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**JOURNAL OF THE
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Influence of the type and content of soluble corrosion-inhibitive pigments on the behaviour of shop primers

B. del Amo, J. J. Caprari, M. J. Chiesa and R. D. Inghiero

Phosphate pretreatments for mild steel

G. W. Kapse and L. K. Aggarwal

Electrochemical impedance on coated metal electrodes. Part 2: Effects of time and potential

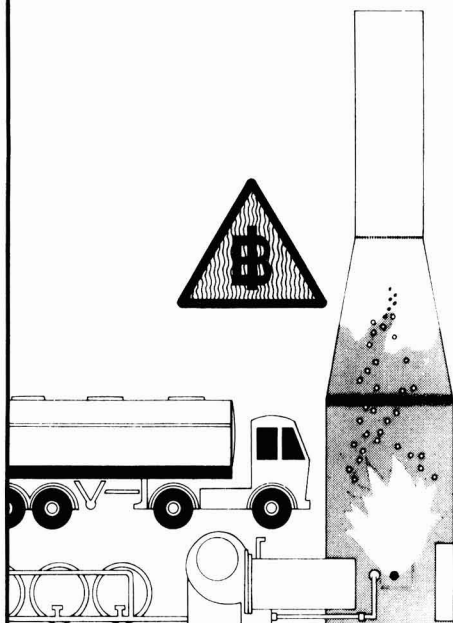
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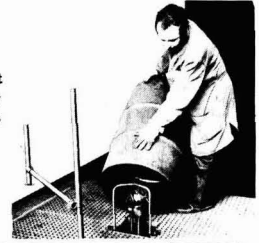
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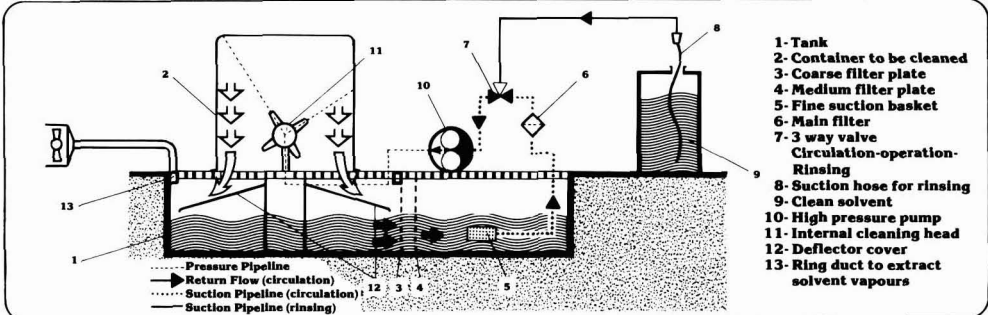
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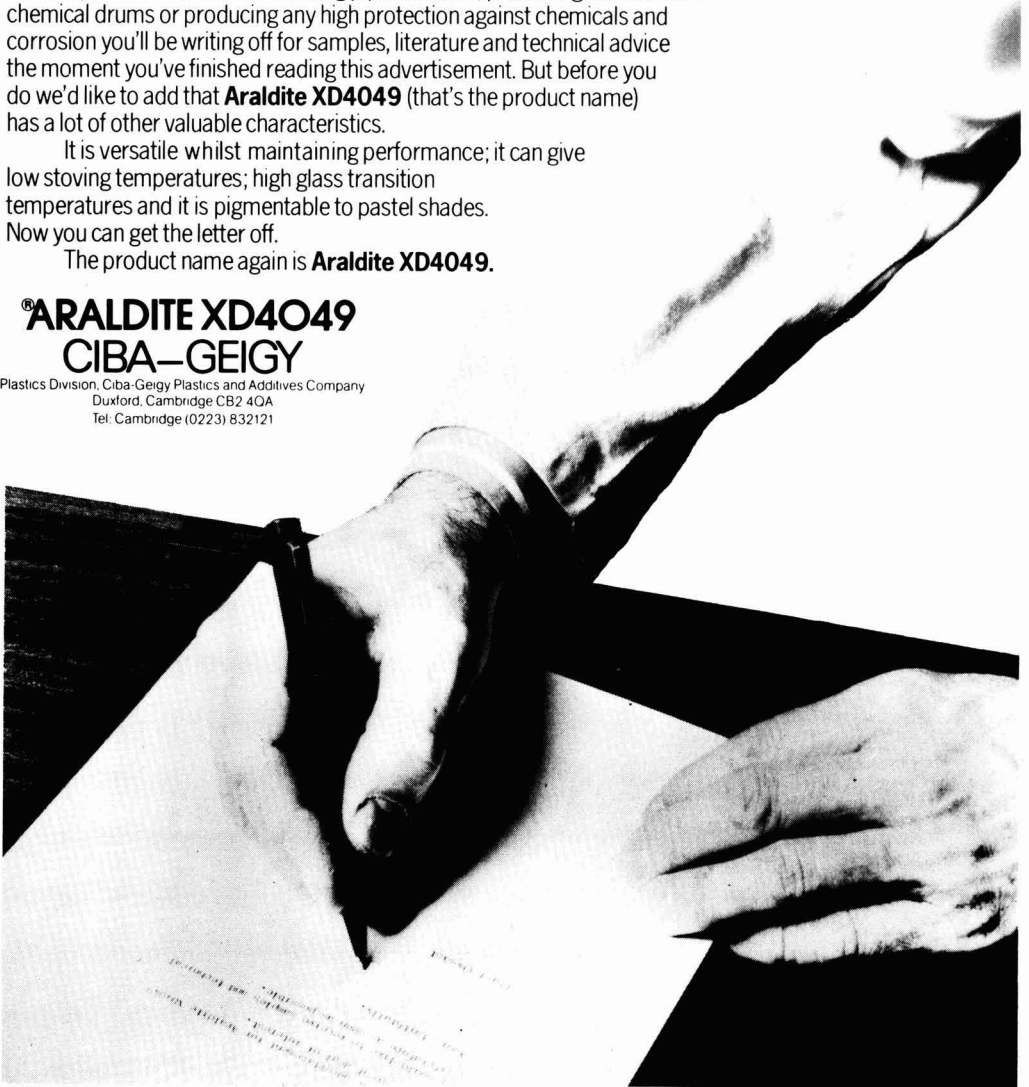
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Influence of the type and content of soluble corrosion-inhibitive pigments on the behaviour of shop primers

By B. del Amo, J. J. Caprari, M. J. Chiesa and R. D. Ingeniero

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Summary

The influence of type and content of corrosion-inhibitive pigments used in shop primer formulations was studied. The purpose was to establish the minimum level of anticorrosive pigment required to obtain good performance in outdoor exposure.

Soluble and basic pigments were used: zinc chromate, zinc tetroxychromate and basic lead silico-chromate. Red iron oxide was used as an extender because of its low solubility, water

resistance and good opacity properties. Binders were formulated with chlorinated rubber (20 cP), vinyl resin and mixtures of those resins with phenolic varnish.

The behaviour, during service, of three concentrations of corrosion-inhibitive pigment was established when shop primers were applied in thicknesses of 20-25 μm . Under these conditions it was not possible to protect steel from corrosion in a marine environment for one year.

Keywords

Types and classes of coatings and allied products

shop coat primer

Properties characteristics and conditions primarily associated with

dried or cured films

corrosion

Types and classes of structures or surfaces to be coated

steel

Raw materials for coatings

chemically active pigments

corrosion inhibiting pigment

L'influence de la nature et de la teneur en pigments anticorrosifs et solubles sur le comportement des primaires d'atelier

Résumé

Au cours de cet exposé on a étudié l'influence de la nature et de la teneur en pigments anticorrosifs que l'on utilise en primaires d'atelier. L'objet de cette étude était d'établir la concentration minimale du pigment anticorrosif qui est nécessaire à assurer un bon rendement lors de l'exposition aux intempéries.

On a utilisé des pigments basiques et solubles: le chromate de zinc, le tétraoxychromate de zinc, et le silico-chromate basique de plomb. L'oxyde rouge de fer était utilisé en tant que matière

de charge en vue de sa faible solubilité, sa résistance à l'eau, et son bon pouvoir opacifiant. Des liants basés sur le caoutchouc chloré (20 cP), la résine vinylique, et des mélanges de ces résines avec du vernis phénolique. Le comportement lors du service de trois concentrations de pigment anticorrosif était établi où les primaires d'atelier ont été appliqués à une épaisseur de 20-25 μm . Il n'est pas possible, sous ces conditions, d'assurer dans un environnement maritime la protection de l'acier contre la corrosion pour une période aussi longue qu'une année.

Der Einfluss des Typs und des Gehalts von löslichen Korrosionsschutzpigmenten auf den Verhalten der Auslieferungsbeschichtungen

Zusammenfassung

In diesem Vortrag wurde der Einfluss des Typs und des Gehalts von Korrosionsschutzpigmenten untersucht. Der Zweck war die Bestimmung der Mindestkonzentration von Korrosionsschutzpigment, die man braucht um bei der Bewitterung eine gute Leistung zu bekommen.

Lösliche und basische Pigmente wurden benützt: Zinkchromat, Zinktetraoxychromat, und basisches Bleisilikochromat. Das rote Eisenoxid wurde als Füllstoff wegen dessen niedrigen

Löslichkeit, Wasserbeständigkeit und guten Deckvermögen benützt. Bindemittel wurden mit Chlorkautschuk (20 cP) Polyvinylchloridharz und Mischungen von diesen Harzen mit Phenolack formuliert. Der Gebrauchverhalten von drei Konzentrationen der Korrosionsschutzpigmente wurde im Falle der Auslieferungsbeschichtungsfilm von 20 bis 25 μm . festgestellt. Unter diesen Bedingungen ist es unmöglich solange wie ein Jahr in einem maritimen Klima das Stahl von Korrosion zu schützen.

Introduction

Refs. 1-7

Shop primers or prefabrication primers are coatings that are applied on shot blasted or pickled steel surfaces, free of millscale, oxides, rust, oil and grease, dust etc. and must protect the steel during the construction and joining stages of a structure^{1,2}.

Any type of binder compatible with the protective system to be used subsequently can be used in its formulation. The pigment or mixture of pigments must be chosen carefully in order to achieve adequate anticorrosive protection. As the shop primer film is very thin (20-25 μm) the protective power will depend both on the type and content of the pigment as well as on the binder used.

During flame cutting and welding operations the primer burns producing toxic fumes. For this reason, international regulations have set out maximum levels of toxicants permissible in the environments of construction workshops. Consequently a compromise must be achieved between the above-mentioned levels of toxicants and the amount of corrosion-inhibitive pigment that must be incorporated in order that the shop primer will have sufficient protective power.

Two types of pigments may be used in shop primers: active (corrosion-inhibitive pigments) or non-active (extenders).

The corrosion-inhibitive pigments may act by means of different mechanisms: by alkalization of the medium and thus stopping the oxidation reactions; by neutralisation of the free acids of the binder, which are corrosion promoters; by forming soaps which increase the impermeability of the film to ions or water; or by passivating the steel surface by providing ions which react with the metal reducing its tendency to corrode.

The latter group includes soluble pigments of the chromate family, such as zinc yellow, zinc tetroxychromate, calcium chromate, barium chromate, strontium chromate and lead chromate. Some authors include in this group basic lead silico-chromate³.

Whether these pigments are used in shop-primers depends on their solubility. Calcium chromate must be discarded due to its extreme solubility in water (17.0 g/l in distilled water), which leads to a fast deterioration of the film⁴. Lead chromate has a very low solubility but does not produce the quantity of chromate ions necessary for the adequate protection of metallic surfaces.

More effective are zinc chromate and zinc tetroxychromate, both of low solubility. Zinc chromate, commercially known as zinc yellow, has the empirical formula³ $\text{K}_2\text{O} \cdot 4\text{ZnO} \cdot 4\text{CrO}_3 \cdot 3\text{H}_2\text{O}$ and a solubility in distilled water of 0.76 g/l; for this reason it is used especially in the formulation of primers for exterior use. Zinc tetroxychromate or basic zinc chromate, whose chemical composition was established by Newton⁵ and Sherman⁶ as $\text{ZnCrO}_4 \cdot 4\text{Zn}(\text{OH})_2$, has a lower solubility in distilled water (0.25 g/l); this pigment is commonly used in paints that will be in permanent contact with an electrolyte, such as primers for marine paint systems.

Basic lead silico-chromate is a silicate complex formed by calcining the active material (lead chromate) on a silica

core. According to Payne³ the anticorrosive action of this pigment is possibly based on the solubilization of chromate ions, although this is highly improbable due to the low solubility of lead chromate in water. The function of the silica core is only to increase the bulking value of the pigment. Another interpretation of its mode of action is that which considers the possibility of a chemical reaction of lead silico-chromate with the acid components of certain binders with the formation of insoluble soaps which reduce film permeability⁷.

Red iron oxide is one of the inert pigments commonly used because of its properties of providing good opacity, low solubility in water and adding high mechanical resistance to the film, at low cost. The red iron oxide advised for use in the formulation of shop-primers must have adequate pH and particle size. It is necessary to control the pH because residual acidity can cause corrosion on the metallic surface; particle size is very important in the manufacture of shop primers because for very thin films, particles exceeding 20-30 μm can cause discontinuities in the coating and thus reduce the protective efficiency.

This paper covers the influence of the type and content of soluble corrosion-inhibitive pigments on the anticorrosive properties of shop primers applied at different film thicknesses on steel surfaces of variable roughness. The purpose is to produce formulations with a minimum content of anticorrosive pigment which will provide effective protection under different environmental conditions.

Experimental

Using a porcelain ball mill, four series of paints were prepared with the following binders:

- Series 1: chlorinated rubber (20 cP), chlorinated paraffin 42 per cent and toluene/xylene mixture as solvent (Table 1);
- Series 2: chlorinated rubber (20 cP), phenolic/wood oil varnish, chlorinated paraffin 42 per cent and toluene/xylene (Table 2);
- Series 3: vinyl chloride-vinyl acetate copolymer resin partially hydrolysed, carboxylated vinyl chloride-vinyl acetate copolymer resin, tricresyl phosphate and methyl isobutyl ketone/toluene (Table 3);
- Series 4: vinyl resin partially hydrolysed, phenolic/wood oil varnish, wood oil, tricresyl phosphate and methyl isobutyl ketone/toluene (Table 4).

The chemical composition of the corrosion-inhibitive pigments and extenders used in the shop primers is shown in Table 5. In all formulations 30 per cent of pigment and 70 per cent of binder (w/w) were used. The content of anticorrosive pigment was increased reducing the amount of extender to obtain CrO_3 concentrations of 4.5, 8.3 and 12.0 per cent of the total pigment content. For formulation reasons basic lead silico-chromate was used at only 4.5 per cent. To assess the barrier effect of the binder, a sample formulated exclusively with extender was included in each series.

The formulation of Series 3 shop primers included a vinyl resin highly resistant to outdoor conditions, the composition of which included vinyl chloride (91 per cent) and

Table 1
Composition of shop primers with binders based on chlorinated rubber (g/100 g)

	Samples							
	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
Basic zinc chromate	3.3	6.2	9.0					
Zinc tetroxochromate				7.5	13.9	20.0		
Basic lead silico-chromate							27.0	
Zinc oxide		0.6	1.3					
Red iron oxide	9.0	7.0	5.1	9.0	7.0	5.1	2.7	12.3
Barite	17.7	16.2	14.6	13.5	9.1	4.9		16.7
Aluminium estearate							0.3	1.0
Chlorinated rubber 20 cP	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
Plasticizer	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Solvents and thinners	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0

Table 2
Composition of shop primers with binders based on chlorinated rubber-phenolic varnish (g/100 g)

	Samples							
	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8
Basic zinc chromate	3.3	6.2	9.0					
Zinc tetroxochromate				7.5	13.9	20.0		
Basic lead silico-chromate							27.0	
Zinc oxide		0.6	1.3					
Red iron oxide	9.0	7.0	5.1	9.0	7.0	5.1	2.7	12.3
Barite	17.7	16.2	14.6	13.5	9.1	4.9		16.7
Aluminium estearate							0.3	1.0
Chlorinated rubber 20 cP/ phenolic varnish*	17.8	17.8	17.8	17.8	17.8	17.8	17.8	17.8
Plasticizer	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Solvents and thinners	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0

*Ratio 1/1 (w/w)

Table 3
Composition of shop primers with binders based on vinyl resins (g/100 g)

	Samples							
	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8
Basic zinc chromate	3.3	6.2	9.0					
Zinc tetroxochromate				7.5	13.9	20.0		
Basic lead silico-chromate							27.0	
Zinc oxide		0.6	1.3					
Red iron oxide	9.0	7.0	5.1	9.0	7.0	5.1	2.7	12.3
Whiting	17.7	16.2	14.6	13.5	9.1	4.9		16.7
Aluminium estearate							0.3	1.0
Vinyl resin	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9
Plasticizer	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Solvents and thinners	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0

Table 4
Composition of shop primers with binders based on vinyl resin-phenolic varnish (g/100 g)

	Samples							
	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8
Basic zinc chromate	3.3	6.2	9.0					
Zinc tetroxochromate				7.5	13.9	20.0		
Basic lead silico-chromate							27.0	
Zinc oxide		0.6	1.3					
Red iron oxide	9.0	7.0	5.1	9.0	7.0	5.1	2.7	13.2
Barite	17.7	16.2	14.6	13.5	9.1	4.9		16.7
Aluminium estearate							0.3	1.0
Vinyl resin/phenolic varnish*	14.3	14.3	14.3	14.3	14.3	14.3	14.3	13.4
Plasticizer	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Solvents and thinners	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0

*Ratio 1/1 (w/w)

Table 5
Chemical composition of pigments used in shop primer formulations

Type of pigment	Name	Chemical analysis (per cent by weight)								Charge materials (By difference)
		CrO ₃	ZnO	PbO	SiO ₂	Fe ₂ O ₃	CO ₃ Ca	SO ₄ Ba	MgO	
Corrosion-inhibitive	Zinc chromate	40.0	42.0							18.0
	Zinc tetroxychromate	18.0	48.0	10.0						24.0
	Basic lead silico-chromate	5.0		47.4	47.6					0.0
Extenders	Zinc oxide		17.8	0.3						81.9
	Red iron oxide				79.3					20.0
	Whiting						86.8		6.7	6.5
	Barite							72.9		27.1

vinyl acetate (3 per cent) and which was partially hydrolysed (2.3 per cent as vinyl alcohol). Hydrolysis improved the flexibility and adhesion characteristics of the film and its compatibility with other resins, but the film obtained did not have sufficient adhesion to enable the primer to be applied directly onto bare steel.

To overcome this difficulty it was added to the binder, a carboxylated resin containing vinyl chloride (86 per cent), vinyl acetate (13 per cent) and interpolymerized maleic acid⁸ (1 per cent).

The use of basic pigments produces a product of low stability during storage due to the reaction of the aforementioned carboxyl groups. To investigate gelation, an exhaustive study was carried out on the sequence of adding the pigments. The best results were obtained by dispersing the resin with whiting (calcium carbonate) for three hours and then the corrosion-inhibitive pigment was incorporated. Thus, the small residual alkalinity of the whiting contributed to partially neutralising the acidity of the medium.

Products with 6-8 months stability during storage were obtained without reduced film adhesion or anticorrosive properties.

The mixture prepared with partially hydrolysed vinyl resin and phenolic varnish (Series 4), made it unnecessary to add carboxylated resin, the object of the phenolic varnish being to improve adhesion to steel, flexibility and also to reduce the final cost of the primer.

The painted plates were exposed in two different environments: La Plata (35°54'27" S, 57°55'45" W) and Mar del Plata (38°08'17" S, 57°31'18" W), an area of low level industrial pollution and a marine area respectively.

The shop primer application was carried out by spraying onto steel plates of low carbon content (150 × 300 × 1 mm) with two different surface treatments (sandblasting and pickling); the purpose of this study was to investigate the influence of substrate roughness (Figure 1).

The plate was divided into two parts: on the lower part one coat was applied resulting in a dry film thickness of

20-25 microns; on the upper part two coats were applied and the final thickness was 40-45 microns.

Results and discussion

At the end of the exposure trials the plates were observed separately by two persons who judged, visually, the degree of corrosion of the metallic surface. The following evaluation scale was used:

Condition of the panel	Numerical "grades" (efficiency)
Completely rusted	0
Very rusted	2
Moderately rusted	4
Little rust	6
Very little rust	8
No rust	10

Trials in the marine environment

The results obtained at the Mar del Plata experimental station are summarised in Figures 2 and 3, and include the "efficiency" (numerical grades) for 6 and 12 months with respect to the different variables studied (surface treatment, type and concentration of corrosion-inhibitive pigment and nature of the binder).

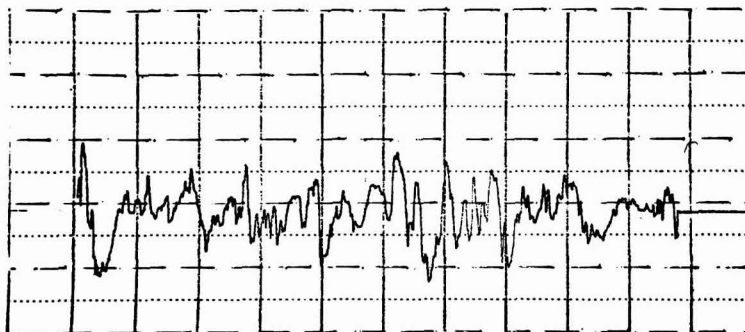
Mar del Plata experimental station is in an area with an aggressive environment with respect to corrosion and its avoidance; the samples were directly exposed to salt fog, as the sea was 20 metres from the racks. The chemical analysis of rainwater samples collected in containers made of an inert material showed a chlorine concentration of 120 ppm ± 10 and a pH of 6.1 ± 0.2.

The samples formulated with chlorinated rubber 20 cp did not protect the steel surface adequately since all the plates (shop primers 1.1 to 1.8) showed rust, irrespective of the type of pigment used (corrosion-inhibitive or extender), its concentration in the paint or the thickness of the film.

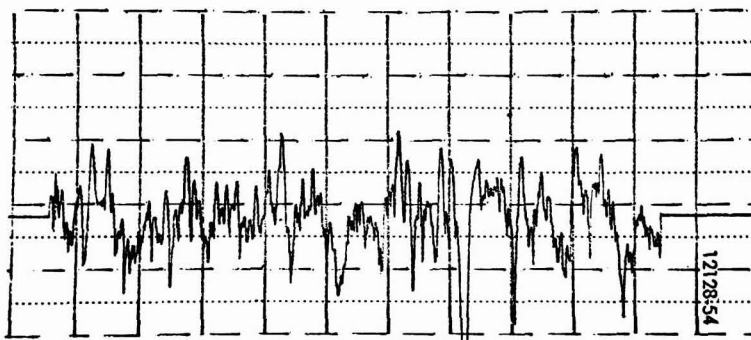
The incorporation of phenolic wood oil varnish to the binder improved the properties of the coating slightly since with a greater film thickness (40 μm) good results were

Table 6
Comparative solubility of corrosion-inhibitive pigments in different mediums

	Distilled water, g/litre			Sodium chloride solution 3%, g/litre		
	CrO ₄	ZnO	PbO	CrO ₄	ZnO	PbO
Zinc tetroxochromate	0.25	0.058		0.55	0.060	
Zinc chromate	0.76	0.002		1.67	0.016	
Lead chromate	0.028		0.067	0.028		0.060
Red lead			0.003			0.003
Basic lead silico-chromate			0.003			0.003



Pickled steel



Sandblasted steel

Figure 1. Roughness of the plates employed in the tests (influence of the method of surface preparation)

obtained with samples 2.5 (for 6 months), 2.6 and 2.7 (for 6 and 12 months).

These results confirm those obtained with shop primers in previous tests⁹ using an experimental raft immersed in sea water, where better performance was obtained for this type of binder compared to those containing chlorinated rubber only.

The samples formulated with vinyl resin had a greater resistance to corrosion than those of the two previous series. Formulations with zinc yellow showed good corrosion resistance after 12 months of outdoor exposure, "grades" of 6 (Little rust) having been achieved for the different pigment concentrations tested (samples 3.1, 3.2 and 3.3) (Figure 8).

Products containing zinc tetroxochromate provided satisfactory protection for one year in one of the samples (3.4) while the remaining samples of the series resisted corrosion for only 6 months (samples 3.5 and 3.6).

Samples prepared with basic lead silico-chromate and red iron oxide did not protect the surface adequately as their "grades" did not go higher than 4 (moderately rusted) after 6 months exposure.

When vinyl resin was partially replaced with phenolic varnish (1:1 w/w ratio) the protection of steel decreased. Satisfactory results after one year of outdoor exposure were only achieved in the case of zinc tetroxochromate at its maximum concentration (12.0 per cent of CrO₃) and in the case of lead silico-chromate.

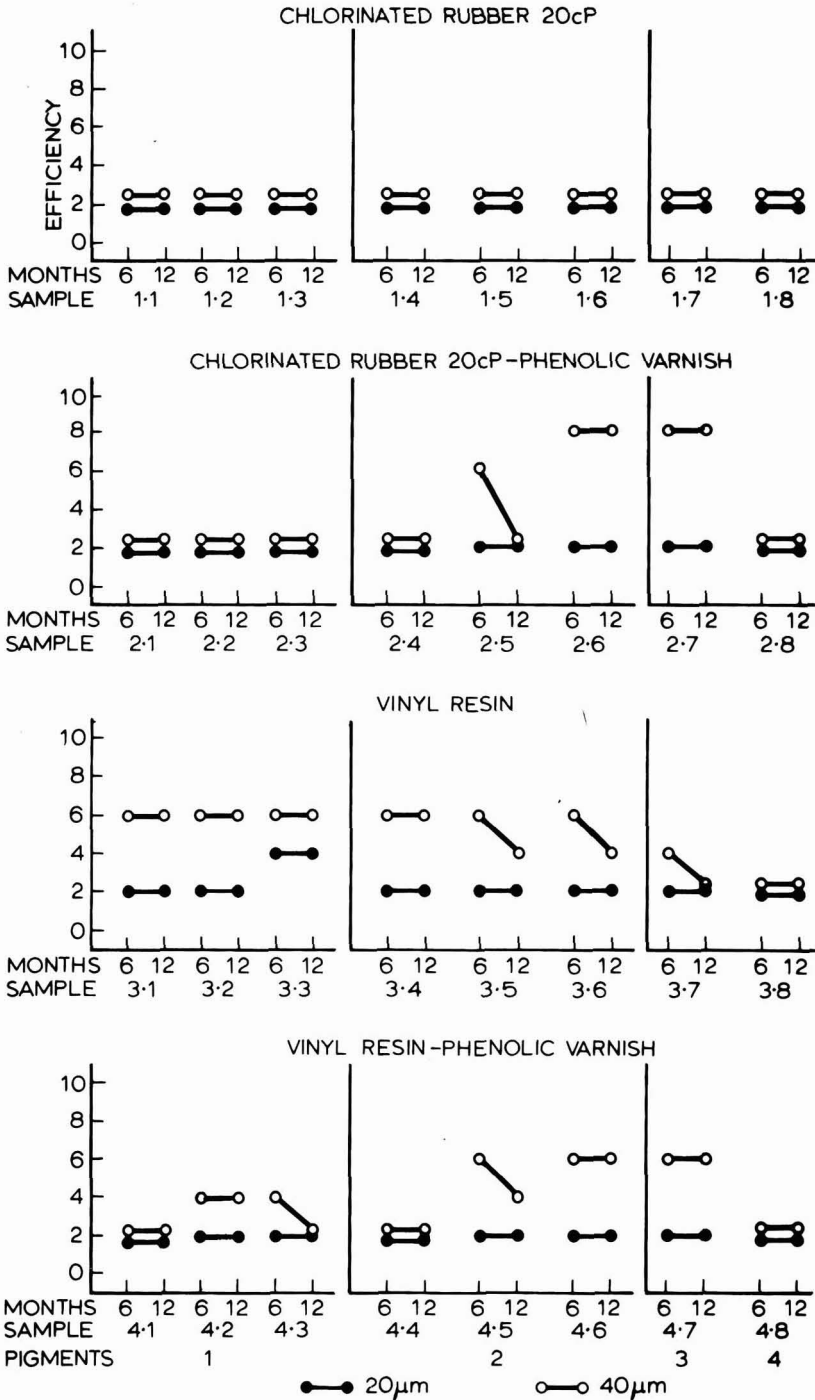


Figure 2. The anticorrosive efficiency of shop primers in a marine environment. Pigments: 1 zinc chromate, 2 zinc tetroxychromate, 3 basic lead silico-chromate and 4 red iron oxide. Pickled steel

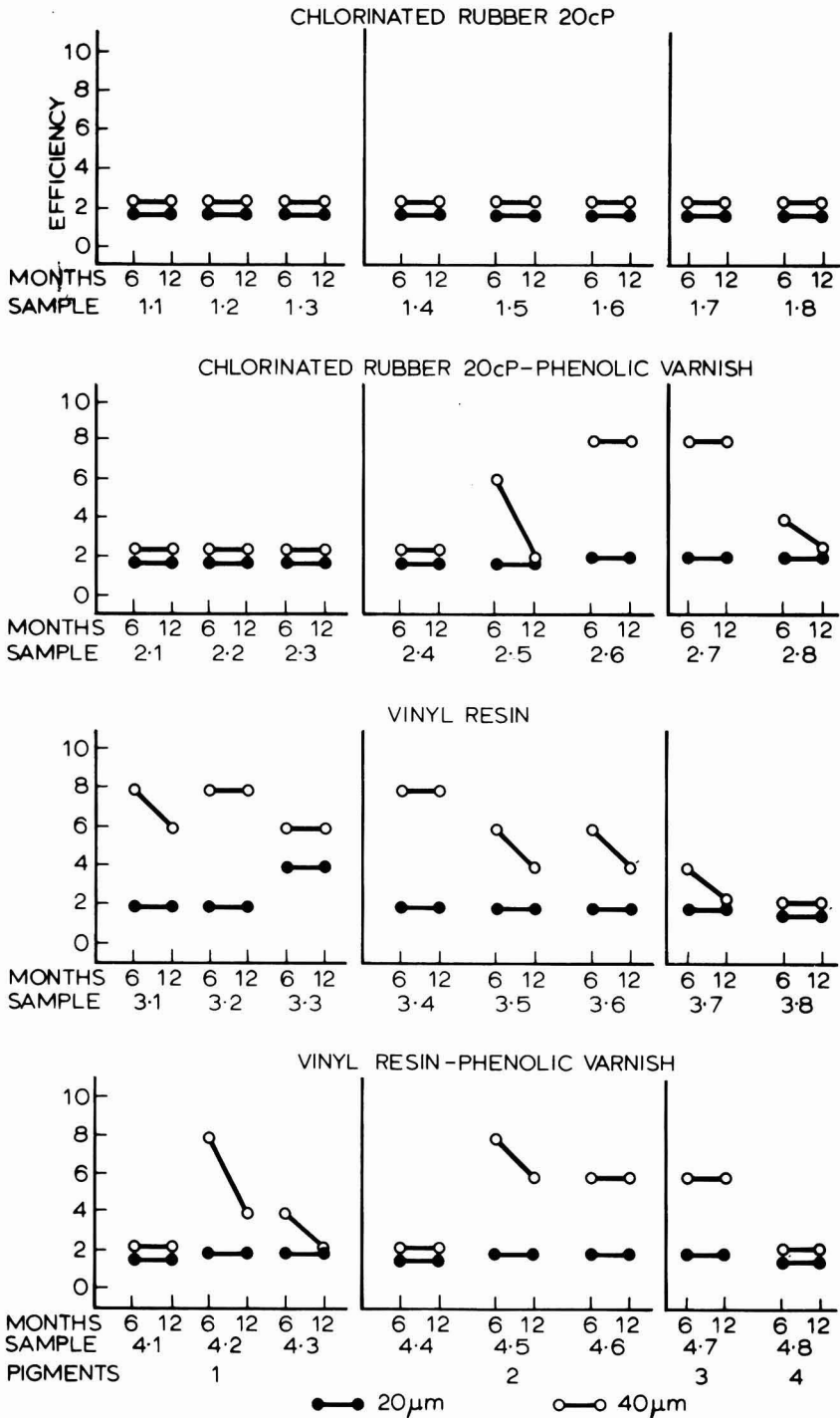


Figure 3. The anticorrosive efficiency of shop primers in a marine environment. Pigments: 1 zinc chromate, 2 zinc tetroxychromate, 3 basic lead silico-chromate and 4 red iron oxide. Sandblasted steel

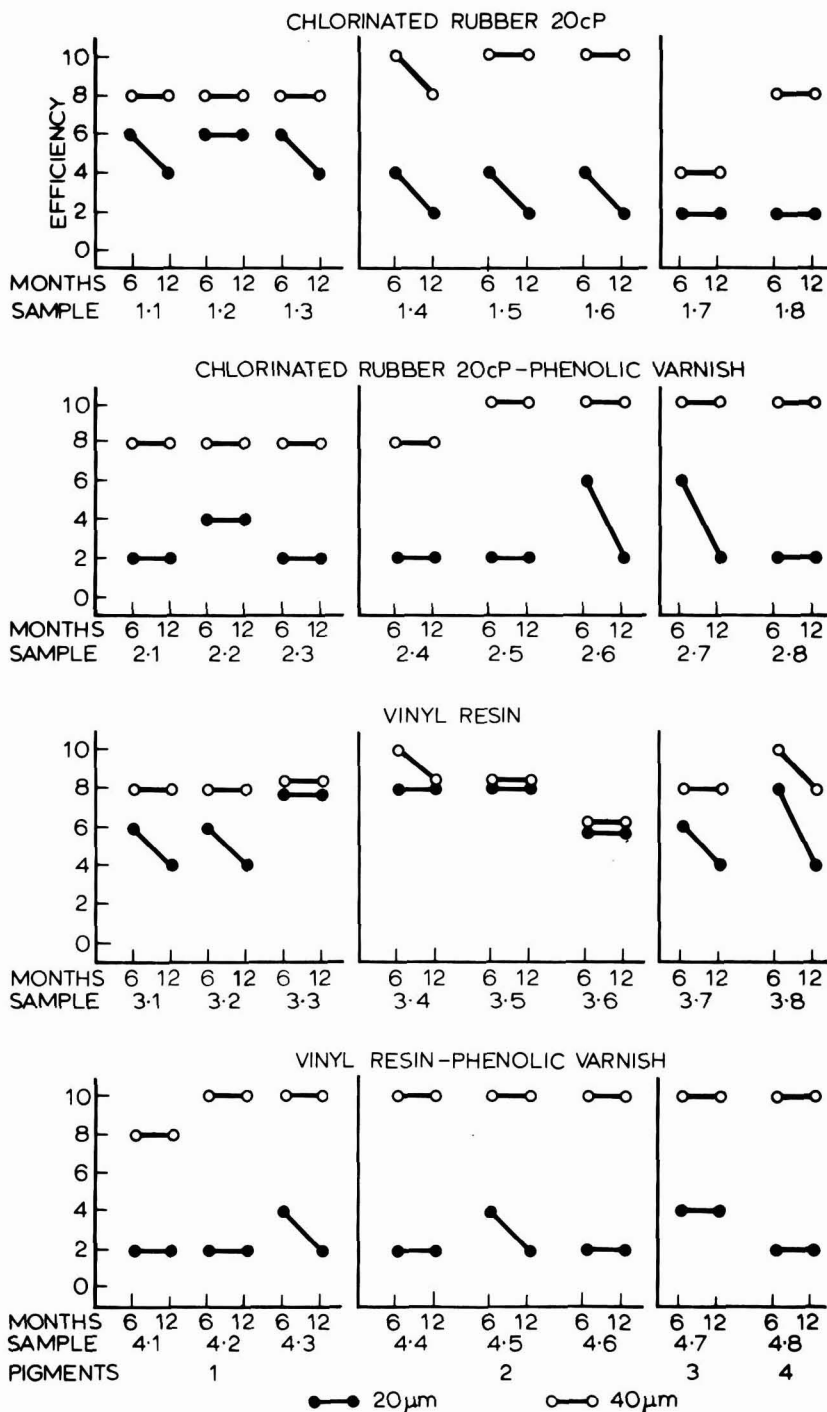


Figure 4. The anticorrosive efficiency of shop primers in a low level industrial pollution environment. Pigments: 1 zinc chromate, 2 zinc tetraoxychromate, 3 basic lead silicochromate and 4 red iron oxide. Pickled steel

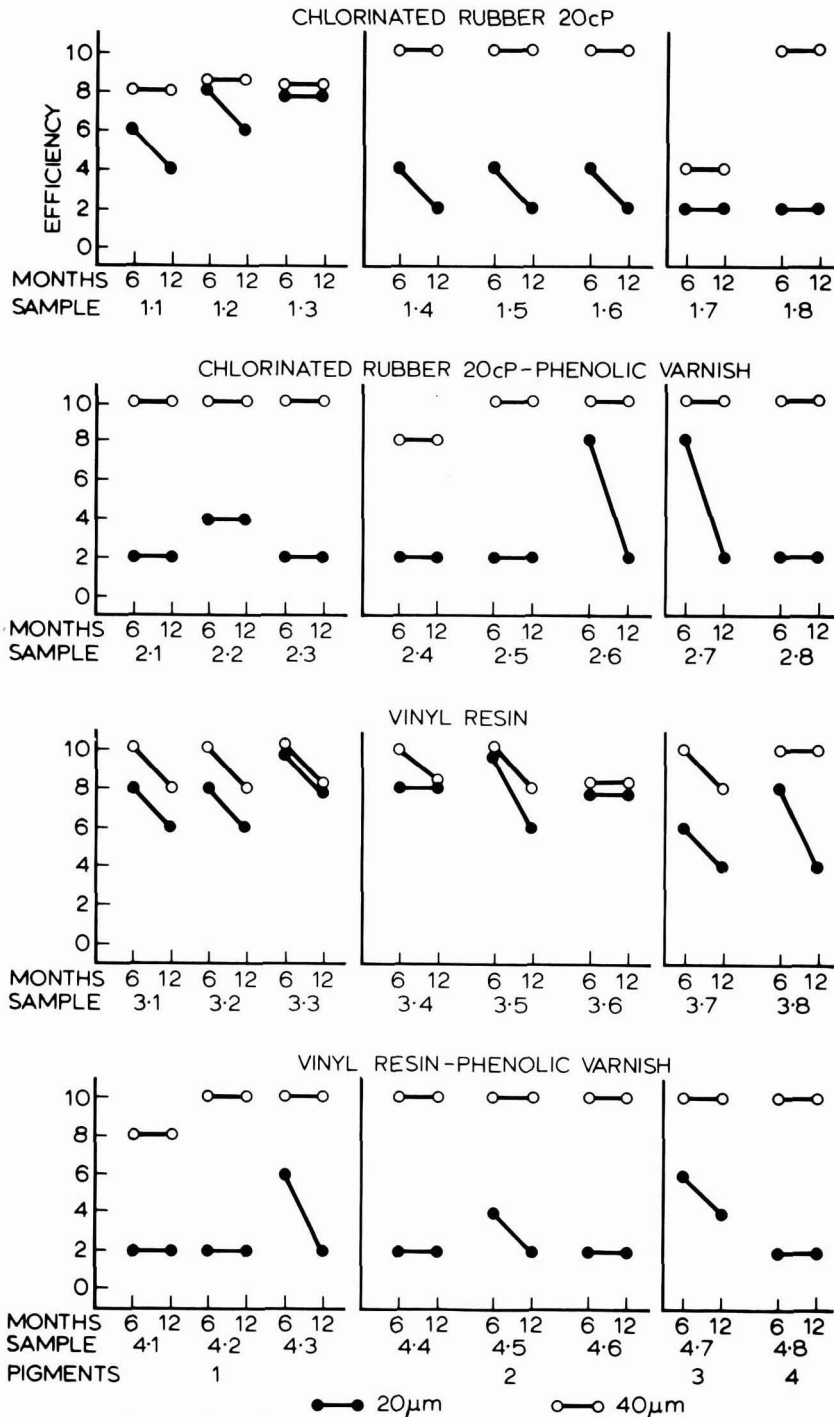


Figure 5. The anticorrosive efficiency of shop primers in a low level industrial pollution environment. Pigments: 1 zinc chromate, 2 zinc tetroxychromate, 3 basic lead silicochromate and 4 red iron oxide. Sandblasted steel

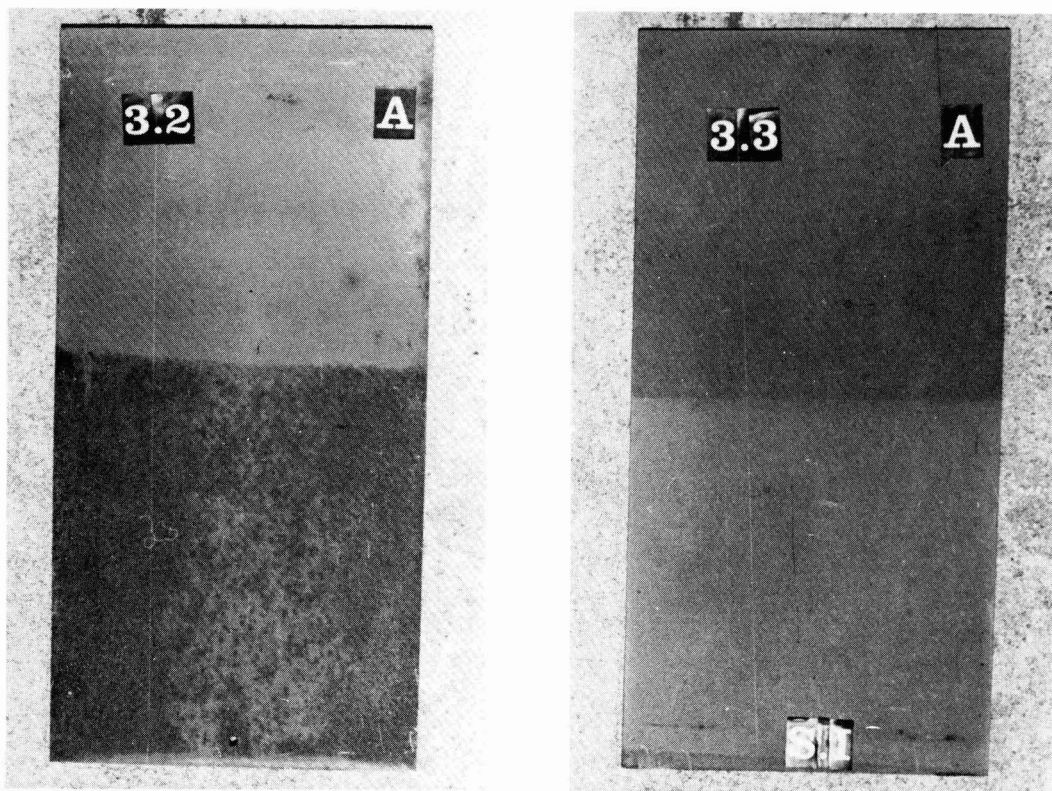


Figure 6. Behaviour of a shop primer prepared with vinyl resin-zinc chromate after 12 months outdoor exposure in a marine environment (left) and a low level industrial pollution environment (right). Upper half of plate, film thickness $40\mu\text{m}$, lower half $20\mu\text{m}$

Basic lead silico-chromate includes in its composition equal parts of basic lead chromate ($\text{PbCrO}_4 \cdot \text{PbO}$) and basic lead silicate ($\text{PbSiO}_3 \cdot 3\text{PbO}$). The basicity of these compounds suggests the possibility of the formation of soaps with the acid components of certain binders such as phenolic varnish and thus increasing the impermeability of the dry film^{10,11}.

The results obtained with shop primers formulated with this pigment seem to confirm the above. Anticorrosive performance is better, after 12 months exposure and at a film thickness of 40 microns, with reactive binders such as chlorinated rubber-phenolic varnish or vinyl resin-phenolic varnish ("grades" 8 and 6 respectively) than with chlorinated rubber and vinyl binders ("grade" 2 in both cases).

Shop primers formulated with an inert pigment such as red iron oxide (samples 1.8, 2.8, 3.8 and 4.8) and the binders already mentioned did not produce a film with good protective properties. This indicates that the barrier effect was insufficient, at the low thickness of shop primer film (20 microns), to protect the metallic substrate in the highly corrosive conditions of the marine environment.

Film thickness is a very important variable and the analysis of the results shows that it is necessary to apply a film thickness greater than 20 microns to obtain good

protection of steel in an environment as aggressive as a marine one.

Under these marine conditions no differences were noticed for the two surface treatments used (pickling or sandblasting).

The low level industrial pollution environment

The results obtained in La Plata's experimental station are summarised in Figures 4 and 5. The chemical analysis of rain water samples collected showed a concentration of chlorides of $10 \text{ ppm} \pm 3$ and a pH of 6.5 ± 0.3 .

The shop primers formulated with chlorinated rubber showed satisfactory results at a film thickness of 40 microns both when zinc yellow (samples 1.1, 1.2, 1.3) and zinc tetroxychromate (samples 1.4, 1.5, 1.6) were used. Similar results were obtained in samples with chlorinated rubber-phenolic varnish binder, with "grades" of 8 which corresponds to a Very low rusting level (samples 2.1 and 2.7).

With vinyl resin as the binder good protection was obtained with all the pigments tested when shop primers were applied in two coats (40 microns). With one coat (20 microns) good results were achieved after 12 months exposure only with samples 3.3, 3.4, 3.5 and 3.6. Using vinyl resin phenolic varnish (also 20 microns) satisfactory results were obtained with samples 4.1 to 4.6

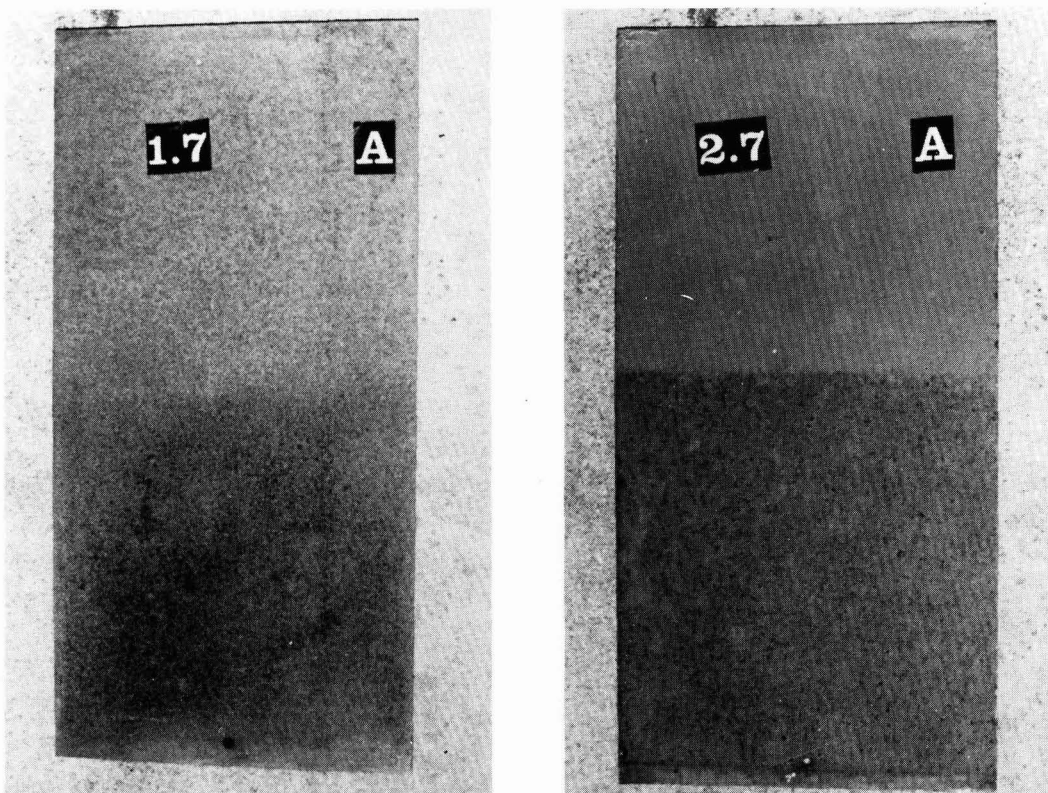


Figure 7. Behaviour of shop primers formulated with chlorinated rubber (20 cP) – basic lead silico-chromate (left), and chlorinated rubber (20 cP) – phenolic varnish – basic lead silico-chromate (right) after 12 months exposure in a marine environment. Upper half of plate, film thickness 40 μ m, lower half 20 μ m

Basic lead silico-chromate showed better results when the binder formulation included phenolic varnish.

In the marine environment samples formulated with red iron oxide gave good protection at a film thickness of 40 microns.

Conclusions

1. Influence of pigment concentration: No significant performance differences were noted between the three concentrations of soluble corrosion-inhibitive pigments studied (4.5, 8.3 and 12.0 per cent CrO₃).
2. Influence of the type of binder: The best results were obtained with vinyl resin binders and the incorporation of phenolic varnish into this binder improved the anticorrosive properties of some of the samples. Chlorinated rubber used alone or with phenolic varnish was not adequate as a binder for shop primers for steel in a marine environment; good results were obtained with this binder (40 microns thickness) in La Plata, the area of low level industrial pollution.
3. Influence of surface preparation: Using new rust free plates, surface preparation had no influence on the results obtained as dry film thickness and environmental conditions proved overwhelming in their effects.
4. Behaviour of basic lead silico-chromate: This pigment

protects steel surfaces when it is used with acid binders (e.g. vinyl resin-phenolic varnish or chlorinated rubber-phenolic varnish) due probably to the formation of insoluble soaps which increase the impermeability of the film.

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Phosphate pretreatments for mild steel

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Summary

It is well known that the proper preparation of a metal surface (pretreatment) prior to the application of a protective system, enhances the life of the latter. Chemical conversion coatings is one such class of pretreatment. This paper deals with the phosphating process wherein a well adhered layer of phosphate film is formed on a steel surface. The paper discusses the effects

of varying parameters such as composition of the bath, temperature and immersion time on the weight/thickness of the phosphate film. Operating conditions were determined which would produce a range of coating weights. Results of laboratory tests and natural weathering tests are included for the different ranges of coating weights.

Keywords

Processes and methods primarily associated with surface preparation before coating phosphate treatment

Types and classes of structures or surfaces to be coated steel

Pré-traitements phosphatiques pour acier doux

Résumé

Il est bien connu que la préparation soignée de la surface métallique avant l'application du traitement de protection choisi, prolonge la vie du système de protection. Les peintures primaires réactives constituent un des genres de pré-traitement éventuels. Cet exposé s'occupe du processus de phosphatation où une bien adhérente couche de phosphate se forme sur la surface de l'acier. L'exposé traite également de l'influence

qu'exercent divers paramètres tels que la composition de la cuvette, la température et la durée du traitement sur le poids et l'épaisseur du film de phosphate. On a déterminé les conditions opératoires en vue d'obtenir des couches de divers poids. On présente les résultats des essais laboratoires et également aux intempéries à l'égard de ces couches de divers poids.

Phosphatschutze für niedriggekohnten Stahl

Zusammenfassung

Es ist wohlbekannt dass richtige Zubereitung der Metalloberfläche, die vor dem Auftragen der gewählten Schutzvorbereitung durchgeführt wird, die Dauer des Schutzsystemes verlängert. Haftgrundmittel bilden eine der Vorbereitungsstufe. Dieser Vortrag befasst sich mit dem Phosphatierungsverfahren, wobei eine auf der Stahloberfläche wohlanklebende Phosphatschicht gebildet wird. Dieser Vortrag beschäftigt sich mit der Wirkung der solchen verschiedenen

Parameter als der Zusammensetzung des Kufeinhalts, der Temperature und der Dauer der Zubereitung, auf die Dicke oder das Gewicht der Phosphatschicht. Betriebsvoraussetzungen, wodurch man Schichten verschiedener Gewichte bekommt, wurden bestimmt. Resultate von Labor- und Bewitterungsprüfungen wurden auf Schichten verschiedener Gewichte festgestellt.

Introduction

Refs. 1-8, 17, 18

It is well known that the life of any protective system coating a metal depends to a considerable extent on the care and efficiency with which the metal substrate is prepared (pretreatment). Phosphating is one such pretreatment process. In this process the metal, generally iron or steel, is kept in contact with a hot solution (either by immersion or by spraying) which contains zinc, manganese or iron phosphates either alone or in combination as a major constituent of the phosphating solution. The above treatment results in the formation of an inert layer on the surface of the metal¹⁻⁴. The effectiveness of the coating thus obtained depends, apart from its chemical composition, upon the crystal structure and coating weight which are governed by parameters such as, immer-

sion time, temperature, pointage*, pH etc. of the phosphating bath^{5,6}. On the basis of their coating weights these coatings have been divided into four types⁷ i.e. extra light weight, light weight, medium weight and heavy weight. The extra light weight and light weight coatings have coating weights ranging from 0.2-1.5 g/m² and 1.5-4.5 g/m² respectively and a heavy coating is one with a weight of more than 7.5 g/m² while the medium weight coatings come in the coating weight range of 4.5-7.5 g/m². The numerous applications^{5,8} to which these coatings have been put can also be categorized on the basis of their coating weights. The heavier coatings may be used unsealed in oil or oil/grease surroundings while the lighter ones are usually used as a pretreatment prior to painting⁸. Light medium weight phosphate coatings are usually produced from zinc based solutions and are mainly specified as pretreatments for paints and organic finishes, while the heavier coatings can be obtained from

*Pointage: A measure of total acidity of a phosphating solution, as indicated by the number of millilitres of 0.1N sodium hydroxide solution required to neutralise 10 ml of the phosphating solution, using phenolphthalein as indicator^{17,18}.

zinc, manganese or iron based solutions. Manganese based coatings give better protection against wear when sealed and lubricated, as they act as good lubricant carriers⁸.

This paper deals with the development of the phosphating process employing zinc as the major cation in the phosphating bath. The effectiveness of the developed heavy weight coatings (unsealed and sealed with oil) was assessed by laboratory and accelerated weathering tests as well as outdoor exposure studies.

Experimental

Refs. 7-12

Preparation of the steel panels

Mild steel panels (sizes 150 × 100 × 1.25 mm and 150 × 65 × 1.25 mm) were first pickled in 10 per cent sulfuric acid at about 50°C and then washed thoroughly in running water. The panels were then allowed to dry under laboratory conditions for about 24 hours. Any superficial rust was removed by rubbing with fine emery paper. The panels were further cleaned with benzene and acetone and dried.

Phosphating

The panels were phosphated by the dipping process using zinc as the major cation in the phosphating bath. The process was carried out under different conditions obtained by varying the concentration of the bath solution, the temperature of the bath and the immersion time in the phosphating solution. The studies were carried out by varying the pointage of the bath solution between 20 and 40, and the temperature between 40° and 70°C. The maximum time for phosphating (in the bath) was 30 minutes. After the above treatment the panels were washed with tap water followed by demineralized water and then heat dried. A thorough washing was carried out to remove the treatment chemicals from the phosphated surface and thus avoid any chance of corrosion from this source⁹.

In phosphating processes it has been general practice to rinse finally with a chromate solution at the end of the phosphating treatment^{10,11}. This no doubt enhances the protective properties but in the present investigation it was decided to restrict the development work to phosphating alone.

Test for the presence of phosphate coating

The following test, as specified in British Standard Specifications⁷, was performed to ensure that the coating obtained was a phosphate coating: The reagent used for this was a freshly prepared solution obtained by mixing 8 g of ammonium molybdate (in 80 ml of water) and 12 ml of concentrated hydrochloric acid, with 20 g of ammonium chloride and 10 ml of saturated potassium persulphate. One drop of the above reagent was added to the test surface. The appearance of a blue colour within 30 seconds indicated the presence of a phosphate coating. A control was carried out using an untreated panel.

Determination of coating weight

The thickness of the phosphate layer obtained under various conditions is generally reported in terms of the coating weight, this was determined using the following method⁷: A weighed panel was immersed in a freshly prepared solution of antimony trioxide in concentrated hydrochloric acid (20 g/l) at room temperature until the coating dissolved. A period of 5 minutes was normally found to be sufficient. The panel was then removed from the solution and washed for about 30 seconds in running water. Any non adherent matter was removed by rubbing and was again washed under running water. The sample was then dried and weighed. The weight of the phosphate coating was calculated by using the following formula¹²:

$$\text{coating weight} = a/2 \times xy \text{ g/m}^2$$

where:

$$xy = \text{area of the specimen (m}^2\text{)}$$

$$a = \text{loss in weight in g}$$

Methods of assessment

Refs. 13-15

The phosphated panels with coating weights of 7.5 g/m² and above were used to evaluate the degree of protection from corrosion afforded by the phosphate coating, as panels with coating weights less than 7.5 g/m² are generally used under organic coatings. The process conditions used along with the coating weights obtained are shown in Table 1. These processes have been designated P-1, P-2, P-3 and so on. Samples of the above treated panels, with and without a layer of inhibiting oil together with un-phosphated panels were subjected to laboratory and accelerated weathering tests as well as to natural weathering. Potential time measurement studies were also carried out using mild steel and tor steel† bars.

Laboratory tests

Humidity cabinet and salt spray tests were carried out in accordance with IS specifications^{13,14}. In the humidity cabinet¹³ there was 100 per cent relative humidity and the temperature varied from 42° to 48°C. The time required for both heating and cooling was approximately the same. In the salt spray test 5 per cent sodium chloride solution was sprayed instead of the salt solution composition given in the IS specifications¹⁴.

Accelerated weathering tests

These tests were carried out in a Twin Arc Weatherometer using both an alternate wetting and drying cycle (102-18), i.e. 102 minutes of UV light followed by 18 minutes of water spray and light. The black panel temperature i.e. the temperature of the paint film as recorded in the weatherometer was 65°C. The panels were examined at intervals of 20 hours.

Natural weathering

Panels were exposed on the terrace of the Central Building

†Tor steel: Mild steel bar deformed whilst hot to provide lugs and ribs on the surface of the bar, IS:1139-1966 and then twisted when cold, IS:1786-1966, no further heat treatment is performed on the steel. Composition of the mild steel used conforms to IS:226-1962.

Table 1
Conditions of the different phosphating processes used

Sample No.	Operating Temperature ($\pm 1^\circ\text{C}$)	Pointage of phosphating bath	Coating weight (g/m^2)	Designated process No.
1	50	30	9.5 – 10.0	P-1
2	60	30	5.0 – 6.0	P-2
3	60	30	13.0 – 14.0	P-3
4	60	30	17.0 – 18.0	P-4
5	70	30	14.0 – 15.0	P-5
6	70	30	20.0 – 21.5	P-6
7	60	20	12.5 – 13.5	P-7
8	60	40	14.0 – 15.0	P-8
9	60	40	20.5 – 21.5	P-9

Research Institute in racks facing south at an angle of 45° . The panels were examined every month for their performance.

Potential time measurements

Potential time measurement¹⁵ studies were carried out using mild steel and tor steel bars 150 mm in length and 10 mm in diameter. These bars were cleaned and phosphatized following the procedure reported earlier. They were then dipped in 3 per cent sodium chloride solution. The potential of the specimen versus saturated calomel electrode (SCE) was measured using a Vibrating Reed Electrometer – "CARRY-31". The potentials were recorded at smaller intervals in the beginning and thereafter daily.

Results and discussion

Refs. 6, 8, 17-20

The coating weights obtained by varying the temperature and time of immersion, and the pointage and time are reported in figures 1 and 2 respectively. A few systems in which the coating weight was more than $1.5 \text{ g}/\text{m}^2$ (Table 1) were chosen to evaluate the efficiency of the corrosion protection afforded; with and without a layer of inhibiting oil. The results of the salt spray, humidity cabinet and weatherometer tests as well as the outdoor exposure studies are shown in Table 2. The data obtained from the potential time measurements³ are shown in Table 3.

A wide range of coating weights ($1.5 - 21.0 \text{ g}/\text{m}^2$) could be obtained by raising the temperature of the phosphating bath from 40° to 70°C . The above mentioned range of coating weights covers most of the studies reported in the literature for the pretreatment of mild steel prior to the application of a further protective system. That is why the studies reported in this paper were not carried out beyond 70°C . It is seen from Figure 1 that the coating weights obtained for a particular time increased four or five fold when the temperature of the bath was raised from 40° to 70°C . The increase in coating weight was very slow up to 40°C , it became faster from 40° to 60°C and then became comparatively slow again (Figure 1).

There was a noticeable effect on the coating weight as a result of a change in pointage of the phosphating bath. It almost doubled if the pointage was increased from 20 to 40 (Figure 2). Somewhat similar increments in the coating weights were obtained if the temperature of the bath was raised while the pointage was kept at a lower level e.g. 40 P at 60°C and 30 P at 70°C (figures 1 and 2).

There was an increase in the coating weight with an increase in processing time irrespective of temperature and pointage of the phosphating bath solution, though it was not uniform. In the beginning the reaction was slow (figures 1 and 2).

The reaction started with the attack of the metal surface by the free phosphoric acid present in the phosphating bath forming soluble primary iron phosphate. The con-

Table 2
Comparison of protective value of various phosphate coatings

Process No.	Corrosion tests			
	Humidity cabinet (1000 hrs)	Salt spray (100 hrs)	Weatherometer (200 hrs)	Outdoor exposure (3 months)
1	9	3	8	3
2	4	1	3	1
3	10	6	9	6
4	10	8	10	7
5	6	2	4	1
6	8	3	7	2
7	10	5	8	4
8	10	3	8	1
9	10	4	9	5
10 (untreated oiled)	1	1	1	1
11 (untreated)	1	1	1	1

1 = General heavy rusting, 5 = rust in a small number of spots, 10 = No rust

Table 3
Potential time measurements in 3 per cent sodium chloride solution

Time (days)	Mild Steel Coating weight (g/m ²)				Tor Steel Coating weight (g/m ²)			
	0.0-0.0	7.0-8.0	13.0-14.0	17.0-18.0	0.0-0.0	7.0-8.0	13.0-14.0	17.0-18.0
	mV versus SCE				mV versus SCE			
Initial reading	-.60	-.60	-.58	-.62	-.64	-.64	-.62	-.63
1	-.72	-.67	-.64	-.63	-.72	-.67	-.66	-.66
3	-.74	-.70	-.67	-.64	-.74	-.70	-.69	-.68
7	-.72	-.70	-.69	-.67	-.75	-.73	-.71	-.70
14	-.73	-.70	-.69	-.68	-.75	-.73	-.72	-.71
21	-.71	-.72	-.70	-.70	-.73	-.73	-.72	-.72
28	-.71	-.72	-.70	-.71	-.73	-.73	-.72	-.72

sumption of free acid by the metal surface lowered the solubility of the zinc phosphate in solution causing some to crystallize out on the surface of the metal, this formed the zinc phosphate coating which consisted mainly of insoluble tertiary metal phosphates^{6,17}. Ferric phosphate sludge formed during the above reaction and its saturation at all temperatures and pointages plays an important role in coating formation¹⁷. On the other hand, when a particular coating thickness was obtained on the metal surface the reaction became slow because, for a particular bath composition and operating temperature, there exists only one maximum coating weight which can be obtained in a given time; any further processing time does not significantly increase coating weight¹⁸. In these preliminary studies it was found that if the immersion time was increased from 30 to 60 minutes the coating weight increase was not appreciable. So the studies were restricted to 30 minutes immersion time.

The results of the potential time measurement studies are shown in Table 3. The untreated mild steel and tor steel bars started rusting 4 to 8 hours after immersion in 3 per cent sodium chloride solution. At the end of one day their potentials were found to be 0.72 mV when measured against a saturated calomel electrode (SCE). At this stage brown corrosion product was found to have settled at the bottom and the rods were also covered in corrosion product. There was no sign of any corrosion on the phosphated bars nor was the salt solution brown. Signs of corrosion were noticed on the phosphated bars and also in the salt solution after different periods of immersion. In all such cases i.e. when rusting was first observed, the poten-

tial of the bars was 0.72 to 0.73 milivolts with reference to the SCE. If the time taken in reaching this potential^{19,20} is taken as a criterion for evaluating the protective efficiency of the coating then it can be inferred from the above that the effectiveness of the coating is increased with increase in coating weight. The different coating weights were obtained by varying the processing time only and by keeping the pointage, temperature etc. constant. This was true for mild steel as well as for the tor steel bars. There is a comparatively faster change in potential in the case of tor steel as compared to mild steel. It therefore appears that corrosion will take place faster in the case of tor steel. The above conclusions are also supported by the visual observations made.

It is generally assumed that the higher the coating weight of the phosphate layer the greater will be its protective value, but in fact it is not purely a matter of coating weight. Chemical nature and degree of porosity (uncoated spots) are other factors which govern the protective value of a coating^{8,17}. Keeping this in mind, coatings obtained from the different phosphating processes (Table 1) were evaluated for their corrosion protection efficiency (Table 2).

On comparing the performance of coatings obtained from processes P-1, P-2, P-3 and P-4, it was found that the corrosion protection efficiency increased with increase in coating weight, provided that the increase was a function of time only i.e. providing that the other parameters governing the phosphating process were kept constant. The effectiveness of the coatings obtained from phosphat-

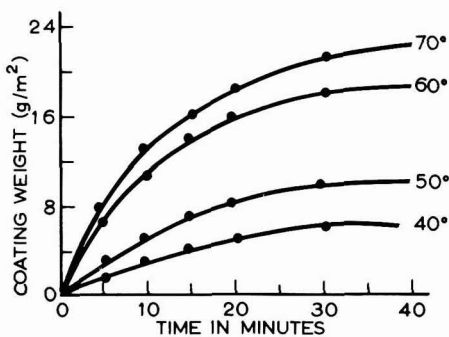


Figure 1. Effect of temperature of the phosphating bath on the coating weight

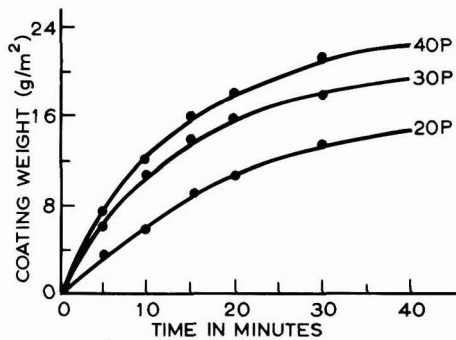


Figure 2. Effect of pointage of the phosphating bath on the coating weight

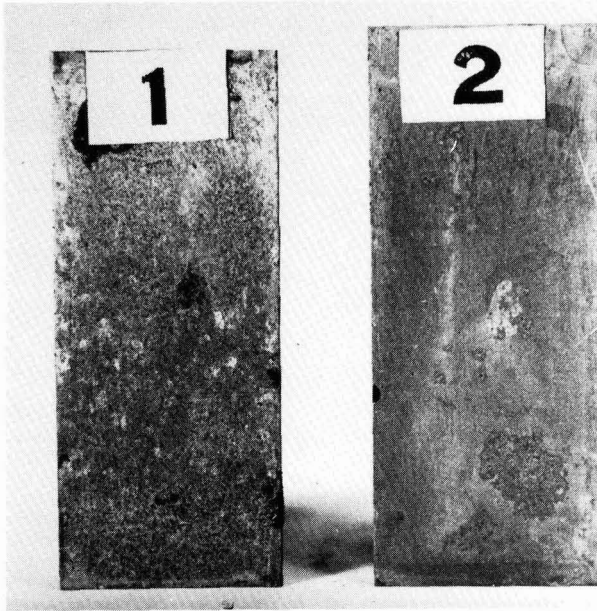


Figure 3. Weatherometer test (200 hrs); Panel 1 Process - 10, Panel 2 Process - 2

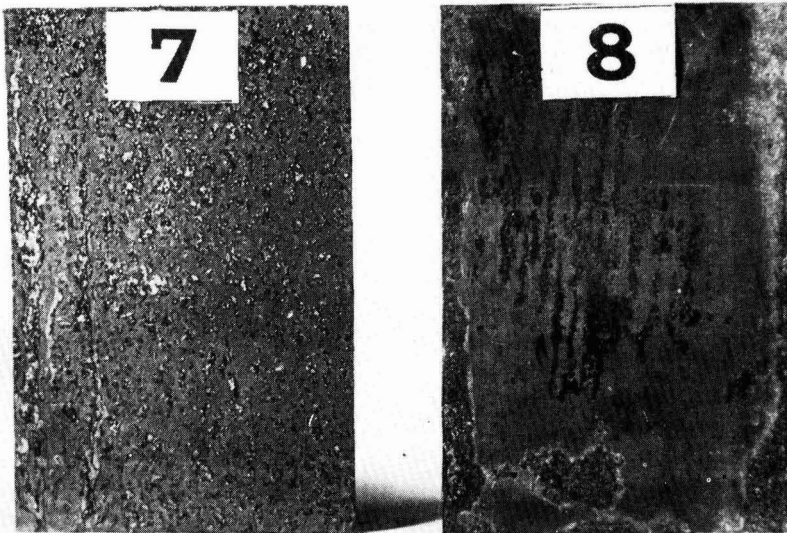


Figure 4. Salt spray test (100 hrs); Panel No. 7 Process - 10, Panel No. 8 Process - 2

ing processes P-5, P-6 (figures 9 and 10) and P-8, P-9 (figures 7 and 8) indicate a similar trend. Furthermore, from the results of the coatings obtained from processes P-6 (figures 9 and 10) and P-9 (figures 7 and 8), it was found that the corrosion protection of the coatings obtained from the latter processes (with smaller coating weights) was better than for those of the former which had

higher coating weights. Therefore, coating weight is not the only factor affecting the protective value of a coating, although thicker coatings help to provide a reserve of material against corrosive attack¹⁸.

Coatings obtained from processes P-3, P-5, P-7 and P-8 have almost similar coating weights (12.0 -



Figure 5. Weatherometer test (200 hrs); Panel No. 3 Process - 3, Panel No. 4 Process - 4

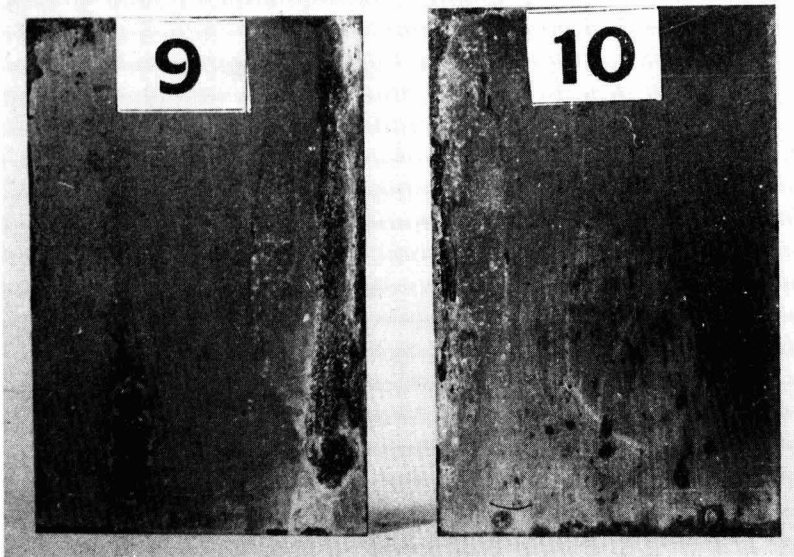


Figure 6. Salt spray test (100 hrs); Panel No. 9 Process - 3, Panel No. 10 Process - 4

14.0 g/m²), though obtained under different conditions of temperature, pointage and time. Comparing the protective values of these coatings, it was found that P-3 (figures 5 and 6) gave the best results followed by P-7 (figures 9 and 10), P-8 (figures 7 and 8) and P-5 (figures 9 and 10) thus indicating the remarkable effect of temperature and pointage on the protective value of the coatings. The

increase in temperature or pointage produced coatings of better quality up to a certain limit, after which their effects were reversed. Also, if the pointage of the bath was low then the reaction was slow and thus required more time to achieve a certain coating weight, P-3 and P-4 (figures 5 and 6). With higher pointage the time required to obtain similar coating weights decreased but this was at the cost

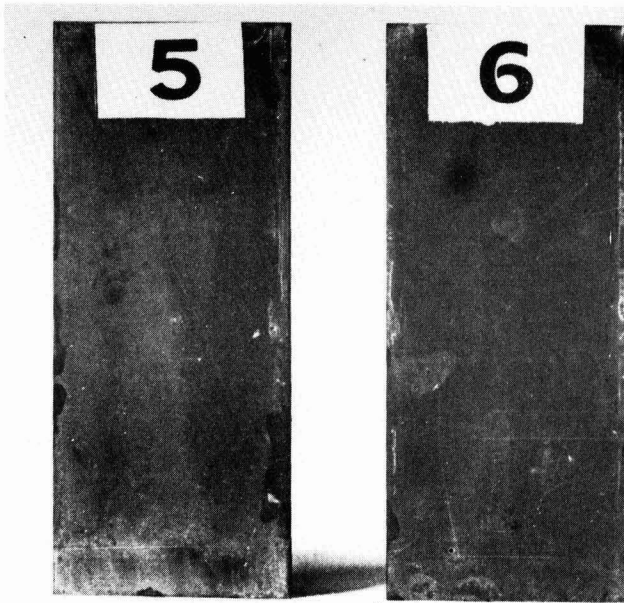


Figure 7. Weatherometer test (200 hrs); Panel No. 5 Process - 8, Panel No. 6 Process - 9

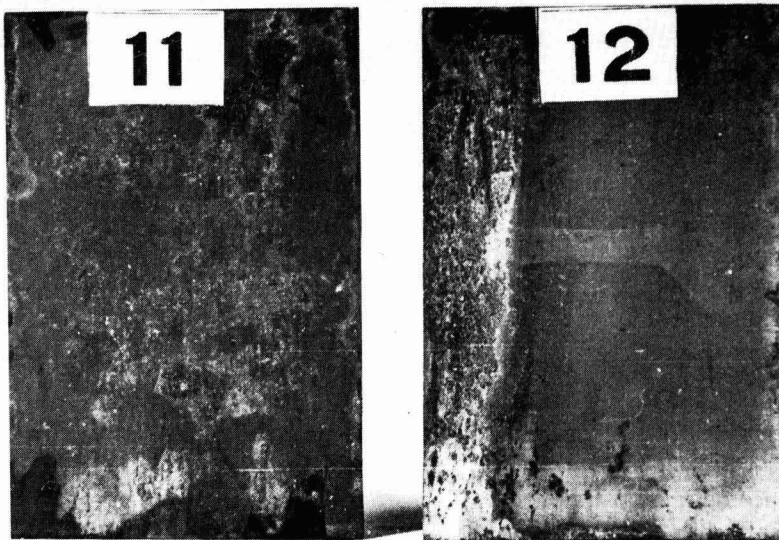


Figure 8. Salt spray test (100 hrs); Panel No. 11 Process - 8, Panel No. 12 Process - 9

of a decrease in protective efficiency, P-3 (figures 5 and 6) and P-5 (figures 9 and 10). It can, therefore, be inferred that the corrosion protection efficiency of the phosphate layer also depends upon the free acid content of the phosphating bath.

Similarly, if the results of changes in temperature of the

phosphating bath are compared, it is found that low temperatures are unsatisfactory as they require longer to produce a particular coating thickness, irrespective of their protective value. This became evident when processes P-1, P-3, P-4 and P-6 were compared. The effectiveness of the coating obtained from process P-1 is comparable to that of the coatings obtained from processes P-3, P-4

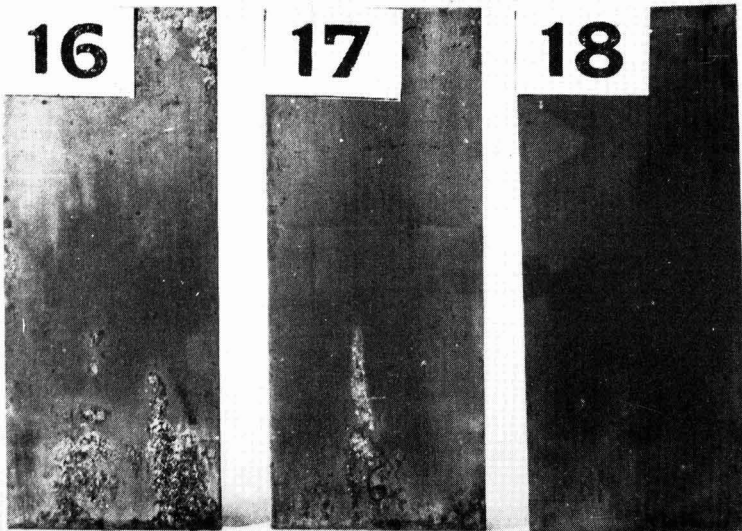


Figure 9. Weatherometer test (200 hrs); Panel No. 16 Process - 5, Panel No. 17 Process - 6 and Panel No. 18 Process - 7

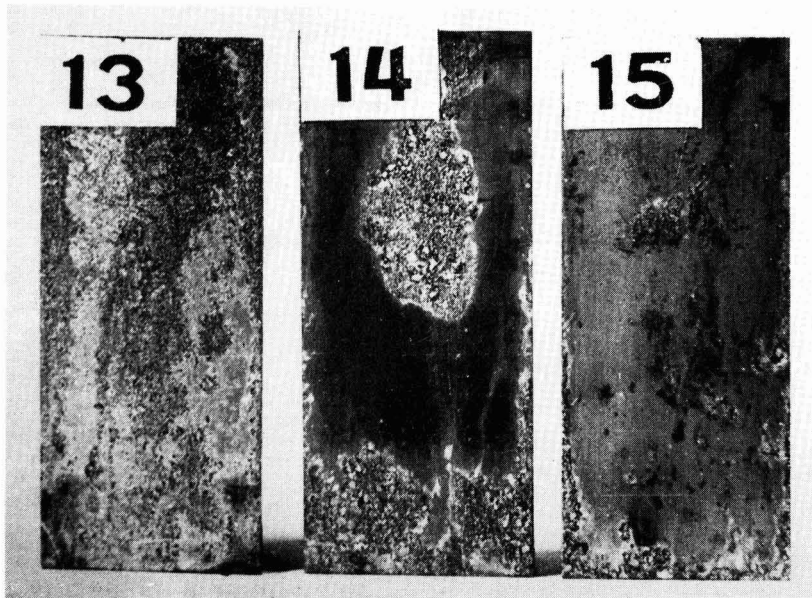


Figure 10. Salt spray test (100 hrs); Panel No. 13 Process - 5, Panel No. 14 Process - 6 and Panel No. 15 Process - 7

(figures 5 and 6) and P-6 (figures 9 and 10), although the latter have lower coating weights. Process P-1 can perhaps produce better results at the higher coating weights obtained with longer processing time. On the other hand a higher temperature produced coating P-6 (figures 9 and 10) whose corrosion protection value was inferior to that of coatings obtained at lower temperatures, P-1, P-4

(figures 5 and 6). Lower phosphating temperature is also useful from another consideration e.g. the pretreatment of large fabricated objects. Such objects could be phosphated by spraying or brushing with the phosphatizing solution at a somewhat higher temperature. When the object cools somewhat to 50 - 60°C the steel would then become phosphated.

The pointage, temperature, nature of the major cation of the phosphating bath and period of immersion are important parameters that have to be juggled in order to arrive at optimum conditions so that phosphate films with the desired protective characteristics can be produced.

The bath composition and the operating conditions using zinc as the major cation in the phosphating bath, were optimised.

Acknowledgement

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Electrochemical impedance on coated metal electrodes.

Part 2: Effects of time and potential

By L. M. Callow and J. D. Scantlebury,

Corrosion and Protection Centre, UMIST, P.O. Box 88, Manchester M60 1QD, England

Summary

Three electrode, potentiostatic impedance measurements were carried out on immersed lacquered mild steel. At the same time,

the specimen surface was photographed and the specimen rest potential was monitored.

Keywords

Properties, characteristics and conditions primarily associated with

dried or cured films

film defect

Processes and methods primarily associated with

analysis, measurement or testing

electrical impedance

L'impédance électrochimique des revêtements appliqués aux électrodes métalliques.

2 Les effets de la durée d'immersion et du potentiel

Résumé

Sur trois électrodes en acier doux, revêtus de vernis clairs et immergés dans l'eau, on a effectué des mesures de l'impédance

potentiostatique. En même temps la surface de l'éprouvette a été photographiée et le potentiel de repos a été contrôlé.

Die elektrochemische Impedanz der auf Metallelektroden aufgetragenen Beschichtungen.

2 Die Wirkungen der Eintauchzeit und des Potentials

Zusammenfassung

Auf drei Elektroden aus niedriggekohltem Stahl, die mit Klarlack aufgetragen und in Wasser eingetaucht wurden, wurden Messungen der potentiostatischen Impedanz durch-

geführt. Gleichzeitig wurde die Probeoberfläche fotografiert und das Proberestpotential kontrolliert.

Introduction

Ref. 1

In the previous paper in this series¹ several polarization techniques were compared and were shown to have a significant effect on the electrochemical impedance data obtained from coated specimens. One of the main conclusions was that in the case of a non-intact paint film the potentiostatic technique was the most suitable polarization method. A necessary prerequisite for this technique is that the specimen should sustain a relatively stable and measurable rest potential. Problems arising from this area will be discussed, some potentiostatic impedance curves will be presented where the changing rest potential has been followed as the paint film broke down and some provisional mechanistic conclusions drawn based on a comparison of the curves with a photographic record of the specimen condition.

Experimental

The polarization techniques and experimental apparatus used have been described previously¹⁻³. Specimens were coated with the acrylic lacquer to a thickness of 50 μm in

the manner described previously and masked off with a thick (ca. 5 mm) coating of 4 parts beeswax to 1 part colophony to leave an exposed area of 26 cm^2 .

Potential measurement

The rest potentials of a number of coated specimens were monitored as a function of time using a Keighley 610C Electrometer. Considerable variation in potential was observed and this is shown in Table 1. Initially it was

Table 1
Rest potential versus time on a 50 μm acrylic lacquer on abraded mild steel immersed in sea water

Immersion time (days)	Potential (mV, SCE)
1	-650
2	-605
7	-740
9	-600
17	-535
18	-524
21	-592
25	-610

thought that this gross variation in potential was due to non-uniform aeration of the solution resulting from salt blocked air bubblers but, when uniform aeration was maintained, potential variation still occurred.

It is an implicit assumption in electrochemistry that changes in potential mirror changes in the reaction taking place at the electrode. Visual observation of the surface of the electrode showed that corrosion was initiating at point sites (which is the characteristic manner by which organic coatings generally fail). It was noticed that after a period of growth the point sites then became blocked after reaching a set size, ca. 2 mm diameter. Concurrently with this cessation a new set of corrosion sites initiated and the previous cycle was repeated. This process is illustrated in figures 1 to 5. These are tracings made from photographs of the same specimen mentioned later in this paper and show the rust pattern building up as a function of time of immersion. As the variation in potential took place over a period of days rather than hours, the potential could be considered stable within the period required to make impedance measurements down to the mHz frequency band.

Impedance measurement

Refs. 1, 4-8

The impedance behaviour of an acrylic coated specimen in aerated artificial sea water was measured at the moment of immersion and then periodically over the following week. A stable potential was measurable after approximately 15 minutes of immersion (see Figure 10 in the previous publication in this series¹). The impedance curves obtained during the first three hours form the family of curves shown in Figure 6. These curves all show a small high frequency semicircle which can be attributed to paint film properties as they are associated with a capacitance of the order 150 pF cm^{-2} , a value typical of organic coatings⁴. The second lower frequency semicircle has been attributed⁵ to a corrosion process on the mild steel substrate. All the curves in this figure were obtained at -610 mV (SCE) . The most significant feature of the impedance curves obtained during this period is that the second semicircle was becoming smaller with time, thus implying an increase in the corrosion rate. This is contrary to the usual behaviour observed with uncoated metals⁶ where the corrosion rate decreases rapidly in the period immediately following immersion. This increase in the

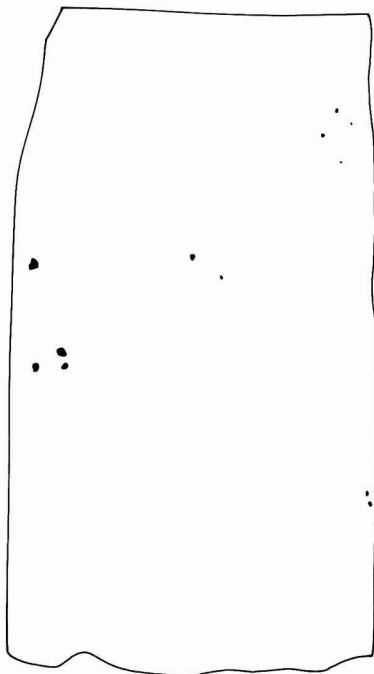


Figure 1. The corrosion pattern on a $50 \mu\text{m}$ acrylic lacquer on abraded mild steel after 12 hours immersion in artificial sea water

apparent corrosion rate is probably due to an area effect resulting from enhanced degradation of the paint film in the manner shown in figures 1 to 5. The initial exposed area was too small for visual assessment but its rate of change can be deduced from examination of the capacitance associated with the low frequency semicircle, Table 2. A small area under corrosion will give a low capacitance, but as the total area increases the capacitance will move towards that of the double layer, ca. $30 \mu\text{F cm}^{-2}$.

When the specimen was left overnight in the

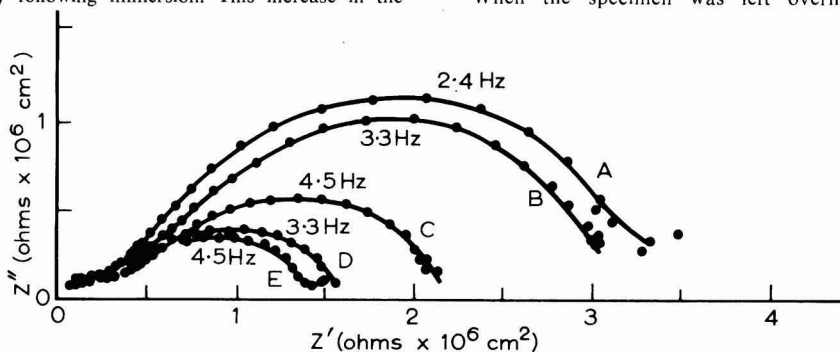


Figure 6. Impedance diagram for a $50 \mu\text{m}$ acrylic lacquer on abraded mild steel in artificial sea water. Curve A after 18 minutes, rest potential -610 mV (SCE) . Curve B after 40 minutes, rest potential -610 mV (SCE) . Curve C after 98 minutes, rest potential -610 mV (SCE) . Curve D after 141 minutes, rest potential -610 mV (SCE) . Curve E after 177 minutes, rest potential -610 mV (SCE)

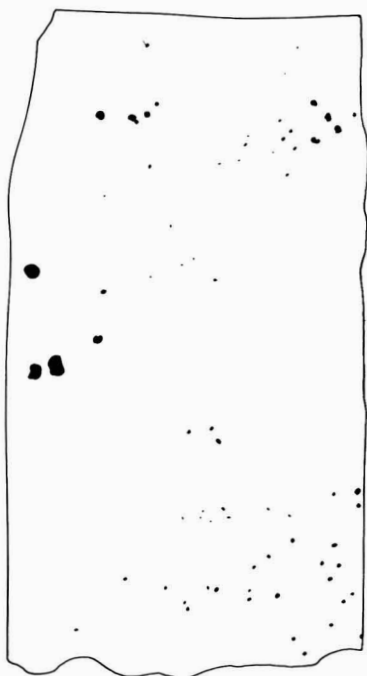


Figure 2. As Figure 1 after 69 hours



Figure 3. As Figure 1 after 117 hours

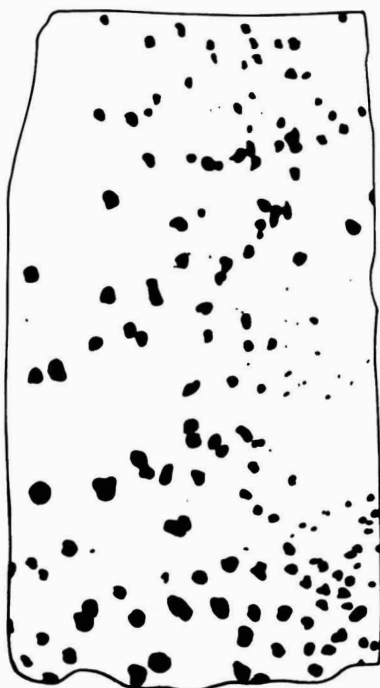


Figure 4. As Figure 1 after 141 hours



Figure 5. As Figure 1 after 165 hours

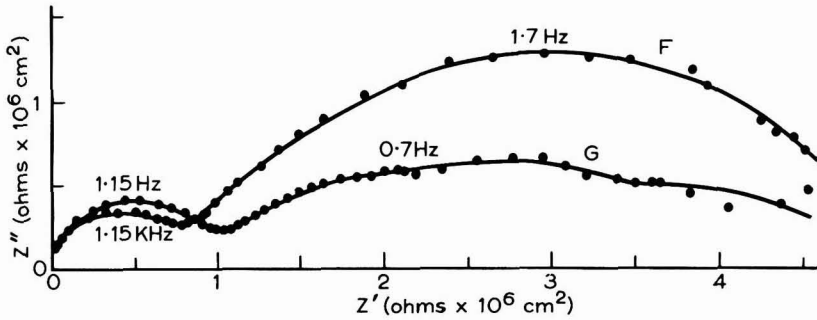


Figure 7. As Figure 6. Curve F after 21 hours 10 minutes, rest potential -535 mV (SCE). Curve G after 24 hours 30 minutes, rest potential -555 mV (SCE)

Table 2
Capacitance versus time calculated from the low frequency data presented in figures 1 to 8

Immersion time (mins)	Capacitance (nF cm^{-2})
18	18
37	19
98	26
141	31
177	28
1270	26
1470	136

unpolarized condition the rest potential became more noble by 50–60 mV and the dimensions of the impedance plots, Figure 7, changed to values greater than those obtained on immersion. The low frequency semicircle was significantly more depressed. This depression of the curve towards the real axis is thought to be attributable to a distribution of reaction time constants across the surface of the specimen⁷. This distribution could result from the presence of at least two distinct types of corrosion site, viz. sites that are initiating and sites that are becoming blocked by corrosion product⁸. The increase in the size of the low frequency semicircle indicates that, at this time, the latter type of site is predominant.

After a further 24 hours immersion, little change had occurred in either the rest potential, or the shape or size of

the impedance plot, Figure 8. Visual examination of the specimen indicated that corrosion sites were continuing to grow and that new sites were initiating, see Figure 3.

One day later, growth had stopped on those rust sites forming a majority of the corroded area, Figure 2. The impedance plot obtained, Figure 9 curve I, proved on analysis to be almost pure Warburg impedance and the rest potential had dropped to -670 mV (SCE). The shape of the impedance curve obtained was therefore almost totally due to the blocked corrosion sites and there was little contribution from the initiating sites. After 117 hours these latter sites had reached the midpoint in their growth process, cf. figures 2 and 3, and they were able to contribute to the impedance curve, Figure 9, in that a departure from pure Warburg was observed.

Conclusions

1. Three electrode measurements can give meaningful results if the varying rest potential is monitored and followed.
2. Photographic evidence shows that the corrosion process varies in a periodic manner in that sets of corrosion sites initiate, grow and become blocked with corrosion product. New sites then initiate.
3. The changes in the processes taking place at the majority of sites can be followed using the electrochemical impedance technique.

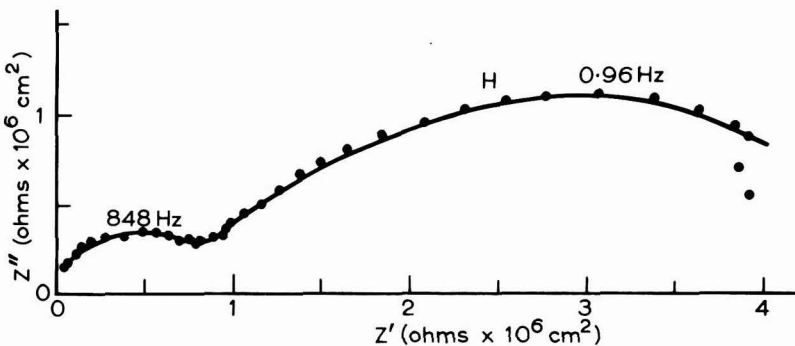


Figure 8. As Figure 6. Curve H after 50 hours, rest potential -530 mV (SCE)

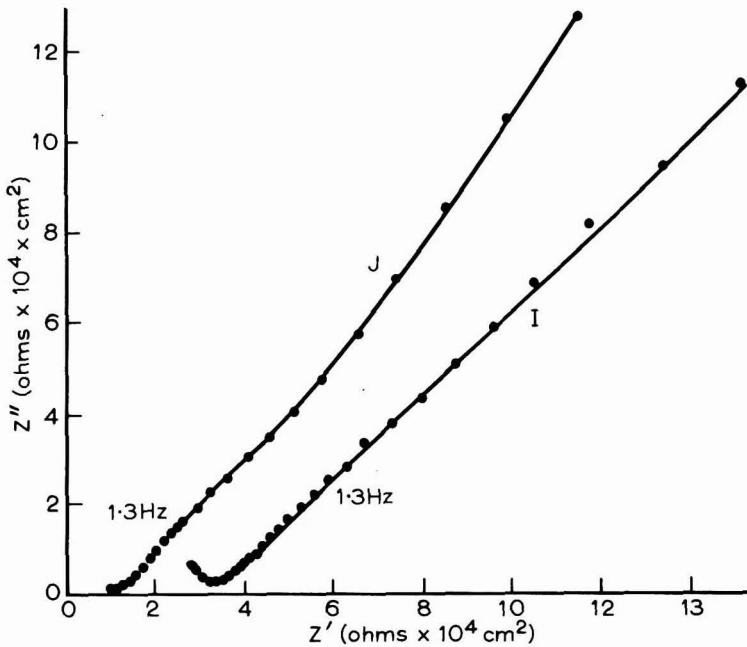


Figure 9. As Figure 6. Curve I after 69 hours 30 minutes, rest potential - 670 mV (SCE). Curve J after 117 hours, rest potential - 650 mV (SCE)

4. Quantitative data must take into account the changing area of corrosion. This may be deducible from capacitance data.

5. When a major proportion of the active sites becomes blocked the predominance of Warburg impedance precludes the observation of the initiating sites by the electrochemical impedance technique.

Acknowledgments

The authors wish to thank Dr W. W. Harpur, Dr P. D. Philpot and Dr C. G. Googan of International Paint Marine Coatings for their encouragement and financial support without which this work could not have been carried out.

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Next month's issue

The Honorary Editor has accepted the following papers for publication. They are expected to appear in the April issue of the *Journal*:

Coating formulation; its effect on the durability of exterior wood finishes by J. Boxall

Electrochemical impedance measurements on coated metal electrodes. Part 3: Measurements at constant potential by L. M. Callow and J. D. Scantlebury

The outlook for the eighties by F. M. Smith

letters

Coloured inks on coloured papers

Judging from the poor legibility of some coloured printed matter, many commercial artists and printers have probably never encountered an exceptional paper by T. Vickerstaff and C. S. Woolvin entitled "Investigation of the legibility and aesthetic value of coloured printing inks on coloured papers" and published *JOCCA*, 1944, XXVII, Nov., 209. It is the sole purpose of this summary to draw attention to it since although inks and papers have changed over the past 36 years, many of the conclusions of the work remain valid. A reading of the original may also prompt further workers to make a similar study with modern materials.

The authors chose 14 different coloured inks and 11 different coloured papers, thereby providing 154 different coloured combinations for the printing of as many leaflets. Unique to the article is the fact that most of these combinations are shown therein – the first time ever a *JOCCA* article possessed a coloured illustration. For presentation of the printed leaflets to the observers two sets of albums were prepared, the first consisting of eleven albums each of which consisted of fourteen sheets of paper of the same colour but printed with different inks, the second set consisting of fourteen albums each containing eleven sheets of paper printed with the same inks.

A preliminary sorting was made by 12 observers, all of whom had some experience of the colour-producing industry. They were asked to make selections in each album of (1) the three most legible combinations (2) the three least legible combinations (3) the two most pleasing combinations in an aesthetic sense, and (4) the two least pleasing combinations. Weighting of choices was effected by allocating three points to the first choice, two for the second choice and one for the third choice. Tables show

the results of the survey, an example of which is given below.

In this and other tables, *comparisons may be made along horizontal rows only, not down vertical columns*. Total points gained by an ink are given in Table 2, but it is admitted by the authors that this particular procedure is of doubtful validity. Other tables show:

Table 3. Most legible – Series B (constant ink – variable paper)

Table 4. Least legible – Series A (constant paper – variable ink)

Table 5. Least legible – Series B (constant ink – variable paper)

Table 6. Most pleasing combination – Series A (constant paper – variable ink)

Table 7. Most pleasing combination – Series B (constant ink – variable paper)

Table 8. Least pleasing combination – Series A (constant paper – variable ink)

Table 9. Least pleasing combination – Series B (constant ink – variable paper)

From the earlier results with 12 observers a selection of colour combinations was submitted to a large number of observers who were asked to choose the three most legible combinations only. These were found to be – black on yellow, black on white and purple on yellow, in that order. When a mass observation was made with selected colour combinations for choice of the three most pleasing combinations, the three most favoured were – blue on white, green on white and purple on pale yellow, in that order.

Anyone concerned with choosing inks and papers today could well profit from a study of the tables given. Using the colour description of the inks and papers or, if possible, examining the coloured illustrations in the original article, an artist or printer envisaging using a particular colour combination would obtain useful information as to the suitability of the choice by observing its placing in the horizontal table rows for legibility and aesthetic value.

A. S. Freeborn

50 Blackbrook Lane
Bickley
Bromley
Kent

17 December 1980

Table 2
Most legible – Series A (constant paper – variable ink)

Paper	Ink							
	Black	Dull greenish blue	Mon- astral blue	Purple	Navy blue	Choco- late	Blue	Bright red
Blue	20	20	4	20	3	3	2	0
Yellow	27	16	11	18	0	0	0	0
Pale yellow	22	13	13	18	6	0	0	0
Green	15	33	18	0	6	0	0	0
Pale green	35	17	13	7	0	0	0	0
Orange	30	14	21	0	7	0	0	0
Pale orange	21	32	12	0	6	0	1	0
Pink	31	15	16	2	5	3	0	0
Pale pink	22	29	21	0	0	0	0	0
Buff	27	9	16	4	17	0	0	0
White	29	6	0	20	8	3	5	1
Total	279	204	145	89	58	9	8	1

NB The following inks: red-brown, green, red, light blue, orange-red and pale mauve failed to receive a single vote.

"Corrosion consultant at large"

Sir – We were surprised to read the remarks of Fowles-Smith (*JOCCA*, 1980, 63, 404-406).

It is not disputed that jobs can go wrong. The reasons however, are often very complex. Those who work in corrosion protection know that a successful job is the only one on which everybody obtains an economic benefit. An unsuccessful job, for no matter what reason, costs all the parties involved money – sometimes out of all proportion to their original commitment.

Reputable coatings manufacturers do not win a large job and then set about cutting the costs of the product or system to the detriment of its performance. What they may do, particularly in the high performance field where a wide variety of raw materials are in use, is to coax their raw material suppliers to ease their prices in return for substantial orders.

Imperfect specification has led to many subsequent problems in the past for manufacturers and applicators alike. When a firm specification has been produced by a consultant and reaches the tendering stage, it is extremely difficult for manufacturer or contractor to comment or suggest changes. Also, when the contract is let the client does not want variation because he knows that this usually leads to a demand for an extra. Hence imperfect specifications go through the system and cause trouble.

There is little doubt that the best specifications come from those who are in day-to-day touch with coatings organisations, such as nationalised industries and petrochemical companies. Together with paint manufacturers they do, in the main, thrash out effective specifications. This is because the parties concerned discuss specifications together before the tender stage is reached. This enlightened and, in our view, correct approach is also practiced by the leading process engineering contractors.

The Paintmakers Association is concerned as to the role of certain "consultants". With one hat they are painting inspectors, with another they draw up specifications. If the specifications are wrong, the consultant bears no financial responsibility and indeed usually lacks resources to fund the sort of claim that could occur on a major project, where today a £100,000 painting contract is not particularly large.

Why not consult the people who make the stuff – the manufacturers – and keep the balance by consulting two or three? Let the consultant do this on behalf of his client and let him use his experience to assist, if necessary, in understanding the paintmakers' reasoning. Present us with an opportunity of explaining ourselves.

Yours faithfully,

L. Bilefield
Secretary

Paintmakers Association,
Alembic House,
93 Albert Embankment,
London,
SE1 7TY

17 December 1980

Mr Fowles-Smith replies:

Sir – When the first of the series of articles "The Corrosion Consultant at Large" was penned it was intended that it should find interest among the readers and possibly

letters

enliven the correspondence pages. Following items will undoubtedly hold to this intention.

I must admit to being somewhat baffled by the apparent lack of knowledge of the real world in which the average paint manufacturer operates as displayed by Mr L. Bilefield on behalf of his Association. In my experience it reflects neither the awareness nor attitude of the technical staff of the Industry.

Fortunately I am aware that this article was well received by our members, not excluding those within the High Performance Group of the Paintmakers Association. It could well surprise Mr Bilefield that five senior technical members and a director of organisations within this group have requested further articles. But then, these people are in touch with the real world. They may not all be aware that this particular consultant started by mopping down the laboratory benches, in the then largest paint manufacturer's laboratory in the world, in 1945. They do appreciate that up to fairly recently I was in the "hot-seat" of Project and Technical Sales Management of probably the most active member of the High Performance Group, and that I am not at all shy of talking to those who know within manufacturers – the Technologists.

The hard commercial world ensures that manufacturers tend to use their technical capabilities to formulate products to meet a particular specification, not necessarily in the spirit of the specification but often to the letter. In an industry where standards are generally non-existent this creates enormous problems for the originators of specifications in an open-competition situation. It is the main reason for closed bidders lists favoured by major organisations, the smaller the list the better the standard of product and service received.

Specifications and product standards could well form the subject of further articles. They are too vast as subjects to be discussed in a letter. It is however indefensible for the paint industry as a whole to hide behind weaknesses in this area, and I am aware that a number of Mr Bilefield's members would not admit to doing so. Clients usually listen to sound technical reasoning. To my knowledge I only lost one major contract while in the "hot seat" through such a discussion, and that was bedevilled by a political situation. Not that every approach resulted in a modified specification, but the problem areas were all recorded for the future.

The nationalised industries and petrochemical companies are an odd group to select as examples in this area. It contains examples of the enlightened, with closed bidders lists and captive technical departments, and areas of absolute jungle. It also contains some of our greatest monuments to corrosion. Among the enlightened are the largest users and supporters of paint inspection as an essential service independent of the paint suppliers or applicators!

I am extremely concerned at the number of "consultants" and so-called specialists operating without any technical background. The majority operate as

"captive" specialists within the nationalised industries, the petrochemical industry and in engineering or similar consultancies, where they have to rely totally on suppliers advice for the maintenance of their position. It would appear that the Paintmakers Association does not object to these, harmless to its own cause, but only to the truly independent and competent consultant.

There are major companies and sections of the public sector where the employment of a full-time, captive specialist cannot be justified. This sector of industry is turning to the independent consultant when such a service is required, if only because of awareness that a paint manufacturer will give biased advice. Such advice is not usually bad, but can rarely be the optimum when it has to be slanted towards the product types that the company has on offer.

The relationship between the consultant and the quality control/inspection function is too well established in so many fields, architecture, constructional engineering etc. for the sour grapes expressed to enhance the reputation of Mr Bilefield's Association. Could it be that the independent service has full commitment to the client's interest?

As for the financial aspect I can only assume some

reviews

Inorganic Pigments. Manufacturing Processes Chemical Technology Review. No 166

Edited by M. N. Gutcho
Noyes Data Corporation, USA
pp. 487. Price US \$54.00 ISBN 0.8155 - 0811.5

This book covers the period January 1 1975 to January 1 1980, and includes references to no less than 300 Patents. Patents included run from 3859109 to 4181772. As with all books from this Publisher, patents are classified carefully, even though the inclusion of a number might be regarded as marginal to the surface coatings industry.

A survey of patents gives an indication of where the research taking place in America and elsewhere is being directed, since some of those cited are of European (mainly German) and Japanese origin.

In the titanium dioxide industry there appears to be a continuing effort to improve the pigment properties by organic and inorganic surface treatments. The section on

occa meetings

minor misunderstanding of the consultant's position. He normally acts for the client, with the client accepting contractual responsibility, for fees on specification work amounting to less than 0.5 per cent of the coating contract value. My own fees on the largest project I have handled was in the region of 0.00004 per cent of the contract value, a little different to the manufacturer's 40 per cent in that particular instance.

Working in a total project consultancy capacity, with direct contractual responsibility for the employment of vendors, there is at least one consultant who carries the appropriate indemnity to cover his possible contractual liabilities. Unfortunately the clients usually maintain the prerogative of making their own mistakes. This could well please Mr Bilefield, but the successful manufacturer might well make better products at better overall prices using my procedure.

Yours faithfully

J. E. Fowles-Smith

96 Ley Lane,
Mansfield Woodhouse,
Nottinghamshire
NG19 8JX

20 January 1981

Further information on any of the publications reviewed may be obtained by circling the appropriate Reader Enquiry Service number on the form at the back of the Journal. Enquiries will be forwarded to the publisher.

yellow and green pigments indicates that efforts are being made to find non-toxic equivalents for well known colours, even though it is clear that there are still improvements to be made in the established products.

The section on iron oxides includes a number of patents on transparent products and also on oxides for magnetic recording tape.

Lustrous pigments, and clay pigments are the subject of 26 and 14 patents respectively.

Corrosion-inhibitive pigments patented indicate that efforts are again being made to develop non-toxic products with equivalent properties to the conventional chromates and red lead. These include mixed phosphates, mixed oxides, molybdate and coated products and molybdate/phosphate pigments.

Other sections are pigments for plastics, carbon black, paper and the inevitable pigments for other specific needs and other processes.

This review necessarily reads like a catalogue, as it must do, but the book should prove a useful source of information for those in the pigment manufacturing industries.

Reader Enquiry Service No. 21

D. S. Newton

For information on membership of OCCA, enquiries should be sent to the Association's offices, see front cover for address.

Midlands

Paint versus corrosion

The annual student lecture of the Midlands section was held on 20 November 1980 at the County Cricket Ground, Edgbaston, Birmingham. Members, guests and

students heard Mr E. V. Carter of Miox Ltd, give a talk entitled "Paint versus corrosion".

Mr Carter opened his talk by saying a survey in 1971 by T. P. Hoare put the cost of corrosion in the UK at £1365 million per annum. In the UK it is estimated that 1 ton of steel is lost every 90 seconds through corrosion. By taking extra care at the design stage many areas where corrosion occurs can be avoided. For example by the use of continuously welded joints instead of lap-joints, by having drainage holes in channel section girders and by ensuring there is sufficient space between structures so that effective painting and maintenance can take place.

Mr Carter continued by saying that painting is the most widely used system for the protection of iron and steel and for a successful system the following three vital principles apply:

1. Correct cleaning. All mill-scale must be removed. This can be achieved by blast cleaning, flame cleaning, weathering or by chemical treatments.

2. Choose best painting scheme for the environment. The steel must be painted immediately after cleaning before the onset of any corrosion. The primer coats must be of a sufficient film thickness to cover all the peaks left after blast cleaning, two or more coats may be required. The finishing coats are really there to protect the primer, they must have maximum resistance to water permeability and resist UV radiation.

3. Good painting practice. This can be achieved more efficiently if the structures are prefabricated off-site.

Throughout his talk the speaker showed numerous coloured slides to illustrate various corrosion problems mainly on bridge structures and how by suitable design changes these could have been avoided.

Finally, Mr Carter suggested several publications such as the 1977 BS 5493 "Codes of Practice for the Protection of Iron and Steel" that the audience might like to read.

The interest shown by the audience was reflected by the numerous questions that were asked. The meeting was finally brought to a close with a vote of thanks proposed by Mr D. Clement.

B. E. Myatt

West Riding

Important parameters in solvent selection

A meeting of the West Riding Section was held at the Mansion Hotel, Leeds, on 4 November 1980.

A disappointingly low attendance didn't do justice to the excellent paper given on the above topic by Mr J. J. Blom of Shell Research, Amsterdam.

Mr Blom restricted his talk to solvents in surface coatings. He discussed the effect of solvents on viscosity, solubility, flash points, volatility, cost and current legislation.

Solubility was defined as the power to dissolve high molecular weight products.

Several empirical test methods for measuring solvent



power were described. They included the Kauri butanol number, aniline point and dilution ratio methods.

The speaker suggested that the above solvent power indicators, although useful and practical had limited applications. He considered that the universal measure of solvent power in the form of "solubility parameters" were more useful to the formulator.

Mr Blom described, in easily understandable terms, how molecular, physical and ionic forces are related to solubility parameters. He also gave examples of how to calculate the solubility parameters of various solvents.

This led onto the topic of solubility maps. Their uses and compositions were described with the aid of several slides. It was suggested that the information gained from such maps would improve cost and performance optimisation.

The definition of evaporation of a solvent was described by the evaporation number of the relative evaporation rate. Mr Blom discussed the theory of evaporation and introduced the effects of solvent mixtures on evaporation rates. The role of computers in determining the evaporation characteristics of a given solvent blend in relationship to solubility was detailed.

The speaker went on to discuss the aspects of viscosity. He briefly outlined the theory of viscosity and detailed the parameters that effected polymer solutions.

Mr Blom concluded his talk by suggesting that the computer approach could make life considerably easier for the formulator.

After a very lengthy discussion period, the vote of thanks was given by Mr Hugh Young.

Pigment chips – manufacture and uses

A meeting of the West Riding Section was held at the Mansion Hotel, Leeds on Tuesday 7 October 1980.

Mr Fred J. Morpeth of Foscolor Ltd, gave his paper on the above topic, to 32 members and guests.

The historical growth of the pigment chipping industry was discussed first, followed by a detailed description of the processes utilised in chip manufacture.

Mr Morpeth described pigment chipping as the art of dispersing large concentrations of pigment into molten resin, using a modified two-roll mill.

Two milling techniques were detailed, the wet milling process and the dry milling process.

The former technique was said to be mainly used in the manufacture of nitrocellulose chips. This involved premix-

occa meetings

ing pigment, damped nitrocellulose and plasticizer in a dough mixer, followed by two roll milling then granulating.

The second method is the one adopted by Foscolor. A very detailed description of the process, which was illustrated by numerous slides, was given.

Mr Morpeth went on to discuss the parameters that are considered during the formulation of pigment chips. These were said to be as follows:

- (a) Pigment type – oil absorption and texture
- (b) Pigment level
- (c) Resin type – melt viscosity and wetting properties
- (d) Additives – surfactants and plasticizers

The properties of many different pigments and their

effects on chipping and end use performance were highlighted.

Many types of resins were said to be utilised in the manufacture of pigment chips. The list included such polymers as chlorinated rubber, vinyls, cellulose propionates, polyamides and many others.

Mr Morpeth gave a review of the cost effective performance of pigment chips compared with powder pigments, easily dispersible pigments, flushed pigments and elaborated pigments. In general chips were said to give better gloss, transparency and brightness.

It was suggested that pigment chips could be substituted for raw pigments in any surface coating application. Chips are available for all solvent systems from aqueous through alcohols, aliphatic distillates and even mineral and vegetable oils. They may be applicable to paper and film, metal and wool, cars, concrete, shoes and vinyl wallcovering.

Mr Morpeth concluded his talk, by mentioning new outlets for chips. These included powder coatings and emulsion paints.

After a very lively discussion period, the vote of thanks was given by Mr David V. Maltman.

D. V. Maltman

Further information on any items mentioned below may be obtained by circling the appropriate Reader Enquiry Service number on the form at the back of the Journal. Enquiries will be forwarded to the organisation concerned.

news

Croda Carson Inc

Croda International announces that Croda Carson Inc. of Lock Haven, Pennsylvania has now become a wholly-owned subsidiary of Croda Inc. (Croda's principal US Division). This change is brought about due to the purchase by Croda from Quad Chemical Corporation (a subsidiary of Lonza Inc) of their 50 per cent shareholding in Croda Carson.

Croda Carson manufactures a wide range of specialised chemicals including alkanolamides, amphoteric and quaternary ammonium compounds for use in cosmetics and household products.

Reader Enquiry Service No. 31

Macbeth move

Macbeth, manufacturers of colour and density measuring instrumentation, have moved offices.

The new address is: Macbeth, Bridgewater House, Bridgewater Street, Sale, Cheshire M33 1EQ. Tel: 061-962 6818 Telex: 665647.

Reader Enquiry Service No. 32

UK chemicals trade figures

The latest figures on the UK chemical industry's trade for 1980 are "a sugar-coated pill" covering seriously eroded profit margins in export business, according to a statement by Martin Trowbridge, Director General of the Chemical Industries Association (CIA).

On the surface, chemical exports held up reasonably well in view of the adverse factors affecting trade in 1980: in particular the recession in the UK, weak overseas demand, strong competition and the strength of sterling. Exports are estimated to have risen by nearly eight per cent in value, while volume was held to within five per cent of 1979's average. However, in many cases exports were maintained only to preserve a position in the market.

By comparison the domestic recession in manufacturing industry and in home demand for chemicals produced a very sharp cutback in chemical imports, estimated to be around seven per cent by value and 14.5 per cent in volume.

The relative movements of export and import volumes, together with the continued improvement in the terms of trade, meant that the industry earned a record net export surplus of just over £2.1 billion, representing 55 per cent of the surplus earned by manufacturing industry as a whole, and some 42 per cent up on the previous year.

Reader Enquiry Service No. 33

Q-Panel open UK branch

The Q-Panel Co., have opened a branch office in Manchester to stock their range of weathering test chambers and metal test panels for coatings tests. The company manufacture Q-Panels in steel and aluminium for research, quality control and sales samples; this is the first time they have been offered in Europe. Q-Panels have a clean and standardised surface which minimises the effect of metal variability in critical coatings tests.

Q-Panel Co. also manufacture the QUV Accelerated Weathering Tester and the QCT Condensation Tester. Both these machines have been sold in the past direct from the USA. However, now the machines, parts and technical service will also be available from the Manchester branch.

Reader Enquiry Service No. 34

ECC aquisition

In December 1979 English China Clays acquired the whole of the share capital of Southern Clay Products Inc (SCP), an American Corporation based in Gonzales near San Antonio in Texas. SCP produces, processes and markets, bentonite, ball clays and talcs. In addition to these minerals SCP produces a range of gellant thickeners marketed under the name of Claytones.

Reader Enquiry Service No. 35

new products

Drum liners

Palagan & Co. has made available polythene drum liners which can be used to overcome cleaning operations and to avoid contamination, maintaining product integrity for water based and other compatible solvent materials. The bags are fabricated in heavy duty polythene in a gauge and size to suit the application. The liners envelop materials contained in ring sealed steel drums to inhibit moisture escape into the ullage space thereby eliminating skin formation and other forms of degradation.

Reader Enquiry Service No. 36



Polythene liners

Electrically conductive adhesive

Industrial Science Ltd has announced a room temperature curing, two component, electrically conductive silver epoxy adhesive. The adhesive Elecolit 325 is a soft paste which can be used with a hypodermic needle, squeeze tubes, spatula or automatic dispensing equipment and has a pot life of 3-4 hours.

The electrical conductivity of Elecolit 325 is claimed to be superior to other silver epoxy adhesives on the market; it cures at room temperature in 24 hours, and can also be rapidly heat cured to yield a volume resistivity of .0005 ohm/cm.

Elecolit 325 is excellent for chip bonding in hybrid circuits, hybrid assemblies, wave guide plumbing, making electrical connections, paths and connecting heat sensitive components to printed circuit boards.

It is supplied in two jars; one resin and one hardener. Equal amounts of each are squeezed out and mixed with no further measurements necessary.

Reader Enquiry Service No. 37

Floor laying in cold weather

Mainmead Ltd have made available a new flooring system based on solvent free, methyl methacrylate aimed at solving the problem of floor laying or repair in very cold weather.

Silikal R17 has an extremely low viscosity and will mix and cure even at temperatures as low as -10°C without the need for special equipment. It is also claimed to be easy to apply in the same cold conditions as its consistency is that of a thin paint, however, this feature is combined with a fast curing time and Silikal R17 takes just 45 minutes to 2 hours before it is ready for use. Surfaces can also be recoated at any period from 2 hours to 20 years and there will still be a chemical bond. Silikal R17 is hard wearing and can be easily applied to concrete and a wide range of other flooring surfaces and is non-toxic. It is supplied in two parts, the premixed powder contains a fine aggregate and the liquid binder has the MMA monomer. It is available in a number of colours.

Reader Enquiry Service No. 38

Semi-automatic image analysis

Quantitative information about the contents of an image so far could only be obtained by time-consuming visual methods or with automatic image analysers requiring high electronic outlay.

The new semi-automatic image analyser Morphomat 10 from Carl Zeiss utilises the advantages of visual assessment without sacrificing the versatility of electronic data processing. The image to be measured is either a photograph or an image projected by an optical or electron microscope. It is measured by screening or sensing the structures of interest by means of a cursor or special stencil. The user can follow the position of the cursor as a luminous point directly or through the microscope. The system allows the simultaneous measurement and statistical evaluation of length, perimeter, and area of arbitrary geometric shapes. Different structures can be sorted into 20 channels.

Reader Enquiry Service No. 39

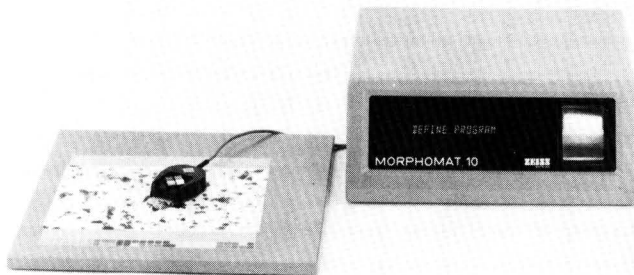


Image analyser

news

Injection moulded tube fittings

Galtex Corporation has introduced its Teflon PFA injected moulded tube fittings.

Injection moulded fittings of Teflon PFA allows the construction of systems with less chance of particulate contamination than systems comprised of most other materials; they are chemically resistant, generally produced at lower cost and have greater creep resistance than fittings machined of Teflon TFE.

The ferrule nut, also injected moulded of Teflon PFA, has an integral ferrule. No metals parts are used.

The tube fittings are available in 1/16, 1/8, 1/4, 3/8 and half inch OD sizes, and in metric sizes of 6, 8, 10 and 12 mm OD.

Reader Enquiry Service No. 40

New mechanical atomizer

A new type of mechanical atomizer has been invented by a team of researchers from Czechoslovakia's Institute of Macromolecular Chemistry in Prague intended as an alternative to using the propellant Freon in pressurized containers.

Pressure pumps usually have the disadvantage that they work intermittently and are not suitable for continuous spraying of large surfaces. The new atomizer however makes this possible and, moreover, the aluminium containers used with Freon can be replaced by much cheaper plastic, glass or metal containers.

Reader Enquiry Service No. 41

news

New Cargill products

Cargill's Chemical Products Division has recently developed and introduced the following:

Resin 7304 (for architectural coatings) and Resin 7405 both brushable and water-reducible. Resin 5713 a very durable soyabean-oil-based resin designed for wrinkle-free, thick, air-dry coatings applications for water-reducible and high-solids coatings. Coatings using 5713 have medium air-dry times for spray or electrostatic applications. Resin 5708 a soyabean-oil-based alkyd resin designed for use in primers where excellent corrosion resistance is required, suitable for automotive metal-finishing applications requiring heat treatment or baking. It also has medium air-dry characteristics. Resin 5707 a tall-oil, fatty-acid alkyd resin developed for the same applications as resin 5713, but with a faster drying time. XP-516-17, a water-reducible silicone resin. 7456 a water-reducible, modified alkyd that gives coatings prepared from it salt fog, humidity resistance and gloss retention. 7208 a water-reducible resin for baking finishes that aids application using electrostatic spray, dip or flow coat processes. 2385 a fast, low-curing, high-solids melamine which can be used in water or solvent-based systems. Polyester Resin 3011 designed for use with urethane curing agents.

2402 a master batch flow control curing agent for powder coatings that contains 10 per cent flow control agent in Cargill 2400 curing agent.

Reader Enquiry Service No. 42

New constant rate feeder control

A new compact controller for constant rate, continuous weigh feeders has been announced by Richard Simon & Sons (Weighing) Limited, it can monitor a comprehensive range of operating parameters, displaying any faults on a series of LED warning indicators on the front panel. The self-contained controller uses up-to-date electronic circuit design to minimise the overall size of the unit and to provide easy access for maintenance.

The controller is designed for use in conjunction with the Richard Simon Totalising Load Cell Amplifier or Microprocessor Load Cell Amplifier to control the speed of continuous weigh feeders used for delivering materials from bunkers onto conveyors.

Reader Enquiry Service No. 43

Emergency showers

Walker Crossweller & Co. Ltd have recently launched a comprehensive range covering eye-wash stations, freeze-proof outdoor showers, decontamination chambers, a range of portable units for use on location where there is no water supply and a drench shower.

The drench shower, shown below, will provide 85 litres per minute (19 gals/min) of water from the "maintained" pressure of a three feet head. The shower can be situated near an area where hazardous liquids or powders are in use and thus provide a useful safety back up.

Reader Enquiry Service No. 44



Drench shower

Sheen instruments

Sheen Instruments Ltd have made available the following three new machines:

Portable glossmeter. Sheen have developed a new range of portable glossmeters which consist of a mains/battery powered digital meter to which a separate lightweight scanning head is connected. They are available in 3 optical geometries: 60° for general purposes, 20° for high gloss finishes and 85° for low gloss or matt finishes. Sheen claim that the new meter may be used all day on battery only and the instrument incorporates a charging unit which will recharge batteries overnight.

Cross hatch cutter. Sheen have made available this instrument which is used to assess the adhesion of paint coatings. The technical merit of it has been recognised by international standards authorities. The test method specifies suitable cutting tools with either single or multiple cutting edges. The instrument introduced by Sheen has either 1 mm or 2 mm spaces between the cutting edges with advantages over the single cutting blade of both safety and simplicity of use.

NEO-DERM dry film thickness meters, have been made available by Sheen by agreement with Mitutoyo UK, for use in the laboratory or on site. They

are supplied for coated ferrous or non-ferrous metals.

Reader Enquiry Service No. 45

Colour chip chart maker

A labelling machine is providing a novel and efficient means of applying colour chips to paint charts. The machine, a Pony Labelrite, specially adapted by its manufacturers Strachan Henshaw Machinery, has a vacuum mechanism to pick up, glue and apply accurately as many as 78 different coloured paint "chips" in one cycle.

Preprinted cards are fed in by hand, with chips applied automatically via a label magazine box which can be replenished without stopping the machine.

A double pick up feature allows for accurate handling combining speed with smoothness.

The work-table is attached to a micrometer adjustment mounting, giving fine adjustment for positioning and allowing chips to be lined up easily and accurately on the preprinted colour cards.

Reader Enquiry Service No. 46

New valve package for industry

David Auld Valves Limited have introduced a new valve package for steam, liquid and air services. Comprising the well known Auld range of reducing and safety valves, the new package is the outcome of an intensive value engineering study aimed at higher quality, whilst meeting the increasing demand imposed by energy conservation programmes.

Available in both bronze and steel from 15 to 300 mm bore, the valves will also offer space saving advantages for a wider range of applications and flange options.

The Auld range of Reducing Valves are available for BSS and DIN ratings, Lloyds approved, for pressures up to 35 bar and temperatures of up to 260°C.

Designed for tight shut-off they have a reduced pressure accuracy of ± 2.5 per cent from full flow to 10 per cent of flow and a closing performance of +7 per cent of reduced pressure.

Reader Enquiry Service No. 47

literature

Notification of accidents rules

On 1 January 1981 the new Notification of Accidents and Dangerous Occurrences 1980 regulations came into force and the British Safety Council, in conjunction with the Industrial Relations Briefing, has produced an Accident, Mishap and Ill-health Record Book to enable employers to understand and comply with the requirements of the new regulations.

Reader Enquiry Service No. 48

PRA publication

"Health and Safety, Environmental Pollution and the Paint Industry"; when the first edition of this survey was published four years ago a good beginning had been made towards listing all potentially hazardous materials and checking their effects upon man and the environment. Replacements were being sought for the more dangerous materials and conditions defined for the safe use of others; means for monitoring controls were being established, and voluntary restrictions were sometimes being adopted by industry in advance of legislative control.

The problems proved even more formidable than anticipated, not only from the many thousands of materials to be examined, but also in defining an acceptable level of risk. In the absence of complete scientific data, only interim legislation has been possible in some cases, necessitating updating amendments in the light of later knowledge.

Solutions will of course be found. The good record of the surface coatings industry over many years shows that it is determined that the manufacture and use of paint shall be achieved in the safest, and most cost effective manner possible.

The second edition of the survey is now available. As a consequence of the large amount of legislation which has recently been passed, or proposed, and of new toxicological information, this publication is more than double the size of the first and contains nearly 600 references, up to late 1980. Price: £40 (PRA Members £34).

Reader Enquiry Service No. 49

Safe powder coating

The 3rd edition of a brochure on the safe use of powder coatings has been published by CEPE. In the booklet of 51 pages consideration has been given to the new methods of application including tribo-electric charging and certain new equipment involving this principle and that of secondary charging of powder particles from secondary electrodes. The text is in four languages and details recommendations for the safe handling and electrostatic application of powder coatings and construction of plant and equipment both to powder users and manufacturers.

Reader Enquiry Service No. 50

Hercules brochure

A new 32-page, three language brochure in colour on hydroxyethylcellulose, Natrosol, has recently been published by Hercules BV.

Interesting features of the new brochure include data on existing Natrosol types and the new Natrosol B series. The B-type product has been designed for thickening products that require maximum resistance against enzymatic degradation.

Reader Enquiry Service No. 51

Fume control

Carter Sherbourne Electrostatic have a new colour leaflet describing some of the ways in which electrostatic fume control systems can be applied to produce a clean workshop environment. It is a characteristic of the electrostatic principle that it will extract particulate matter from the air irrespective of whether it be solid or liquid and ranging from the largest airborne particles to those below .03 microns in size. A significant benefit of electrostatic extraction is that filtered air is recirculated and thus heated workshop air is not lost.

Reader Enquiry Service No. 52

meetings, etc.

PRA training course

The Paint Research Association has launched a new type of training course designed to meet the requirements of the engineer who has a responsibility for choosing, or controlling, a painting process. It may also be suitable for less experienced sales and technical staff of the paint manufacturing companies whose duties include support for the engineer.

Many engineers are not happy with the unfamiliar technology of paints, with its chemical background. The course is intended to tackle this rather unhappy situation. It aims to classify the main types of paint, to show their properties and how they determine methods of application and likely end-uses. The related topics of corrosion and surface preparation are covered so far as time allows. This material is then used as the basis for discussion sessions on the choice of paints for typical end-uses. This leads to a general treatment of paint specifications. For further information contact: Mr L. A. Tysall, Training Manager, Paint Research Association, Waldegrave Road, Teddington, Middlesex TW11 8LD.

Cathodic protective systems

The Corrosion Science Division and Scottish Branch of the Institution of Corrosion Science and Technology are holding a joint one-day meeting on "Modelling of Cathodic Protection Systems" at Robert Gordon's Institute, Aberdeen on 15 April 1981.

The organisers thought it timely to review the state of the art concerning techniques, e.g. computer simulation and scaled-down experiments, for evaluating cathodic protection systems for large structures and those of complex design. For further information contact Mr T. E. Evans, BNOC, St. Vincent Street, Glasgow G2 5LJ (Tel: 041-204 2525).

Accelerated testing of coatings

A one-day symposium organised jointly by the Institute of Metal Finishing, London Branch and the Working Party

news

on Corrosion Tests in conjunction with the Institution of Corrosion Technology, London Branch and the Corrosion Science Division will be held on Wednesday 8 April 1981 at the School of Navigation, City of London Polytechnic, Tower Hill, London. For further information contact Dr Michael Clarke, Department of Metallurgy and Materials Engineering, City of London Polytechnic, Central House Annexe, Whitechapel High Street, London E1 7PF.

Corrosion control

The N.W. Branch of the Institution of Corrosion Science and Technology is holding a one day meeting, symposium and exhibition, on "Corrosion control in the chemical and processing industries". It is to be held on Thursday 26 March 1981 at the Eurocrest Hotel, Runcorn, Cheshire. For further information contact Mr F. B. Windsor, England Hughes Bell & Co. Ltd, Valley Works, Monton Road, Eccles, Lancs. Tel: 061-789 5191 Telex 669336.

FATIPEC congress

The XVIth FATIPEC Congress will be held in Liege from 9-14 May 1982 and copies of the first circular will be available during March 1981 from the Association's offices.

appointments

John P. Webb has been appointed Associate Director of Cornelius Chemical Co. Ltd with effect from 1 February 1981.

Michael John Evans has been appointed as Technical Manager of BEE (UK) with effect from 2 February 1981. A Devon-born man, Mike lives in Gidea Park with his wife and two children. He studied at Hull University and obtained a BSc in Chemistry. The whole of his working life has been spent with Berger Paints on technical development and technical service of, almost the complete range of that company's industrial products, and he was for the last two years Technical Manager of the Berger Industrial Division.

Mr M. J. Heavers has been appointed Managing Director of the newly established company, NL Chemicals (UK) Ltd. Mike Heavers was previously Company Manager of Kronos Titanium Pigments Ltd which he joined in 1964 shortly after its inception.

OCCA news

For information on membership of OCCA, enquiries should be sent to the Association's offices, see front cover for address.

News of Members

R. E. G. Johnson, Chairman of the Zimbabwe Branch of the General Overseas Section, recently attended the 6th World Congress of Economists in Mexico City, the only delegate from Zimbabwe. He was accompanied by his wife, Shona.

Dr Johnson also attended the Annual Congress and Annual General Meeting of the Royal Economic Society in London in July last, where he met Sir Alec Cairncross and Sir Austen Robinson and other distinguished economists from Britain and Europe.

Dr Johnson is mentioned in the "Men of Achievement 1980" 7th Edition published by the International Biographical Centre in Cambridge.

Obituary

Mr D. G. Dowling

We regret to record the death on 24 December 1980, of Mr David Gordon Dowling of Sear Green, Beaconsfield, Bucks.

Mr Dowling was educated at West Hartlepool Grammar School and obtained an Honours Degree in Chemistry at the University of Durham,

after which he took a course in Industrial Management at Hull College of Commerce.

He was an associate of the Institute of Works Managers and a member of the Oil and Colour Chemists' Association.

Professional Grade

The following Ordinary Members of the Association have been admitted to the Professional Grade. The sections to which the successful candidates are attached are shown in italics.

Admitted as Associates (ATSC)
McClellan, Michael Denis (*London*)
Pyett, Albert Lawrence (*Manchester*)

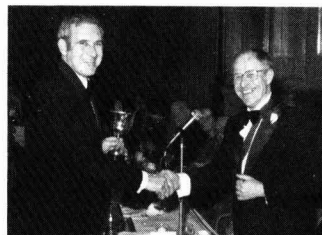
West Riding Section

Ladies' Evening

The Annual Dinner Dance of the West Riding Section, was held on Friday, 28 November, at the Crown Hotel, Harrogate.

Despite the recession, a greater number of people attended this much enjoyed function, than last year.

A party of 240 sat down to a most enjoyable meal. The Chairman, Mr M. G. Bentley, presented Mr J. Wood with the West Riding Golf Trophy for the second year running.



Mr J. Wood (left) receiving the Golf Trophy from the Chairman of the West Riding Section (right) Mr M. G. Bentley

Following the dinner, the party rapidly got underway with dancing to the Peter Edwards Sextet.

The Section Chairman (Mr M. G. Bentley) proposed the toast to the guests to which the President (Dr F. M. Smith) replied.

D.V.M.



Left to right, Mr M. G. Bentley (Chairman, West Riding Section), Mrs Bentley and the Guest of Honour Dr F. M. Smith (President)



OCCA-33 ANNUAL EXHIBITION

28-30 April 1981



The thirty-third annual OCCA Exhibition, a three day event, will be open as follows:

Tuesday 28 April	09.30 - 17.30
Wednesday 29 April	09.30 - 17.30
Thursday 30 April	09.30 - 17.30

The venue for the 1981 Exhibition will be the same as for OCCA-32, i.e. the Cunard International Hotel, Hammersmith, London, W6 and the Exhibition will be in two sections; on the ground floor, forming the entrance to the Exhibition, and in the rooms on the third floor of the hotel. A fully licensed bar and seating area will be installed in the New Hall.

The hotel has a selection of restaurants, shopping facilities and bars. The hotel is situated near Hammersmith Station on the Piccadilly Underground Line between Heathrow Airport and the centre of London. Hammersmith Station is also served by the Metropolitan and District Underground Lines (the latter of which connects to Victoria Station for those arriving at Gatwick Airport). Car parking at the hotel is limited, but there is a large NCP car park close by in King's Mall off King Street.

Admission to the Exhibition will be free, and visitors will be asked to complete registration cards which will be

available in advance from the Association's offices with copies of the Official Guide. Copies of the official Guide will be charged at £1.50 each, and both registration cards and copies of the Official Guide will also be available at the entrance to the Exhibition.

Additional exhibitors

Since the first list of exhibitors was published in the February issue of *JOCCA* a number of other companies have shown an interest in exhibiting and the following have booked stand space at OCCA-33:

Geosource (UK) Ltd
Impex Trading Ltd and Unishear

News of Exhibitors at OCCA-33

Stand 107 and Room 3126

British Oxygen Chemicals

British Oxygen Chemicals are the only fractionators of tall oil in the UK and will be exhibiting their range of products which are available to the surface coatings industry.

Stand 108

BOC Automation

Hunterlab announce new instruments in their range of appearance measurement equipment.

1. Hunterlab Interspec Colour and Colour Difference Meter.
2. Hunterlab D54IR spectrophotometer.
3. Combined Colour and Gloss meter.

Stand 117

Stratford Colour Co. Ltd

Stratford Colour Co. Ltd will show its ranges of lead chrome pigments for paints, inks and plastics. Having acquired the inorganic pigment factory in Stratford, London E15 from the Receiver of Burrell Colours Ltd in January 1981, the new company is developing and extending the products, which cater for a very broad spectrum of applications.

Stand 126

Cappelle Freres

Cappelle Freres are pleased to exhibit, for the first time at an OCCA Exhibition, their range of organic and inorganic pigments suitable for the paint, plastics and printing ink industries.

Stand 102

W. R. Grace Limited

W. R. Grace Limited being a part of one of the largest international chemical companies in the world, will be exhibiting details of their wide range of SYLOID® matting agents, SYLOSIV® moisture scavengers, SYLODEX® thixotropic and gelling agents for the coatings industry. W. R. Grace Limited are trying to create a beneficial environment by continuously developing materials for coating systems that are environmentally harmless.

Stand 129

ISC Alloys Ltd

ISC Alloys have centralised the production of zinc phosphate and zinc dust at their Bloxwich plant, to facilitate delivery to customers, and provide a central technical service facility to the paint industry. Production includes zinc phosphate and zinc dust anticorrosive pigments.

OCCA news

Stand 127

Norwegian Talc (UK) Ltd

A/S Norwegian Talc has for more than 45 years been a supplier of high-quality extenders to the paint industry. These materials include minerals such as dolomite, talc and mica. Each type is produced in several grades of fineness.

Technical staff from A/S Norwegian Talc will be present and look forward to discussing the various aspects of filler technology.

Stand 113

Institution of Corrosion Science and Technology

The prime object of the Institution is to further the understanding of the science of corrosion, and the technology of corrosion prevention and control, and to facilitate the flow and exchange of information in this field.

The following elections to membership have been approved by Council.
The Section to which each new Member is attached is given in italics

Ordinary Members

BROWN, PATRICK STEPHEN, Bayer, PO Box 1366, Johannesburg 2000, South Africa
(Transvaal)

KIRBY, WILLIAM JAMES, 20 Cumberland Way, Garden Est. Washington, Tyne & Wear NE37 2NW
(Newcastle)

LOVE, STEPHEN, 51 Walter Street, Glasgow G31 3PX
(Scottish)

McNAMEE, PATRICK ANTHONY, BSc, Glanmire Industries, Glanmire, Co. Cork, Ireland
(Irish)

OTT, MICHAEL, BSc, 8 Eclipse Place, Half Moon Bay, Auckland, New Zealand
(Auckland)

PISCANE, PAUL VINCENT, 2j Lennox Road, Seafar, Cumbernauld, Glasgow G67 1LL
(Scottish)

SCHIESS, WALTER, PO Box, 675, 1725 Roodeport, South Africa
(Transvaal)

SHAD, SHABBIR HUSAIN, Pandya House, 5th Floor, 103 Modi Street, Fort, Bombay 400-001, India
(General Overseas)

SHAW, PETER JAMES, 9 Naples Road, Darwen, Lancashire BB3 3JL
(Manchester)

new members

SHROFF, FARROKH, MSc, Hoechst Canada Inc., 100 Tempo Avenue, Willowdale, Ontario M2H 2N8, Canada
(Ontario)

TAN, HILDUARD, 20 Ben Lomond Crescent, Pakuranga, Auckland, New Zealand
(Auckland)

Associate Members

BARKE, ROY DUDLEY, PO Box 2953, Cape Town 8000, South Africa
(Cape)

HUNTER, R. ALASTAIR, S. Banner & Co. Ltd, 20 Pinkston Road, Glasgow
(Scottish)

Registered Students

REYNOLDS, RONALD GUY, PO Box 6151, Dunswart 1508, Transvaal, South Africa
(Transvaal)

SOUTHWORTH, MARK ANTHONY, Leyland Paint & Wallpaper Ltd, Northgate Leyland, Lancashire PR5 2LT
(Manchester)

occa diary

Details are given of Association meetings in the United Kingdom and Ireland up to the end of the third month following publication.

March

Manchester Section: Student Works Visit. *Details to be announced.* Informal Buffet Dance. *Details to be announced.*

Monday 2 March

Hull Section: Ladies' Evening. *Details to be announced.*

Tuesday 3 March

West Riding Section: "Colour Systems" by G. Pakvis and L. Wehrens of Tenneco Colotrend BV, at the Mansion Hotel, Roundhay Park Leeds 8, commencing at 7.30 p.m.

Thursday 5 March

Newcastle Section: "A Hundred Years of Colour Chemistry" by Prof. Rattee, Colour Chemistry Dept. University of Leeds, at the Students Common Room, St. Mary's College, Elvet Hill Road, Durham, commencing at 6.30 p.m.

Monday 9 March

Manchester Section: Lecture "Medials" by Manchem Ltd at the Crest Motel, Bolton, commencing at 6.30 p.m.

Wednesday 11 March

Scottish Section - Eastern Branch: "Line Measurement of Colour" by Dr Ferguson of Instrumental Colour Systems. This is organised by BP and BIF Scottish District, and will be held in the King Malcolms Hotel, Dunfermline, at 7.30 p.m. to which all interested persons are invited.

Thursday 12 March

Scottish Section: "Pigments" Film and Lecture - Lecturer from BASF Ltd, at the Albany Hotel, Glasgow, commencing at 6.00 p.m.

Trent Valley Branch: "British Rail Specifications - What, Why and How" by Dr F. G. R. Zobel, Head of Surface Coatings Laboratories British Rail, at the Derby Crest Motel, Pasture Hill, Littleover, Derby, commencing at 7.15 p.m.

Wednesday 18 March

London Section: "Applications of

Colour". Joint one-day symposium with the Society of Dyers and Colourists, London Region at the Thames Polytechnic, Woolwich, SE18, commencing at 10.00 a.m.

Ontario Section: Meeting at the York Suite of the Cambridge Motor Hotel, Ontario, commencing at 6.00 p.m.

Thursday 19 March

Midlands Section: Newton Friend Ladies' Invitation at Chamber of Commerce and Industry, Birmingham. "National Trust" by Mr Harrison of the National Trust.

Thames Valley Section: "Developments in building chemicals and compositions" by Dr Maurice Wilkinson of Blundell Permgolaze Ltd, at the Beaconsfield Crest Motel (White Hart), Aylesbury End, Beaconsfield, Bucks, commencing at 6.30 p.m. for 7.00 p.m.

Friday 20 March

Bristol Section: "Solvent evaporation - some interesting aspects", by Mr D. Clark of BP Chemicals Ltd, at the Post House, Cardiff.

Irish Section: "Timber Preservation" by E. A. Hilditch, Technical Director, Cuprinol Ltd, at the Clarence Hotel, Dublin, commencing at 8.00 p.m.

Friday 27 March

Bristol Section: Ladies' Night. *Details to be announced.*

April

Thursday 2 April

Newcastle Section: Annual General Meeting. *Details to be announced.*

Monday 6 April

Hull Section: Annual General Meeting at the Queens Hotel, George Street, Hull, commencing at 6.45 p.m.

Tuesday 7 April

West Riding Section: Annual General Meeting at the Mansion Hotel, Roundhay Park, Leeds 8, commencing at 7.30 p.m.

Thursday 9 April

Thames Valley Section: Annual General Meeting, talk "Tourism around the Thames" by Thames & Chiltern Tourist Board at the Beaconsfield Crest Motel (White Hart), Aylesbury End, Beaconsfield, Bucks, commencing at 6.30 p.m. for 7.00 p.m.

Scottish Section: "Glasgow theatres - behind the scenes" by D. Smith of Ault

& Wiborg Ltd at the Albany Hotel, Glasgow. *Details to be announced.*

Friday 10 April

Midlands Section - Trent Valley Branch: Annual General Meeting followed by Buffet Dance at the Cross Keys Inn, Turnditch. *Details to be announced.*

Manchester Section: Annual General Meeting at LCC in the Library, Lancaster and Jubilee Suite. *Details to be announced.*

Wednesday 15 April

Scottish Section - Eastern Branch: Annual General Meeting followed by "Innovations in Wallcovering" by George Niven, Development Manager, Nairn Coated Products at the Murrayfield Hotel, 18 Corstorphine Road, Edinburgh, commencing at 7.30 p.m.

Friday 17 April

Irish Section: Annual General Meeting. *Details to be announced.*

Wednesday 22 April

Ontario Section: Annual General Meeting at the York Suite of the Cambridge Motor Hotel, 600 Dixon Road, Rexdale (Toronto), Ontario, Canada, commencing at 6.00 p.m.

Thursday 23 April

London Section: Annual General Meeting at the Rubens Hotel, Buckingham Palace Road, London SW1, commencing at 6.30 p.m. followed by a lecture of general interest to which members' ladies are invited. *Details to be announced.*

Friday 24 April

Bristol Section: Annual General Meeting. *Details to be announced.*

Saturday 25 April

Midlands Section: Annual General Meeting. *Details to be announced.*

Tuesday 28 April-Thursday 30 April

OCCA-33 Exhibition at the Cunard International Hotel, Shortlands, Hamersmith, London W6. 9.30-17.30 each day.

May

Wednesday 20 May

Ontario Section: Meeting at the York Suite of the Cambridge Motor Hotel, 600 Dixon Road, Rexdale (Toronto), Ontario, commencing at 6.00 p.m.

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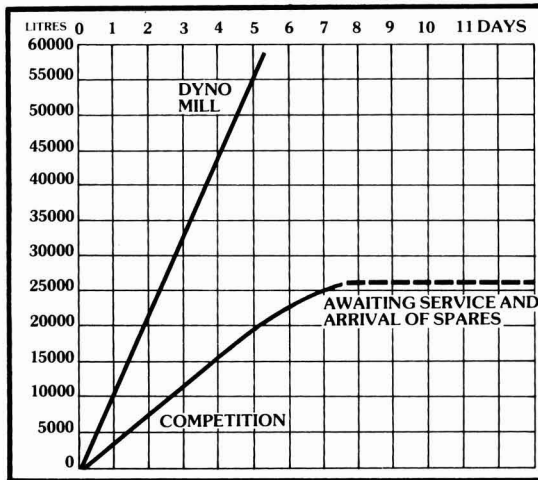
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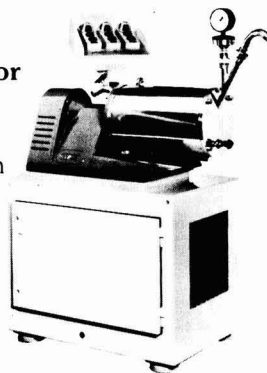
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