THE SPRING RESEARCH AND MANUFACTURERS' ASSOCIATION

TEMPORARY CORROSION PROTECTIVES

Report No 373

by

M O'Malley, B.Sc.

MARCH 1984

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SUMMARY

A range of temporary corrosion protectives have been examined and assessed for their application to the spring industry. The examination consisted, primarily, of corrosion testing spring steel panels coated with the various protectives. Assessments were made of the performance in association with the relative cost of each protective.

It was found that, in general, the best overall performance was obtained with the relatively expensive wax type protectives. The grease protectives gave fairly good performance, but oils could only be recommended for very short term or interprocess protection.

Recommendations have been made to the best buys currently available for each protective type.

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1. INTRODUCTION

One cause of material wastage for the spring industry is the corrosion of non stainless spring steels during transportation or storage. This corrosion is brought about by the electrochemical reaction of the metal surface with water vapour and oxygen in the surrounding atmosphere. As the presence of both water and oxygen is required for the reaction to take place, exclusion of either will prevent rusting. Most protectives operateby preventing water vapour from contacting the metal surface.

A steel which has not been permanently protected by means of an electrodeposit or paint finish can be protected by a temporary corrosion protective. These protectives normally consist of a protective medium in a solvent base. The term "temporary" indicates that the material can be easily removed when necessary and does not signify the duration of corrosion resisting efficiency.

It is now 14 years since the Association carried out an assessment of temporary corrosion protectives and a second survey was considered necessary in regard to both the advancements which have taken place in this field and to provide a guide to the systems currently available to the spring industry.

As it was not possible to test all the protectives which are currently on the market, a survey was made of the membership to identify the most frequently used materials. The protective manufacturers were then approached for samples of these materials and of their most recently developed protectives if possible.

Wherever possible, the tests carried out in this report have been in accordance with BS 1133: Section 6: 1966 "Temporary Protection of Metal Surfaces against Corrosion (During Transport and Storage)".

2. MATERIALS USED IN THE INVESTIGATION

The results of the membership survey indicated that a very wide range of protectives from a large number of manufacturers are currently used by the spring industry. Therefore, the most popular manufacturers were approached for samples of their products and a total of 27 different protectives were received from 6 manufacturers willing to take part in the investigation. A full list of the manufacturers, protective names and product descriptions is given in Table I.

The 27 protectives used in the investigation could be classified into 3 major types.

1. OIL TYPE

These were either a) straight oil
b) organic solvent deposited oil
c) water deposited oil

2. GREASE or SOFT FILM TYPE

Either a) organic solvent deposited grease
or b) water deposited grease

3. WAX or HARD FILM TYPE

Deposited from organic solvents

Water deposited protectives are a relatively recent development in the temporary corrosion protective field and have certain advantages over the other forms of protective in that the non-flamable emulsions elimate fire hazards and the replacement of volatile solvents by water improves plant safety.

Testing of the protectives was carried out using standard size corrosion panels (150 mm x 100 mm x 0.7 mm) made from CS80 strip, hardened and tempered to produce a blued surface finish and a hardness of 450 HV30 ie comparable with hardened and tempered springs. All the panels were ultrasonically cleaned and degreased prior to application of the protectives.

3. TESTING PROCEDURES

3.1 Coverage and Relative Cost

The relative cost of any temporary corrosion protective depends on both the price per litre and the covering power of the protective. Thus an inexpensive protective which is only capable of covering a small area could cost more, relatively, than an expensive protective with good covering power.

The price per litre for each protective is listed in Table II. This price is based on a 205 litre quantity ie a standard barrel size, with the exception of the Canning materials where the price is based on a 250 litre quantity ie 10 x 25 litre drum size.

The evaluation of covering power was carried out using 10 panels per protective. The panels were coated by dipping in a known volume of protective allowed to drip for one minute and then removed to drying racks. By measuring the remaining volume of protective, it was possible to determine the covering power. The results are listed in Table II together with the cost per square metre covered.

3.2 Corrosion Testing

The corrosion protecting abilities of the test materials were assessed under cold salt spray, high humidity and atmospheric conditions. Duplicate panels were used for each material and test method, and degreased, unprotected control panels were included for comparison purposes. The test panels were coated by dipping and allowed to dry for 24 hours at room temperature prior to the commencement of testing.

3.2.1 Cold Salt Spray Testing

This involved subjecting the coated test panels to a fine spray or fog of 5% sodium chloride solution at ambient temperature for a maximum period of 72 hours in a test cabinet with the panels inclined at approximately 60° to the horizontal (see figure 1). The panels were repeatedly checked during the course of testing and the protectives were considered to have failed the test at the first indication of rusting on the panel face for both panels tested. The results of the tests are given in Table III.

3.2.2 Humidity Testing

The testing was carried out in accordance with the conditions laid out in Appendix K of BS 1133: Section 6. The panels were inclined at approximately 60° to the horizontal in a closed cabinet in which the relative humidity was maintained at approximately 100% and the temperature varied between $42^{\circ}C$ and $48^{\circ}C$ ensuring alternating conditions of condensation and evaporation. Each complete heating and cooling cycle lasted approximately 45 minutes.

As with the salt spray testing, the protectives were considered to have failed when rusting commenced on the faces of both panels. The test results are given in Table III.

3.2.3 Environmental Exposure Testing

Panels were tested under outside atmospheric conditions on the laboratory roof using special corrosion racks constructed in accordance with the conditions laid out in BS 3900: Part F6 (Notes for guidance on the conduct of natural weathering tests for paints). The racks were inclined at 45^{o} to the horizontal and positioned, facing towards the equator, away from any protection or overshadowing by neighbouring objects. The panels were held in place by electrically non-conducting fibre washers to prevent contact with the steel rack and so eliminate any possible electrochemicalcorrosion. The rack is illustrated in Figure 2.

As only a limited amount of space was available on the rack, and to ensure that all the protectives experienced the same atmospheric conditions, only one panel per protective was tested. However, retests were carried out on those panels which experienced very early failure to check whether this early failure was a valid result.

The testing results are given in Table III.

3.3 Ease of Removal

The ease of removal of a temporary corrosion protective is of considerable importance, especially if it has been used to provide corrosion protection during interprocess storage. As this storage may extend over a considerable period, it was necessary to test the ease of removal of the protectives after they had dried and aged. The coated panels were, therefore, stored at room temperature out of direct light for a period of 60 days to allow the coating to dry thoroughly.

Trichloroethylene was used for the removal tests as it is commonly used as an industrial cleaner. The relative ease of removal of the protectives was classified into 5 categories, and the results are presented in Table IV.

3.4 Adhesion Testing

The adhesion properties of corrosion protectives can be important as accidental removal by packaging materials could lead to exposure of bare metal and subsequent corrosion.

The adhesion properties of the protectives were tested using the procedure specified in Appendix G of BS 1133: Section 6. After drying for 24 hours at room temperature, the coated panels were covered with a piece of brown packing paper (of specified size and quality) and subjected to a standard weight for a specified time period. On removal of the paper it was noted whether any bare metal was exposed.

The results of the adhesion tests are given in Table IV.

4. DISCUSSION OF RESULTS

One immediate observation from examination of the corrosion testing results is that all the protectives gave some protection against corrosion under all the test conditions, even though some of the protectives only inhibited the onset of corrosion for a very short length of time.

It would appear from examination of the results in Table III that a protective with good resistance to one form of corrosion testing eg salt spray testing, would not necessarily perform well under another form of corrosion test, and vice versa. (The exception to this was the Croda Multitec PW68 which had excellent corrosion resisting properties under all the test conditions). However, in order to assess whether there was any overriding correlation between the results of the corrosion tests for the protectives that was not immediately obvious, a Rank Order Correlation analysis was carried out. An analysis was also made of the protective cost versus performance.

The results of these analyses indicated that there was no correlation between a protective's cost and its subsequent performance, and no correlation between the performance in the different corrosion tests.

It was found that, by grouping the protectives into the three different categories, ie oil, grease and wax, and then assessing the performance, there was a correlation in the results. Thus, generally, wax or hard film protectives gave better corrosion resisting performance than grease or soft film types, with oils providing the least protection of the three groups. However, there were exceptions to this general observation with some protectives having superior or inferior performance to their general type.

In general the wax or hard film type protectives (with the exception of Canning Lactrene) performed very well in all the corrosion tests and would be recommended for long term indoor protection or for short term outdoor protection. However, these coatings had the highest relative costs (between approximately 4-8p per m^2 covered) due to their low covering power. These protectives give a hard dry coat on components and so subsequent handlability is relatively easy. But, the protectives are fairly thick in their liquid form (the Multitec PW68 having the consistency of molasses) and batch dip treatment of components could result in problems of them sticking together while drying. Also, although the protectives were readily removed by trichloroethylene, some scrubbing was required to ensure complete removal. This could, thus, lead to problems with intricately shaped components where removal of the protective from inaccessible surfaces would be difficult.

The grease or soft film type temporary corrosion protectives performed relatively well in the tests and are suitable for short term indoor or very short term outdoor applications. These protectives, which are supplied in the form of thin liquids, were easy to apply by dip treatment to give very good even coverage, were also very easily removed by trichloroethylene. However, as the coatings are greasy in nature, there could be some removal of them by, and resultant contamination of, packaging materials during storage.

These grease type of protectives are relatively inexpensive (approximately 1-2p per m^2 covered), and the best overall performance obtained from a grease temporary corrosion protective was by the Burmah-Castrol Rustilo DWX22 grade.

The oil type temporary corrosion protectives can only be recommended for short term indoor or interprocess applications. This type of protective is very easy to apply using a dip treatment and was very readily removed using trichloroethylene. However, the protectives are also very easily removed by packing materials to expose bare metal and so this will limit their use for wrapped storage applications.

The relative cost of this type of protective varied considerably (from 0.3p to 3.4p per m^2 covered depending on the manufacturer) and the more expensive protective did not necessarily give the best performance. Good general performance was obtained from the following grades:

Crodafluid PM43
Burmah-Castrol Rustilo Aqua 2
Esso Rustban 310
Edgar Vaughan Rust Veto 421A
Edgar Vaughan Rust Veto MP20

and of these, the best value for money was considered to be the Burmah-Castrol Rustilo Aqua 2 and the Edgar Vaughan Rust Veto 4214 grades.

5. CONCLUSIONS

1. The recommendations of a "best-buy" will depend on the weighting given by the user to the various attributes of the protective and to the proposed application.

2. For interprocess protection the cheaper oil type protectives would be recommended of which the best buys were:

   Burmah Castrol Rustilo Aqua

3. For short term indoor protection a grease type protective would be recommended and the overall best buy was:

   Burmah Castrol Rustilo DWX224

4. For fairly long term or indoor, or short term outdoor protection, a wax or hard film type protective should be used of which the best buys were:

   Croda Multitec PW68 - best performance
   Esso Rustban 395 - good performance and lower cost2
   Edgar Vaughan Rust Veto 4214

6. ACKNOWLEDGEMENTS

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Esso Petroleum Company Limited
Mobil Oil Company Limited

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TABLE I RANGE OF TEMPORARY CORROSION PROTECTIVES EXAMINED

Sample No	Protective Name and Manufacturer		Protective Type
1	CASTROL	- Rustilo 647	Oil
2		Rustilo DWX20	Solvent deposited oil
3		Rustilo DWX22	Solvent deposited grease
4		Rustilo DWX30	Solvent deposited grease
5		Rustilo DWX31	Solvent deposited grease
6		Rustilo DWX32	Solvent deposited grease
7		Rustilo Aqua 1	Water deposited grease
8		Rustilo Aqua 2	Water depostied oil
9	CRODA	- Crodafluid PM43	Solvent deposited oil
10		Crodafluid PM47	Solvent deposited oil
11		Crodafluid PG69	Solvent deposited grease
12		Crodafluid PG71	Solvent deposited grease
13		Crodafluid PU20	Solvent deposited hard film
14		Multitec PW68	Solvent deposited wax
15	ESSO	- Rustban 310	Water deposited oil
16		Rustban 335	Solvent deposited oil
17		Rustban 337	Solvent deposited oil
18		Rustban 392	Solvent deposited wax
19		Rustban 395	Solvent deposited wax
20		IL 2390	Solvent deposited oil
21	EDGAR	- Rust Veto 4214	Solvent deposited oil
22	VAUGHAN	Rust Veto MP20	Water deposited oil
23		Rust Veto C3	Solvent deposited oil
24	MOBIL	- Mobilarma 247	Solvent deposited soft film
25		Mobilarma 775	Solvent deposited oil
26	CANNINGS	- Sealphos 705	Water deposited oil
27		Lactrene	Solvent deposited hard film

TABLE II PROTECTIVE COST AND COVERAGE

Sample No	Protective Name	Price + p/l	Coverage m^2/l		Coverage Cost p/m^2
			SRAMA Tests	From Technical Literature	
1	Rustilo 647	100.6	250	269	0.40
2	Rustilo DWX20	74.9	100	104	0.75
3	Rustilo DWX22	81.5	70	70	1.16
4	Rustilo DWX30	82.3	100	105	0.82
5	Rustilo DWX31	79.1	85	86	0.93
6	Rustilo DWX32	85.3	64	64	1.33
7	Rustilo Aqua 1	105.5	175x	190	0.60
8	Rustilo Aqua 2	107.5	204x	230	0.53
9	Crodafluid PM43	82.0	60	62	1.37
10	Crodafluid PM47	87.0	40	39	2.18
11	Crodafluid PG69	77.0	80	81.5	0.96
12	Crodafluid PG71	80.0	39	42	2.05
13	Crodafluid PU20	82.0	22	21.6	3.73
14	Multitec PW68	115.0	15	15	7.67
15	Rustban 310	88.9	120x	-	0.74
16	Rustban 335	68.6	23	20	3.00
17	Rustban 337	66.2	19	20	3.48
18	Rustban 392	65.9	25	24	2.64
19	Rustban 395	66.2	12	12	5.12
20	IL 2390	68.8	50	-	1.38
21	Rust Veto 4214	70.9	245x	250	0.29
22	Rust Veto MP20	45.0 (1)	78x	75	0.58
23	Rust Veto C3	67.2	300	320	0.22
24	Mobilarma 247	63.0	45	45	1.40
25	Mobilarma 775	63.0	78	75	0.81
26	Sealphos 705	174.0 (2)	100x	-	1.74
27	Lactrene	169.2 (2)	29	-	5.84

\+ Cost per litre for 205 litre barrel
x 20% emulsion in water
(1) Also available as concentrate at 108.7 p/l
(2) Price for 25 litre drums

TABLE III RESULTS OF SALT SPRAY, HUMIDITY AND ENVIRONMENTAL TESTING

Sample No	Protective	Coating Thickness (taken from makers literature) 10^{-3} mm	Number of Hours before Onset of Corrosion		Number of Days before Onset of Corrosion - Environmental
			Cold Salt Spray (72 hr maximum)	Humidity (720 hr maximum)	
	Control panel	-	<1	2	2
1	Rustilo 647	3.7	5	152	4
2	Rustilo DWX20	2.5	14	3	16
3	Rustilo DWX22	3.7	N/F	N/F	17
4	Rustilo DWX30	0.6	14	3	11
5	Rustilo DWX31	2.0	N/F	3	17
6	Rustilo DWX32	4.1	N/F	16	39
7	Rustilo Aqua 1+	1.0	8	272	8
8	Rustilo Aqua 2+	0.9	30	N/F	15
9	Crodafluid PM43	3.8	N/F	152	17
10	Crodafluid PM47	12.5	30	3	17
11	Crodafluid PG69	1.7	55	3	17
12	Crodafluid PG71	6.8	30	104	21
13	Crodafluid PU20	21.0	55	224	39
14	Multitec PW68	40.0	N/F	N/F	122N/F
15	Rustban 310+	not known	30	104	8
16	Rustban 335	6.0	5	80	4
17	Rustban 337	6.0	5	3	12
18	Rustban 392	0.6	5	3	16
19	Rustban 395	2.5	55	N/F	122N/F
20	IL 2390	not known	N/F	3	15
21	Rust Veto 4214	0.5	N/F	590	4
22	Rust Veto MP20+	2.8	30	N/F	8
23	Rust Veto C3	3.1	5	80	8
24	Mobilarma 247	not known	8	422	24
25	Mobilarma 775	not known	5	8	4
26	Sealphos 705+	not known	55	5	4
27	Lactrene	not known	5	5	17

\+ 20% emulsion in water
N/F not failed

TABLE IV EASE OF REMOVAL AND ADHESION TESTING

Sample No	Protective	Ease of Removal after 60 Days at Room Temperature	Adhesion Test - Metal Left Unprotected
1	Rustilo 647	A	YES
2	Rustilo DWX20	A	YES
3	Rustilo DWX22	B	YES
4	Rustilo DWX30	A	NO
5	Rustilo DWX31	B	NO
6	Rustilo DWX32	B	NO
7	Rustilo Aqua 1	A	YES
8	Rustilo Aqua 2	A	YES
9	Crodafluid PM43	B	YES
10	Crodafluid PM47	B	NO
11	Crodafluid PG69	A	NO
12	Crodafluid PG71	C	YES
13	Crodafluid PU20	C	NO
14	Multitec PW68	D	NO
15	Rustban 310	B	YES
16	Rustban 335	A	YES
17	Rustban 337	A	YES
18	Rustban 392	B	NO
19	Rustban 395	C	NO
20	IL 2390	B	YES
21	Rust Veto 4214	B	NO
22	Rust Veto MP20	A	YES
23	Rust Veto C3	A	YES
24	Mobilarma 247	B	YES
25	Mobilarma 775	A	YES
26	Sealphos 705	B	YES
27	Lactrene	E	NO

A - dipping only
B - dipping and agitation required
C - rubbing required
D - scrubbing required
E - not removed by trichlorethylene - required scrubbing in acetone

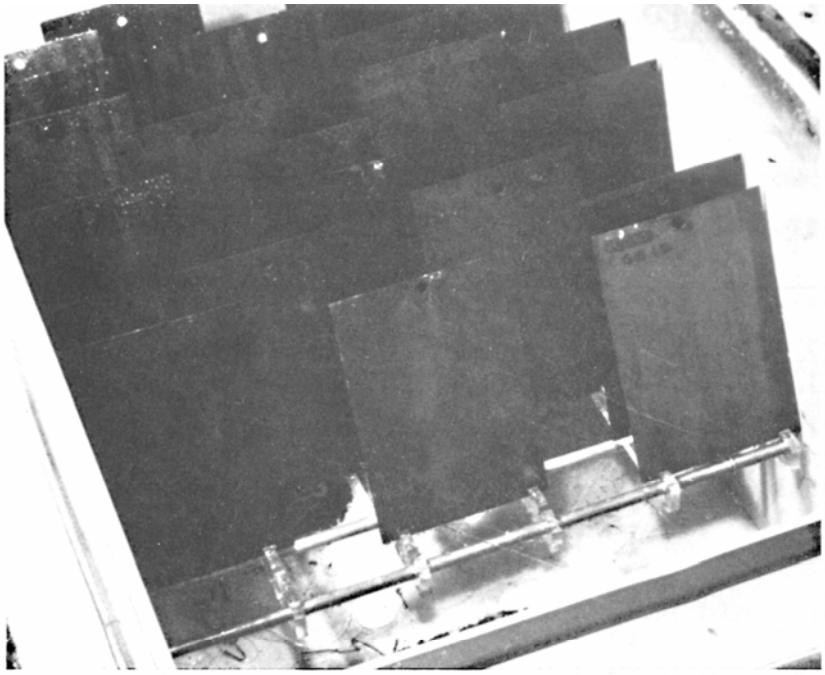

Figure 1 Arrangement of panels for salt spray and humidity testing

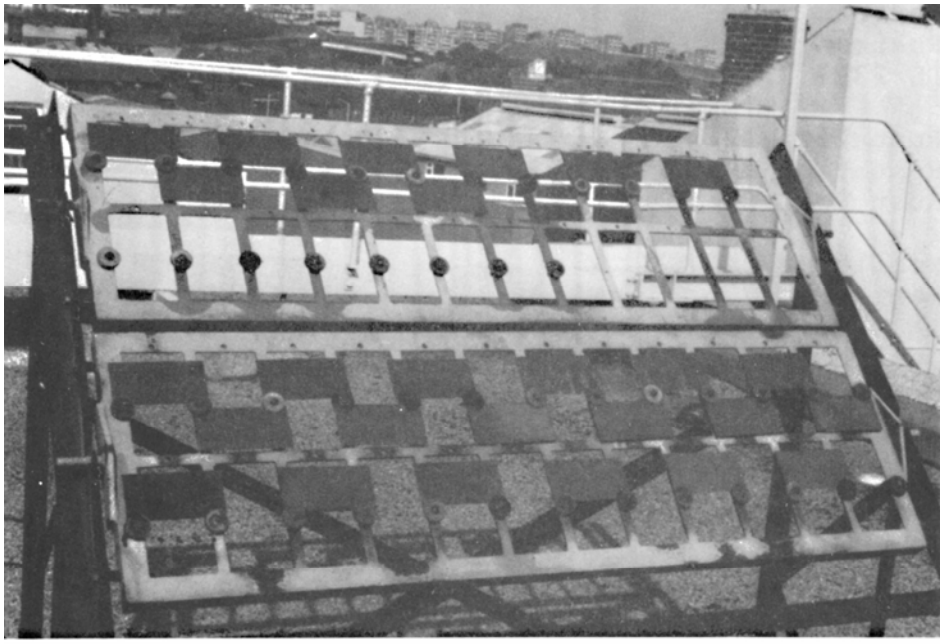

Figure 2 Environmental exposure racks