	7.7				
25		7.0			
28		9.1		2.7	
30			9.8	6.0	
32					7.4
37			5.4		
47	8.6				
55					9.4

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Table 4
RUST PREVENTIVE COATING WEIGHT
Versus
SALT SPRAY PROTECTION USING MISCELLANEOUS COMPOUNDS

Coating Weight (mg/link)	Protection (Days)									
	I	J	K	L	N	O	P	Q	R	S
0.6							0.3			
2.0									0.1	
3.0							0.3		0.6	0.3
5.0	0.1	0.4	2.3	1.1	0.3					
6.0			3.0		1.2					0.3
6.5							0.1	0.3		
7.0					1.2					
7.3	1.1									
8.0			4.3	1.4						
8.7		3.1								
9.3									1.2	
10.5									1.9	
11.0		1.3		3.7				1.3		
11.5								0.3		
13.0	1.6									
13.5			9.1							
14.5						0.5				
15.5				7.8				2.0		0.98
17.0		7.8	11.3							
17.5										0.98
18.0									8.4	
19.0									7.5	0.95
21.5									9.7	
23.0			10.2	11.3				7.6		
25				18.0						
30		6.0		11.6	9.0	1.3	22.8) 1.0)* 9.3)			0.97
40					10.4	1.4		8.0	13.1	
50	2.1					1.0			14.5) 4.6)* 12.9) 23.9)	
83.5							9.1			

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* Non-uniform and grainy coatings.

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Table 5
COMPARISON OF BEST COMPOUNDS FROM
TABLES 2, 3 and 4

Coating Weight (mg/link)	Salt Spray Protection (Days)					
	AXS-1759-1 A	AXS-1759-2			Miscellaneous	
		E	F	G	K	L
4.0			1.3			
5.0	0.5			1.0	2.3	1.1
6.0		2.1			3.0	
7.5	4.5					
8.0					4.3	1.4
9.5				1.3		
10.0				3.7		
10.5				1.1		
11.0						3.7
13.5					9.1	
15.5						7.8
16.5		3.2				
17.0					11.3	
21.5			5.7			
23.0					10.2	11.3
24.5		7.7				
25			7.0			18.0
27	8.7					
28			9.1			
30				9.8		
34	9.6					11.6
36	5.9					
37				5.4		
47		8.6				
75	6.8					

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Table 6
TYPE OF PHOSPHATE FINISH
Versus
SALT SPRAY PROTECTION

Com- pound	Coating Weights* (mg/link)	Protection (Days)		
		Satis- factory	Unsatis- factory	None
A	7.5-9.7	4.5	0.1	
	27.5-24.9	8.7	0.2	
B	28-29	1.3		0.3
D	25-27	1.3		0.3
E	6.0-10.3	2.1	0.04	
	24.5-23.1	7.7	0.04	
F	4.0-6.5	1.3	0.04	
	21.5-24.7-21.5	5.7	0.1	0
G	9.5-9.2	1.3	0.1	
	10.5-20.2	1.1	0.2	
H	22.5-24.5	1.8		0.2
I	7.3-9.8	1.1	0.1	
	13.0-20.3	1.6	0.1	
J	8.7-10.6	3.1	0.3	
K	8.0-9.2	4.3	0.8	
	17.0-22.0-22.9	11.3	0.9	0.03
L	5.0-7.1	1.1	0.2	
	22.5-22.8-22.5	11.3	0.6	0.3
M	6.5-5.2	0.8	0	
	14.5-20.4	1.3	0	
N	8.0-10.9	3.1	0.5	
	29.5-25.4	9.0	0.9	
P	29.0-28.5	22.8		0
R	10.5-16.5	1.9		0.04

*Coating weights appear in the same order
as the protection days.

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Table 7

WET AND DRY LINKS Versus SALT SPRAY PROTECTION

Com- pound	Coating Weight (mg/link)	Protection (Days)		Type
		Dry Links	Wet Links	
A	5	0.5	0.1	AXS-1759 Gr. 1
	10	0.7	0.2	
E	5	0.1	0.1	AXS-1759 Gr. 2
	10	0.2	0.2	
F	5	0.1	0.1	AXS-1759 Gr. 2
G	5	0.6	0.5	AXS-1759 Gr. 2
	10	1.3	1.3	
M	5	0.1	0.1	AXS-1759 Gr. 2
	10	0.2	0.1	
I	5	0.1	0.1	Miscellaneous
	10	0.2	0.2	
J	5	0.6	0.2	Miscellaneous
	10	(1.3	0.1	
		(1.2	0.3	
K	5	0.7	0.1	Miscellaneous
	10	0.9	0.4	
L	5	1.1	0.1	Miscellaneous
	10	(4.3	0.9	
		(1.0	0.7	
N	5	0.1	0.1	Miscellaneous

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Rock Island Arsenal Lab., Ill. (RIA Lab. Report No. 52-4447)

RIA-52-4447

Evaluation of Corrosion Preventives for Use on Phosphated Machine Gun Links - Report No. 20 - Project No. TB5-6010A

Ammunition Feed Mechanisms Corrosion Inhibition

Waddell, Lyle O. 15 Oct'52 25pp. tables

Inhibitors, Corrosion
Coatings, Corrosion resistant
Ammunition - Feed systems
Machine guns

Materials, Non-Metallic (8)
Miscellaneous Materials (8)

EO 10501 dd 5. Nov 1953

REF

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