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of the

NATIONAL PAINT, VARNISH & LACQUER ASSOCIATION, INC.

San Francisco, California
October 31 - November 3,
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PACIFIC STENOTYPE REPORTING COMPANY

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FIFTH SESSION

November 2nd, 1939

The Fourth Session of the National Paint, Varnish and Lacquer Association met in the Fairmont Hotel, San Francisco, California, Thursday, November 2nd, 1939. The meeting was called to order at 2:30 P. M. by Mr. H. R.Prentys.

CHAIRMAN PRENTYS: We will now call the meeting to order. I am sure we all realize the complexities of modern business and the complex structure involved in its many activities. I am sure none will dispute the statement that in its functioning none is more important than the production of material which we distribute. Without the production of this material we would have very little to do.

With this brief preamble I take pleasure in introducing to you someone who is well known to most of us - Mr. A. E. Stauderman, the Retiring President of the Federation of Paint and Varnish Production Clubs. He is connected with the DeVoe Reynolds Company of Louisville and he will talk to us on "The Highlights of the Federation Convention in Chicago." Mr. Stauderman! (Applause).

THE HIGHLIGHTS OFTHE FEDERATION CONVENTION IN CHICAGO

Mr. A. E. Stauderman,
Retiring President, Federation of Paint and Varnish Production Clubs

MR. CHAIRMAN, MEMBERS OF THE NATIONAL PAINT, VARNISH AND LACQUER ASSOCIATION, AND MEMBERS OF THE LOS ANGELES AND GOLDEN GATE PRODUCTION CLUBS:

I will attempt to skim over the high spots of the Papers presented at the Chicago Federation Convention. I know it would be an easy matter to bore you to sleep with ~~the most~~ scientific data, but I will try not to wear you out to much in that respect, though certain references are unavoidable and will slip in here and there, which I hope you will pardon.

Some fifteen papers were presented, all of which have now appeared in THE AMERICAN PAINT JOURNAL, and bound copies have now been sent to all Federation members.

CHICAGO decided to study "The Losses in Weight and Volume Involved in Varnish Cooking". They report that the loss of weight in resins range from 1% to 39% and that oils range from 1 to 9%, prepared varnish bases from 1 to 13%. Such maximum loss would automatically change the oil length of the varnish from 26 to 33 gallons. The loss in volume or shrinkage due to cooking show linseed oil to lose approximately 4-1/2%, China wood oil 2.3%, and the varnish shrinkage of resins and oils would amount to a solid loss of 3%.

KANSAS CITY endeavored to investigate the "Loss of Drying Power in Brown Paints". They chose a tough question, and unfortunately are still in the dark. While they can make no definite statement as to the cause of the phenonema they will continue the study.

CLEVELAND is studying the effect of "Humidity and Temperature Effects on ~~Productive~~ PROTECTIVE Coatings", and is at present concerned with proper testing technique. As we all know, the effects of moisture on ~~productive~~ PROTECTIVE coatings are as complex as they are important. This complexity is matched by the number of studies of the subject appearing in the literature and the diversity of approach to the subject. A Carrier Brief is employed as a principal unit of their testing equipment, ~~Here~~ capable of providing constant temperature from room temperature to 200 degrees F., and from room humidity to nearly 100%. It looks as though they will get somewhere in the study.

LOUISVILLE, in studying "Effects of Resins on Kauri Reduction" brings out the fact that there is a great divergence of ~~carrier~~ KAURI reduction values between 100% phenolics and of non-phenolics, Ester Gum and Rosin. Even at 50 gallons, where the effect of the oil is considerable, rosin varnish has a much lower reduction value than the Phenolics. A rather unique idea of running K. R. ~~reduction~~ figures on various oils at varying viscosity shows that as the oil is bodied, its K. reduction or elasticity is lowered. For instance, "E" bodied linseed oil has a K. R. of 310, yet this same oil bodied to "Z-5" which is much like heavy molasses in consistency, would have a K. ~~reduction~~ value of 270. A combination of 90% wood oil and 10% linseed oil would run 280. All resins used in the test except 100% phenolics have an embrittling action on the oil greater than might be expected. This Paper shared second-class

honors with the Philadelphia Paper on Pictorial Standards among the research papers competing for the American Paint Journal Award.

THE BALTIMORE CLUB by means of a series of interesting tables and graphs show the hiding power of a given weight of pigment to be different at different pigment/non-volatile ratios, and state it is futile to attempt to assign absolute hiding values to pigments. The title of this paper, "The Effect of Pigment Concentration on the Hiding Power of White Pigments" won the first prize for research papers made possible by The American Paint Journal.

MONTREAL in their third published study on Driers point out that the moisture content of pigments should be kept as low as possible, as contained moisture greatly effects drying. This is definitely shown to be so when flushed colors are used. They also bring out the fact that the sweating of paints or pastes before use does not correct for drier absorbtion. The interesting possibility of overcoming drier absorbtion by the use of coated pigments is shown. They also claim that contrary to the popular belief, turpentine does not hasten the drying of linseed oil.

The DETROIT paper covers the evaluation of many wetting agents and their effects on Titanium Calcium pigment and Titanium Dioxide. The method of measuring dispersion by means of the X-ray diffraction pattern (the method used by the Ford Motor Company) is also described in this paper. It is thought that this method will aid them considerably in the further study of wetting agents.

The C. D. I. C. Club reported the "Study of Bodying Dehydrated castor-oil With Other Oils". They observed the behavior of several commercially available dehydrated castor-oils used in combination with Soya, Fish, Tung and Perilla Oils. Modified phenolic resin, 100% phenolic resin and Maleic resins were made in varying lengths with these oils. Complete tests covering viscosity, color, gravity, drying time, water resistance, alkali resistance, and hardness were run. While none of the castor-oils worked with, could be classed as a direct substitute for Tung, varnishes can be made with them that are equal to medium length Tung oil varnishes in all respects, simply by changing cooking procedure or resins, or both. A very interesting paper, and timed just right.

PITTSBURGH is studying "The Painting of Brick Surfaces" and while this is a progress report only, the construction of the various primers employed is interesting. Whether the attack is comprehensive enough is questionable.

The LOS ANGELES paper, "Viscosity Reduction Method" for Commercial Evaluation of Hydro-Carbon Solvents for Synthetic Varnish Resins" was very well prepared and presented. They depicted a question of practical evaluation of the solvents in a unique and interesting way. Complete study of the paper is necessary to fully appreciate the work of the authors and the paper certainly merits this study.

One group of the PHILADELPHIA CLUB "Proposed Pictorial Standards for Designating Degrees of Failure of Organic Films". They acknowledge the usefulness of the paper presented by the New York Club in 1931. "Code for Designation and Evaluation of

Exposure Tests on Paint, Varnish and Lacquer Coatings". They suggest that this system which is now in general use, be embellished with groups of standards in photographic form which would depict various degrees and types of failure. Such photographs would cover checking, cracking, flaking, erosion, chalking, mildew collection and rusting. It was thought that such standards would be of real value in recording the picture of the degree of failure at the time of observation. A rather practical idea -- one which might prove of considerable value. This paper shared second place honors with Louisville for the American Paint Journal Award for Research Papers.

Another group of the PHILADELPHIA CLUB in reporting the second addition "Proximate Analysis of Hydro-carbon Thinners" report the need of control of aromatic content of high solvent power in hydro-carbon thinners to be most important. They propose a change in the method of determining this aromatic content substituting fuming sulphuric acid for silica gel. They report that their new method is accurate and the precision excellent.

GOLDEN GATE. The Golden Gate Club in their study of "Primers for Non-Ferrous Metals" has certainly chosen a modern subject, and one that is rapidly becoming of increasing importance due to the unprecedented increase in aircraft production. While many non-ferrous metals are used for this work, the Club wisely confined its study to magnesium and aluminum alloys. Of the 14 available magnesium alloys they selected three most commonly used types. They also selected six types of the fifty available aluminum alloys. A primer . . .

made in accordance with Navy Aeronautical Specification P 27b was selected as standard. 104 additional primers embracing almost every conceivable formulation for replacement were ~~also~~ made. All told, the study comprises some 250 tests which are exposed in two different sections of this general locality. The finish coat was the same in all cases, being 2 pounds of aluminum paste and one gallon of spar varnish meeting Navy Specificat~~ion~~ V 10c.

The Club is to be congratulated on the selection of such a subject, and we will follow future reports with interest.

NEW YORK. The New York Club in their paper, "Measurement of Adhesion of Dried Coatings" said that adhesion is accomplished by two forces, mechanical and specific. Mechanical adhesion being the characteristic of the base material, while specific adhesion is the characteristic of the film and base. They have developed a new method for measuring the specific adhesion known as the "direct tensil method" which is applicable to a wide range of coatings. It is simple and the results are reproducible. Values are given in pounds per square inch. They have also designed a "quantitative knife-blade" method and of course the instrument. They believe that this is an improvement over the regular knife-blade or finger-nail test since it permits a quantitative measurement of knife pressure in removing film. Further work is necessary to correlate existing methods before it is to be made available for testing laboratories. 001952

This paper was given second prize for practical papers

in the American Paint Journal Award.

NEW ENGLAND. The New England Club reported on "Study of Natural Resins in Combination with Synthetic Resins for Floor Varnishes". They wish to investigate whether natural resins would improve toughness, wear-resistance and general durability of floor varnishes. The claim is often made that old-time varnishes were far more durable than the fast-drying floor varnishes of today. Also it is true that many of the technical men of today have entered the industry after natural resins have been replaced by synthetic resins. A greater knowledge of the natural resins would be of advantage to the younger men, and that Club is to be commended for this thought. Their results indicate that better wearing floor varnishes can be mafe by utilizing the ~~Quick~~ Good adhesion and wearing qualities of Pale East India, ~~Batu~~ BATU, Pontianak and Esterified Congo, which have been modified with small amounts of phenolic resins (not the heat reactive type) to provide increased water, alkali and gas checking resistence.

This paper won the American Paint ~~General~~ JOURNAL Award First Prize for practical papers, which we believe was truly deserved.

The Paint Forum Meeting was splendidly handled by Mr. R. J. Smith, our newly elected president. Over 400 attended this meeting and stayed throughout the session. The discussion of 26 major questions will be reported in the December issue of The Official Digest.

The Federation went on record to recommend that reference to specific quantities of wood oil be omitted from Federal specifications, and that in the future such specifications read, "China Wood Oil or approved Substitute".

The honors for the presentation of Club papers went to Chicago, Baltimore and New England Clubs in that order.

I might state that the Paint Show this year was a very remarkable success. There were 33 exhibitors occuping about 54 booths. Incidentally, all through the Federation meeting there was certainly a huge crowd attending the exhibits although I do not believe that effected the attendance at the meetings. They came early and stayed late. We think it was a most successful Paint Show and mainly due to Mr. Maniman and due also to the fact that the Stevens Hotel in Chicago, where the convention was held, had ample display facilities. The air was excellent and there was plenty of room. I believe the Paint Show this year was better than all others.

You have probably been advised of the election of officers. Mr. R. J. Smith was elected President, Mr. R. P. Prentys who is Chairman was elected Vice-President, Mr. Clark was elected Treasurer and Mr. Heckel Secretary. Mr. Eastwood of the Golden Gate Club was elected a member of the Executive Committee, Mr. Hancock of Kansas City and Mr. Douts of the Southeastern State Federation was also elected, as well as Mr. Cusper of the New England Club was retained. Thank you. (Applause).

PRESIDENT TRIGG: May I just say a word. I think we are all getting first hand data of the value of the work which is being done by the production groups. We appreciate Mr. Stauderman's report here today and I think it would be very nice,

Mr. Chairman, if this meeting were to express to Mr. Stauderman its appreciation for the time, work and effort and accomplishments in his term of office as President of this Federation. I so move.

CHAIRMAN PRENTYS: Gentlemen, you have heard the motion.

... The motion was seconded, put to a vote and it was unanimously carried. ...

CHAIRMAN PRENTYS: I wonder if anyone has any questions to ask Mr. Stauderman on the highlights of the Chicago convention.

I am told that there will be a special publication covering the papers that were presented there in detail, as well as the details of the discussion here today.

I will now turn the meeting over to Mr. Grieve, President of the Golden Gate Production Club, and he will introduce the next speaker.

CHAIRMAN GRIEVE: Within the past year the members of the Golden Gate Club had the privilege of hearing a lecture and discussion on a subject which proved most interesting and beneficial to them. The subject was "The Fouling of Submerged Surfaces and Possible Preventitive Procedures". The reception given that lecture at the time was very gratifying. It was the opinion of our Committee on Arrangements that we might have

a talk on this subject here today. We have been successful in accomplishing that very thing.

It is with a great deal of pleasure that I turn the meeting at this time over to Dr. Claude E. ZoBell who is Marine Micro-Biologist and Assistant Director at Scripps Institution of Oceanography at La Jolla, California. He will talk to us on "The Fouling of Submerged Surfaces and Possible Preventitive Procedures". Dr. ZoBell! (Applause).

THE FOULING OF SUBMERGED SURFACES AND POSSIBLE PREVENTITIVE PROCEDURES

"The Biological Approach to the Preparation of Anti-fouling Paints."

Dr. Claude E. ZoBell
Scripps Institution of Oceanography
University of California, La Jolla

It is deemed an honor to be afforded this privilege of discussing with members of the National Association certain biological aspects of the fouling problem that may be of interest to the paint technologist. For many years I have been actively interested in the fouling problem, and while other responsibilities prevent me from devoting my time exclusively to its study, I follow the developments in this field with much interest. It is gratifying to have been instrumental along with Professor W. E. Allen and Director H. U. Sverdrup of the Scripps Institution of Oceanography in initiating a co-operative project with the Bureau of Construction and Repair of the United States Navy Department for the intensive investigation of primary film formation and possible preventive procedures. More recently a similar project has been started at the Woods Hole Oceanographic Institution on the East Coast where I have been during the past summer months. Very encouraging results are accumulating from these studies on primary film formation, but since the prevention of fouling is

of considerable importance in increasing the effectiveness of the Navy in the stratagem of national defense, these findings must be regarded as military secrets. However, I hasten to assure you that while definite progress is being made, the fouling problem still awaits solution.

It is my opinion that the responsibility for the solution of this troublesome and expensive problem rests squarely with you. You command the services of the most capable technical and production men, you possess the research facilities, and the ultimate gain by the paint industry would be second only to the benefits to the Navy and the merchant marine. It has been charged that the paint industry itself is largely responsible for failing to fabricate effective anti-fouling dressings for boats' bottoms because it may seem to be good business to sell such materials every year rather than only once every two or three years. However, little credence is given to this accusation in view of the record of the industry of producing paints for other purposes which are more and more durable. If progress in the development of satisfactory anti-fouling preparations has lagged far behind other technological developments, it is partly because of the excessive expense of experimentation, partly due to the complexities of the fouling problem and partly because the fouling of ships' bottoms has become accepted as a necessary evil.

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Fouling is the attachment and growth of both plant and animal organisms on ships' bottoms, piles, water conduits and other submerged marine structures (Fig. 1). Virtually all types of structural materials whether they be wood, metal, concrete, glass or plastics will sooner or later become fouled. In popular or nautical parlance this accumulation of fouling organisms is termed "barnacles", "shells", "seaweeds" or "moss". While barnacles are usually the principal offenders, there may be a score or more of other animals as well as plants present, and not infrequently over a hundred different species of organisms have been identified in fouled surfaces.

Microscopic observations indicate that organisms begin to attach to most solid surfaces almost immediately after they are immersed in the sea although it may be several days or even a few weeks before the growths become macroscopically visible. The continued growth of the fouling organisms accompanied by their multiplication or reproduction and the attachment of other organisms oftentimes on top of each other may ultimately result in fouling cumulations which are 2 or 3 inches or more in thickness. Sometimes nearly a hundred tons of such organisms will be found on the half acre or more which constitutes the bottom of a large vessel after it has been at sea for a year.

Fouling organisms retard the progress of a vessel

through the water. They may diminish the speed of the vessel by as much as fifty per cent, prolonging the voyage and materially increasing fuel consumption. Finally after a few months conditions become so bad that the vessel must be taken out of service, dry-docked, cleaned and re-painted, depriving commercial carriers of revenue in the meantime and interrupting the activity of other craft. For the larger passenger carriers like the Normandie, Queen Mary, Bremen, or Roma this process costs around $100,000 and must be repeated at least once a year. To operators of smaller craft ranging in size from the smallest dinghy afloat to the most luxurious yacht fouling organisms are a constant source of annoyance and expense. The attachment of fouling organisms on the pontoons of hydro-planes rapidly reduces their lifting load and cruising range. The volume of sea water which will pass through a pipe line is soon lessened by the attachment and growth of fouling organisms in the conduit regardless of whether it is constructed of lead, iron, concrete or other material. In short, it is estimated that in the United States alone between one and two hundred million dollars tribute is being paid each year to fouling organisms.

The fouling problem has undoubtedly challenged the ingenuity of man ever since he put to sea in a boat. The first small craft in use were probably hauled ashore at frequent intervals thereby causing the desiccation and death

of the fouling organisms. Others were beached in the surf where they were cleaned by the scouring action of sand and broken shells. It being impractical to beach larger vessels, early attempts were made to repel fouling organisms by covering the vessel's bottom with sheet lead held in place with copper nails, and various other combinations of metals which produce electrolytic effects have been tried. Some navigators still run their vessels into fresh water for a few days whenever this is feasible to kill the attached organisms, although the merits of this procedure are hotly contested by sea-faring men. Under certain conditions the fresh-water treatment affords temporary benefit but since only the succulent growths drop off, the remains of other organisms having calcareous or chitinous holdfasts may actually aggravate the fouling of the vessel when it returms to sea.

Literally thousands of patents have been taken out in this country and abroad on various preparations, special procedures and mechanical devices designed to prevent the fouling of vessels. Many of these show some promise but I am aware of no practical method that gives boats' bottoms the desired protection. Most of the procedures which involve the use of mechanical devices, compressed gases, chemical treatment, refrigeration or electrical potentials present difficult, if not insurmountable, engineering problems.

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The majority of the preventive procedures have centered around the idea of finding a paint or dressing to apply to ships' bottoms which will discourage the attachment and growth of fouling organisms. Some fairly efficacious products have resulted but the world is still awaiting the development of anti-fouling paint which is entirely satisfactory. The chief difficulty is getting a mixture which has more permanent anti-fouling properties. If it is compounded in such a way that it exfoliates or chalks-off fast enough to prevent the accumulation of fouling organisms, it doesn't last long enough to be practical. Similarly if soluble poisons are used in the paints, they leach out in a short time leaving the vehicle porous and thus render the surface susceptible to deterioration and the subsequent attachment of fouling organisms. If less soluble poisons are used, they fail to leach out in sufficient concentration to have the desired effect. Confronted with these difficulties and knowing little of the life-histories or habits of fouling organisms, most marine paint manufacturers and consumers have placed the emphasis upon the anti-corrosive properties and durability of their products. Then using rule-of-thumb or "shot-gun" procedures they have tried a little bit of everything in their anti-fouling paints which precedence rather than direct experimentation indicates might discourage the barnacle and his nefarious allies. Consequently progress has been slow.

In testing the anti-fouling properties of a paint it must be recognized that there are several factors which influence the amount and extent of fouling. For example, other things being equal, fewer fouling organisms will attach to test panels (Fig. 2) in turbulent waters than in calm water. By the same token vessels which are more or less in continuous operation will be fouled less than those which are inactive much of the time. Thus vessels which are out of commission, light-ships, colliers and battleships in times of peace will be fouled more than passenger liners, destroyers and freighters. The cruising speed of the vessel also influences the attachment and growth of fouling organisms as do the structural relations and contour of the hull of the vessel. Some sedentary organisms show a preference for the underside of horizontal plane surfaces, others settle and set principally upon the top side of plane surfaces while still others prefer plane surfaces which are at some angle to horizontal. It may be partly for this reason that rough surfaces are fouled worse than smooth surfaces even though the irregularities are microscopic in size because, indeed, the fouling organisms are themselves microscopic in size at the time of attachment.

In general, vessels foul more readily in warm than in cold water. This is illustrated by Figure 3 which shows the relationship of temperature to the rate of growth of mussels

attached to experimental blocks in the sea at La Jolla. The fact that the period of the maximum rate of growth of the mussels precedes by a few weeks the maximum water temperature is probably due to the seasonal abundance of foodstuffs in the water and this in turn is influenced by a multiplicity of other interrelated factors besides temperature. The temperature of surface sea water is largely a function of the latitude, oceanic circulation and season.

The amount and kind of organic matter in the water is another factor of importance. Organic matter might exert a protective action against toxic agents. It favors primary film formation, and it serves as food for fouling organisms. Moreover, the kind of fouling organisms found in water is influenced by the organic matter content. As a rule test panels and ships foul more quickly and more severely in the polluted waters of bays than in the open sea.

The abundance of any given fouling organism in a given locality exhibits marked seasonal periodicity. Whereas there will be some algae and diatoms attaching to test panels throughout the year at La Jolla with the maximum number in February and March, bryozoa (moss-like colonial animals) attach only from April through November with the maximum during the midsummer months. The relative seasonal abundance of the larvae of other kinds of fouling organisms in the La Jolla region is

shown graphically by Figure 4. From this chart it will be noted that if test panels were immersed in the winter, one might expect to find few or no barnacles, oysters, bryozoa, tunicates, sponges or mussels for three or four months regardless of whether the test panels were protected with an anti-fouling paint or not. Radically different seasonal periodocities of fouling organisms might prevail in other localities. Moreover, due to various reasons some of which are not well understood by oceanographers, the same seasonal periodicity may not occur each year in a given locality.

The irradiation of test panels influences the quality and quantity of fouling organisms which attach. Filamentous algae usually predominate on test panels which are near the surface of the water where they are well illuminated while at greater depths where less light penetrates barnacles, bryozoa, and hydroids predominate. There is evidence that cyprid barnacle larvae and the free-swimming forms of certain other sessile organisms are photophobic or light-sensitive which causes them to seek areas of semi-darkness before "setting" on a solid surface. This has been shown strikingly by the work of Visscher who reports that not only do barnacle larvae show a preference for shaded areas; they actually settle in greater abundance on black, dark green, chocolate or red surfaces than upon yellow, white or light green ones. This

suggests the desirability of experimenting with light-colored paints in place of the dark-colored ones now in common use.

Most control measures have been directed against barnacles because, of the many kinds of fouling organisms, barnacles are usually the most conspicuous. More than 150 different species of barnacles have been described. Acorn barnacles (Fig. 5) are perhaps more troublesome than the stalked or gooseneck variety because the former attach themselves to solid surfaces with a lime-like cement and remain there dead or alive while if the stalked barnacles can be killed with poisons or otherwise they drop off. Once the acorn barnacle has succeeded in cementing himself to a ship he is quite safe from poisonous paints within his calcareous shell with its functional mouth growing farther and farther away from the surface as the organism increases in size. Being hermaphroditic or capable of self-fertilization each individual may produce young, many of which settle down in a a circle around or upon the parent. In warm water there may be two or more generations produced in a year, and single individuals may attain a diameter of an inch or more and twice this height in one season. Other points of interest concerning the life history of barnacles with emphasis upon the reasons the barnacle is virtually immune to the action of ordinary poisonous paints have been summarized in an earlier

number of the Official Digest (Volume 178, pp. 379-385, 1938).

The microscopic examination of glass slides reveal that within a few minutes after they are submerged in the sea film formation begins (Fig. 6). Bacteria are the first organisms which appear and within a few hours several hundred thousand bacteria are found per square inch of glass so tenaciously attached that they resist dislodgement in running water (Fig. 7). Differential staining procedures supplemented by micro-chemical analyses show that the attachment of bacteria is accompanied by the accumulation of organic matter both particulate and dissolved. Although sea water normally contains less than 10 mgm. of organic matter per liter, enough is absorbed by glass slides to give a positive test. The attached bacteria commence to multiply at the expense of the organic matter and micro-colonies become evident within a few days. In the meantime other bacteria are attaching and more organic matter is accumulating.

Once this primary film has begun to form it serves to enmesh and hold additional amounts of detritus as well as both living and dead microorganisms. Then in rapid succession there appear increasing numbers of diatoms (microscopic plants), and the larvae of various sedentary or sessile forms such as barnacles, bryozoa, worms and others. Table 1 shows the average number of predominating organisms found by Miss

Esther Allen per square inch of glass slide submerged in the sea at La Jolla during the month of June.

Type of organism	Period of submergence 24 hours	48 hours	96 hours
Bacteria	1,876,000	13,240,000	78,100,000
Diatoms	940	3,750	8,200
Protozoa	72	290	1,100
Barnacle larvae	0.1	0.3	1.2
Others	389	1,360	9,700

Appreciable numbers of barnacles are usually not found for a week or two after a clean surface is immersed in the sea, but if the slides are covered with a film of bacteria in the laboratory prior to immersion, barnacles appear sooner and in greater numbers. This together with other observations suggests that the primary film favors the attachment of sessile forms. On the other hand it has been reported that "slime" inhibits the "setting" of oysters. It is understandable that a layer of slime several millimeters in thickness might prevent the attachment of certain sedentary organisms because the larval forms are unable to penetrate it to the solid surface below. Furthermore the slimy growths which are frequently found in bays and estuaries may render conditions anaerobic and otherwise vitiate the environment thereby discouraging

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the approach of the larval sedentary animals and preventing the growth of those which might become enmeshed.

Primary film formation might promote the fouling of submerged surfaces in a variety of ways: (1) By enmeshing the free-swimming larval forms of the fouling organisms or otherwise mechanically facilitating their attachment. (2) By discoloring glazed or bright surfaces. (3) By serving as a source of food. (4) By protecting the fouling organisms from the toxic constituents of poisonous paints. (5) by increasing the alkalinity of the film-surface interface, thereby favoring the deposition of calcareous cements by the sessile organisms although if conditions become anaerobic the reverse might occur. (6) By influencing the potential of the surface on which they are growing bacteria might expedite the attraction and attachment of fouling organisms.

More attention should be devoted to primary film formation and methods of its prevention. By following microscopically the sequence of events in the fouling of submerged surfaces information may be obtained which will make it possible to combat fouling more effectively. Moreover, since there seems to be a relationship between primary film formation and the subsequent attachment and growth of macroscopic fouling organisms, primary film formation may serve as a useful indicator of the anti-fouling properties of a paint. This would

effect the saving of much time in the development of an anti-fouling paint.

It is hoped that the foregoing fragmentary outline of the nature of the fouling problem will at least serve to stimulate your interest. A bibliography of selected references is appended for those who desire more detailed information.

In conclusion the opinion is expressed that in spite of the complexities and longevity of the problem, it is susceptible to rational scientific treatment and solution. It seems to be a most promising field for applied research by the paint technologists, but one in which the early life histories of the fouling organisms should be taken into careful consideration with particular attention being given to the sequence of events in primary film formation.

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CHAIRMAN GRIEVE: Thank you very much. We will have time for a few questions if you have some you would like to ask Dr. ZoBell.

MR. J. B. HEYMES: Dr. ZoBell described how the barnacles feed themselves through their mouth. I would like to ask him how they feed themselves if they fasten themselves to the surface on that side. Does he twist himself around?

DR. ZoBELL: As an organism he attaches himself first by means of his antenna. He is first microscopic in size and by the time he becomes visible he is protected. He continues to build himself up and as he builds his house larger and larger it is further and further away. They attach themselves with a lime-like cement and remain there dead or alive. They are there permanently unless freed by a mechanical disturbance. There is not enough poison in the paint to irritate him. During the first two or three weeks that he is fastening himself to the surface he does not eat so therefore it is impossible to poison him them. By the time he does eat he cannot be poisoned and it is then necessary to irritate the very sensitive antenna by giving him an electrical shock or something of that nature.

MR. MacINTYRE: I suppose that these slides you showed us were painted surfaces.

DR. ZoBELL: In order to hurry through this paper,

there are some things that I did not go into in detail; as a matter of fact, the pictures that I showed you were taken on tile.

MR. MacINTYRE: I have tried the same procedure using baked finishes in trying to verify that result. Apparently, the barnacles in our neighborhood vary.

DR. ZoBELL: At what depth was that?

MR. MacINTYRE: At from four to ten feet. There was the same growth on all colors.

DR. ZoBELL: That is a very interesting experience.

A DELEGATE: Please tell us about the effect on wood pilings or other wood surfaces.

DR. ZoBELL: Most of my experiments have been with marine structures but I know others have had the same trouble with wood pilings, conduits and so forth. The barnacle passes through a complex life history from the time the microscopic larvae begins. As soon as he gets in contact with wood he will proceed to get a foothold and as soon as he has he will very effectively protect himself. Here is where your marine paints come in and it is a matter of poison.

A DELEGATE: What is the effectiveness of light and dark surfaces.

DR. ZoBELL: Plant growths such as algae and diatoms are not repelled by light surfaces although many animals are repelled.

CHAIRMAN GRIEVE: Are there any other questions?

If not, we will start in on the Open Forum Discussion. Before we start, I would like to point out again that a transcript is being made of all the discussion that is going on today. It will not be necessary for you to take notes but it will be necessary, in order to complete the record, that, if you have a question to ask or a contribution to make, that you stand up and speak clearly as well as give your name in order that the stenographer can make the record.

We are going to depart from the orderof the questions as printed here. The first question for the afternoon will be the one listed as second on the program, "Roller, Pebble and Stone Mills" and it will be delivered by Mr. R. Rucker.

ROLLER, PEBBLE AND STONE MILLS

R. Rucker

It is through consideration and discussion that progress is made in any line of endeavor. That primarily is the purpose of this meeting today.

The second topic for discussion this afternoon is the relative efficiency of roller, pebble and stone mills.

Plants having these three types of equipment usually use each one for grinding a particular type of paint.

Roller mills are used mostly for grinding white and colored enamels and are very efficient because they are rapid and can be easily cleaned. Small batches can be run most economically on this type of mill. Losses are small on batches run through a roller mill due to the fact that very little material is left on the equipment.

Pebble mills are very good especially where large batches are to be made. One excellent feature is that it is possible to put the materials to be ground directly into the mill without preliminary mixing of a paste as is required for roller and stone mills. Losses are extremely small, there being no loss of volatile during the grinding period, and also no loss of base paste in the mixer that occurs with other equipment where it is necessary to make a paste before grinding.

When the mill is to be cleaned in changing from one

product to another, some of the thinner in the formula is held out of the batch and is used to wash out the mill. These washings, of course, are stirred into the batch. When a large number of batches of the same product are to be made they can be run one after another, without cleaning the mill, therefore, eliminating any loss. Material containing large quantities of volatile such as flat wall paints and traffic lacquers are economically ground on pebble mills.

Stone mills are used for grinding and harder pigments such as natural red oxides, crystalline silica and other similar pigments that are very abrasive and would cause considerable wear on roller mills. The largest losses usually occur on paints ground through stone mills due to the fact they grind slowly which allows the paste in the mixer to thicken up and make it hard to scrape down. Where volatile is present in the mix a large proportion of it is lost because of the length of time it is in the mixer.

CHAIRMAN GRIEVE: Is there any discussion?

MR. HEDRICK: Have you found it necessary to make variations in warm weather? I know that seems to be a common practice.

MR. RUCKER: Yes, we have found that some of these mixes vary greatly.

MR. HEDRICK: My experience has been that in warmer weather even the roller mills have a slight tendency to be less volatile than stone mills due probably to the fact that the material stays in the mixer longer.

MR. RUCKER: It depends on the speed of the volatile.

CHAIRMAN GRIEVE: The other thing that is not appreciated on the stone mill is the high temperature on the long run. Sometimes paste will come out at times and be known to cause burns on the flesh which are due to splashing, and that is with a temperature of over 200 it, of course, facilitates removal. Are there any other questions?

A DELEGATE: In regard to pebble mills, I would like to ask if it is possible to produce a whiter enamel.

MR. RUCKER: I have not been able to see any difference. We have run batches in pebble mills and I have not been able to see any difference.

A DELEGATE: In some of the quick drying enamels there seems to be rust spots. I am wondering if there is a

possibility of iron contamination from the roller mills. I am wondering if this could be overcome by grinding those same types of enamels in pebble mills. I have seen this condition in a good many cases. In this enamel that I have ground in roller mills there seems to be a rust spot.

MR. RUCKER: Are you sure that is a rust spot.

A DELEGATE: No, I am not sure. It just gives that appearance and I could not account for it any other way.

MR. RUCKER: In our locality it is quite windy and we get maccadam dust blowing in which leaves that rust appearance. We have checked that.

CHAIRMAN GRIEVE: Is there any further comment on this subject? It is open for a lot of discussion.

We now come to the point where there may be in our production a faulty formula, a faulty material or a combination of both. As to the methods of handling such complaints, Mr. Loeserman will make a contribution on that point.

HANDLING INDUSTRIAL COMPLAINTS

Mr. M. Loeserman

Factors involved in handling industrial complaints can usually be limited to three, namely, material, surface and conditions of application.

Taking them in order, the material should be carefully checked in all characteristics against a standard known to be satisfactory. This should include application of both on as nearly identical surfaces as possible and under identical conditions of application. The retained factory sample, if available, should be included in the test as well as a sample taken from the batch on the job.

It should then be ascertained whether or not a surface condition caused the complaint. Sometimes the nature of the complaint is sufficient to immediately point to bad surface conditions. Examples would be blistering and crawling. In the discussion to follow you will probably have many other examples.

Finally, the conditions under which application was made should be investigated. Type and amount of thinning should be determined. If the material was sprayed, the spray system should be gone over for cleanliness, pressures, moisture elimination, gun adjustments along with type of gun used and so forth. While the weather is usually blamed, sometimes

laughlingly and sometimes not, weather conditions should be eliminated as a possible cause of complaint. On baked products, possible causes might be unintentional changes in baking time or temperature due to faulty recording instruments, difference in time between application and baking, unusual drafts in the oven, changes in gas-air ratio of burner, and so forth. Here, too, your discussion will no doubt bring up unusual experiences in locating sources of trouble. Investigation should, if possible, be made with the actual applicator. By his answers, attitudes and general manner it is sometimes possible to discern other hidden factors having some bearing on the complaint.

The "trouble shooter" in industrial work can usually by an elimination process limit possible reasons for the complaint and by checking these, arrive at a solution. His extra-vocational requisites are a little intuition, tact, psychology, and the ability to put a few "leading" questions.

CHAIRMAN GRIEVE: Does anyone have any comments to make or a contribution to add?

... No response ...

CHAIRMAN GRIEVE: If not, we will go on to the next paper which is "Permanent Color Standards". It will be presented by Mr. W. J. Quinn

PERMANENT COLOR STANDARDS

W. J. Quinn

Mr. Chairman, Members of the National Paint, Varnish and Lacquer Association, Los Angeles Paint and Varnish Production Club, Brother Members of the Golden Gate Paint and Varnish Production Club and Guests: The subject I am going to discuss is Permanent Color Standards.

Since the beginning of the paint industry, permanent color standards have been a universal problem. Many experiments have and are now being made in an earnest effort to protect the consumer from variation of shades. We are here to discuss some of the successes or failures.

Standards have been made of lard oil, porcelain discs, tile, lacquered sheets, and photo electric cell readings in an attempt to control color matches.

The lard oil standards had a tendency to flooding with the resultant error in judgment of matches.

Baked tile or porcelain discs were hard to obtain in

the wide range of shades required, and due to light reflection, were hard to match.

The drift standards of lacquered cardboard which match the standard shades are more accessible, but again there is no guarantee as to the amount of fading which will take place over a period of time.

The photo electric cells readings are not constant as the cells vary in light intensity. The instrument has to be calibrated before each reading, and a brightness reading made at the same time with relation to the magnesium oxide block. It is very sensitive and requires much practice to operate, and as so many variables enter into the picture, it is almost impossible to duplicate readings.

Until some other time when some different method or instrument is devised and has proven accurate for color determinations, the paint manufacturer will have to be content with the methods now in vogue.

The Production Departments are doing their best to maintain standards through laboratory control of paint-outs, close scrutiny of the same before releasing, and protection of the standards from contamination.

At this time a few thoughts on the reduction of color complaints with reference to the Advertising and Sales Departments may not be amiss. As a large quantity of paint is sold

from color cards it is imperative that shades shown are close matches to the standards. Surprising as it may seem, there is a great discrepancy and greater concern should be exercised by the Advertising Department in keeping a closer control over them. The Sales Department's responsibility in this matter should be to advise those selling to the public to fill orders from the same batches if possible. This is very simple to do as code dates are shown on all containers.

The most apparent questions that come to mind are:

1. What is being done to prevent contamination of standards?

2. What is the most logical size and type of container?

3. When should standards be renewed?

Suggestions and experiences on this subject are now open for discussion with the hope that some universal method for the protection and maintenance of standards will be advanced and developed.

CHAIRMAN GRIEVE: That is an age-old subject in our industry and there should be some discussion on this.

MR. EASTWOOD: In regard to porcelain panels, I have had some considerable experience with them over the past eight years. Originally we started in, as did many others, in using porcelain panels whenever we could get them and using such as we were able to find to match our standards. Later we were

able to find a satisfactory source of supply and this one company at least will match any color at least within very close tolerance. The difficulty in matching is quite serious, particularly in some of the lighter shades like creams and buffs. It is very difficult to get complete shading on the metal panels. Apart from that difficulty, you will find it a reasonably satisfactory method because no matter what your light variation from the standard, at least your standard is permanent and your variations are within any one limit, from one to the next.

MR. HEYMES: I wonder if any of our Eastern visitors have ever experimented with other vehicles other than lard oil or those comparatively easy to use. Possibly there may be some other vehicle and I was wondering if some of our friends from the East might have some helpful suggestions or information.

MR. EASTWOOD: I have used mineral oils of a similar consistency of lard oil. I have used them in connection with other standards and the differences are much the same in regard to the flow.

CHAIRMAN GRIEVE: In any mineral oil we have used, I have found that it has a slight color of its own.

MR. L. M. DUCOMMON: I am wondering if Dr. Gardner has any suggestions to make.

DR. GARDNER: The only suggestion I have to make is

that the enamel standards should be the best of calibre. There are two firms in the East who regularly make up these standards, The Baltimore Enameling Company and the other the Hyde Fuller Company of Cleveland. The Navy Department has now standardized on something like 20 of their colors. The Navy and War Department say these are very easy to use and to that extent they are just as good as ever.

MR. DUCOMMON: Could you give us any indication of the cost?

DR. GARDNER: It is from seventy-five cents to $1.25 a panel, according to the color.

MR. EASTWOOD: The company I had in mind was the Sheppard Chemical Company of Cincinnati. Their price was $10.00 per batch or fifty cents per panel. They may have changed that, of course.

MR. HAWLISH: I would like to know if you have any suggestions as to how to look for color. If you are matching a sample and you try to match it in one light, and then use another light, you have a different color. Is there any artificial light or anything to keep away from the reflections of light in order that you may satisfactorily see that color the same way every time you look at it. Our experience has been that we think the color is matched and then we turn it the other way and it is not matched. Has anyone any information on that subject that they wish to present?

CHAIRMAN GRIEVE: As far as I know, there is no standardized method of lighting. There have been various lights developed but nothing has been standardized.

MR. STAUDERMAN: This question was discussed in Chicago last week to some extent. It came about in another way but I believe you will find a full discussion of it in the Official Digest and it will contain a complete record of the Chicago meeting. They discussed quite at length the various flourescent lamps of varying colors and it was quite surprisingly brought out how many were using that type of equipment for matching shades and carrying them out so that you would really get all the proponents.

It so happens that my company has among its possessions one gentlemen who is quite an artist in handling these lights. His name of John G. Hand. He is an old man in the Federation. He can give you some information on those lamps, I am sure, and it would help a great deal. Apparently, these lights are becoming in more active use in many of the plants throughout the country. Unfortunately, I cannot give you full information as to how to make them.

MR. EASTWOOD: Mr. Grieve, that was just the reference that I was going to make. I was just going to make the same statement about the Chicago convention when I got up at the same time as Mr. Stauderman. The point that was interesting

to me was that those who are using these lights compare color under different lights so as to get the picture under red and blue, if those were the colors, which I do not just recall, in that way blocking out differences which might not be caught looking at it under the ordinary light.

CHAIRMAN GRIEVE: Was there such a variation looking at it under different lights?

MR. EASTWOOD: At least there was a variation and you do not have the color match.

MR. HEYMES: I would like to ask Mr. Stauderman if he has ever noticed in using these lamps that the hand seems to travel at a terrific rate of speed. Have you ever noticed that?

MR. STAUDERMAN: I have never noticedthat.

MR. HEYMES: We have noticed that. The hand seems to be traveling about three times as fast and it is quite dizzy to the operator.

MR. HEDRICK: I had one of these lights in question in our plant sometime ago. There was a pulsation of the current which is 60 cycles and it rotates so fast. If you speed it up, it reverses and goes backwards. It is quite a problem to keep it down and I do not know how to take care of it. Perhaps a transformer and direct current would do the job.

CHAIRMAN GRIEVE: If there are any more questions,

we will go ahead with the discussion and, if not, we will skip the next paper listed and go on with "Pacific Coast Fish Oils in Paint and Varnish". It will be presented by Mr. Dexter.

PACIFIC COAST FISH OILS IN PAINT AND VARNISH

Mr. Dexter

In describing the subject of paint oils, it seems advisable to me, at least to a certain extent, to include the use of fish oils and possibly classify how the different oils will be used.

Development of the use of fish oils by the paint and varnish industry to its present position as an oil raw material is largely due to their being characterized by the same general structure as the vegetable drying oils.

Of the various fish oils which have been graded and used by the paint trade (Pilchard, Menhaden and Sardine Oils), California sardine oil enjoys a very large consumption, both because of its larger production and greater percentage of drying glycerides.

The iodine number of California sardine oil after the removal of the non-drying stearines by refrigeration ranges between 195 and 200. This, although not a true evaluation of relative drying, shows large potential drying power when it is considered that this iodine number exists as an average in the presence of a large percentage of saturated non-drying

glycerides. Several processes based upon the reduction of these saturated acids or non-drying glycerides contribute to a large potential future use of this oil, provided by-products can be marketed satisfactorily.

The increase in the use of sardine oil itself is natural because of the economy in its use. The amount of research generated by this economy is apparent in its development from a dark, highly oxidized, poorly extracted oil in 1916 to a gradually increasing production of 1750 tank car average over the past five years.

No accurate individual consumption figures are available comparing the different fish oils used by the paint trade. A comparison of production figures of Menhaden and California sardine oil shows production to be three to five times greater in sardine oil than in Menhaden oil produced on the Eastern Coast. Bulk fish oil consumption including all fish oils has ranged from 1,554,000 gallons in 1934 to a peak consumption in 1937 of 3,637,000 gallons. From these figures, it can be concluded that there is an acceleration of use of fish oils not entirely due to increased production and the work accomplished in increasing the use of California sardine oil bears this out.

What is known of the uses and formulations of sardine oil is to some extent kept secret. In general, however, the oil can be discussed with respect to evaluating its good and bad points compared to the vegetable drying oils, its

durability, water-proofness, drying, touchness, elasticity, after-yellow and hardness.

The greatest objection to using sardine oil has been the odor but now that has been practically eliminated and they are permanently deodorizing the oil. The paint manufacturers have found out to a great extent the advantages of its use. One of the worse habits it has is the loss of after-gloss. It is very difficult and I would not have the faintest idea how to explain that.

CHAIRMAN GRIEVE: Are there any questions you would like to ask Mr. Dexter or contribute anything to the question.

MR. STAUDERMAN: I wonder if there is any set temperature in use for sardine oil in this part of the country. We use a 600 or 605 high temperature but I just wondered if you had any set temperature.

MR. DEXTER: I do not believe there is. Everyone's idea seems to be different. The difference has not been determined by myself. There are people who will say the use of a low temperature from 535 produces a true oil and there are others who believe that the use of high temperature would promote the jell structure quite a bit. In my opinion the use of the high temperature in an oil actually gives you a better oil for after-yellowing. You still have to treat the sardine oil for after-yellowing, either with the use of resin or

or the addition of some of the lanolin types. I believe more durability would come about by its being cooked at the higher temperature. Also, there is a point in cooking at the higher temperature. Sometimes it is more practical to cook it at a higher temperature over a long period of time not so much for the reason of giving it body as focalizing the acids which free themselves; hydrozation of the acids which free themselves and which have a tendency to prove drying.

MR. EASTWOOD: It has been my experience that the oil cooked at a high temperature, say 600 degrees, does not dry as well as those which are cooked at a low temperature, say, 535. Do you know why?

MR. DEXTER: I have looked around vainly for someone to answer that question but no one seems to have volunteered.

MR. BOWMAN (Los Angeles): Isn't it a fact that when you boil oil above 535 you get a cloud on it?

MR. DEXTER: I believe that cloud on sardine oil is misnamed. It is possible with the use of solids to extract that cloud from sardine oil and examine it. This cloud has the consistency of lard or I should say hardened oil. It is a very good drying phase. There is one interesting thing I have noticed, although I have not attempted enough work or thought on the subject to figure out exactly what the situation is, and that is that if you take sardine oil and cook it up to 485 or 490, at

just that point primerization begins. Drying off the volatile matter of the presence of steam also helps clear it up. The oil naturally is entirely free of that cloud. If you take oil and cook it up to a higher temperature, and it is fairly thick, it has much more cloud than if you took the oil and cooked it up directly to your higher temperature from the beginning. I would also like an explanation of that myself. The only explanation I can put to that is that the groups which are in the sardine oil have a tendency to primerize at very low temperature, which later is effected, shows a cloud, and it becomes a jell structure.

CHAIRMAN GRIEVE: Is there anything further? If not, thank you, Mr. Dexter.

The next subject for discussion is "How Can a Control Laboratory Check 100% Phenolic Resins Accurately?" It will be presented by Mr. Heymes.

HOW CAN A CONTROL LABORATORY CHECK 100% PHENOLIC RESINS ACCURATELY

Mr. J. B. Heymes

Mr. Chairman and Guests: I am not going to read a paper. I have been fortunate enough to have some tables which contain all the data that we are going to discuss.

We have separated this into four groups. Group I is not heat reactive nor oil reactive; Group II is Oil Reactive Resins, Group III is heat advancing or resin hardening types,

and Group IV is the Dark - low cost or cresol resins. This is about as good a classification as we could put out.

The characteristics which the Phenolic Resin manufacturers are specific gravity, ASTM. B&R Melting Point, acid value and color. In order to give you a little background, in starting out this work we happened to come across Company A who listed their resins ASTM boiling points in Centigrades. Then we came to Company B and they reported their degrees in Fahrenheit and every other company reported their degrees in Fahrenheit so we had to do some transposing. Likewise, in the color specifications some companies used their own methods and we were forced to make some variations. Some also used the capillary tube or cube in air method and it was necessary there to make some changes. In going through our files we have found these specifications so nicely given but using various methods so we have had to go back and convert the new compilations to the old.

I think a condition of that kind is evidence that we should stick together and have some uniform method in order that there may be no confusion for anyone who is trying to get his data in an intelligent manner. It certainly would be a big help to him if it were uniform.

In considering the matter of the acids, we had a little experience in our organization. We had been buying a certain phenolic resin which had a certain acid value. One day some

one called our attention to the fact that our laboratory was gaining no information as to what performance a resin will yield when combined with oil.

In mixing color there was another thing that gave us a great deal of headache. That was in trying to get this thing so that you could compare them on the same basis. We found that the manufacturers were using a 50 solution in oil and comparing it with the Gardner color standard; the next fellow was taking the American Resin standard as a basis of comparison and the third fellow was using the Barrett color scale, whatever that is. Again, there is no reason why things should not be expressed in terms that a laboratory can take and identify them.

After we did get all of this data it meant very little because we were taking the 100% phenolic resins and reacting them with oil. The melting point became very meaningless and the acid value disappeared and yet in the two main central tests we are using here there is an indication of the quality of our resin. With that in view we contacted several of the resin manufacturers and told them it was time something should be developed in the line of a more significant method of testing. One of the companies suggested that a Brown heat test would be of value. The results we have reported here are not reported with the idea that we were going to write up final

specifications but just with the idea that here is, perhaps, a start for some further work. Our tests, unfortunately, do not show sufficient difference between the various groups of these resins to be considered as any too promising. As far as that is concerned, the official Brown heat test is not any too accurate; in other words, you can pass China Wood Oil on that, run it 12 minutes, and yet the majority of our China Wood Oil, if it is pure, will run roughly about 9 minutes or, perhaps, 10 minutes, but yet under the ASTM test, it came up to 12 minutes. We think the whole subject of determining the purity of oil merits some work in this classification.

We had three recommendations to offer, and we can say:

First - The practice of each resin manufacturer, in employing his own special methods of laboratory control, creates a confusing condition to the technician studying the conflicting welter of figures, supposedly indicating identical characteristics.

Second - The paint and varnish industry is at least partially responsible for allowing this confusion to exist. If the demand for uniformity of specifications were strong enough the synthetic resin manufacturer would quickly act to eliminate this condition.

Third - It would seem highly desirable that the Federation of Production Clubs should take the initiative in

coordinating the efforts of resin manufacturers, the ASTM, or other technical groups in attempting to develop improved control tests, and to induce all concerned to use uniform methods of testing.

CHAIRMAN GRIEVE: There is a lot of meat in that report. Are there any comments on that or are there any contradictory remarks?

MR. HEYMES: I was hoping some of these synthetic resin people would get up and start an argument.

CHAIRMAN GRIEVE: I fail to see any of them rising to their feet. Is there any further discussion on the subject? (No response).

We will go to the next subject, "Metal Bridge Finishing Systems." For that subject we have asked George Lichthardt, Chief Chemist for the Division of Highways of the State of California, to introduce the subject for us. He is in very close contact with the bridge painting as regards the Division of Highways. We welcome his comments on it.

THE DEVELOPMENT OF PAINT SYSTEMS FOR PAINTING IRON AND STEEL

G. H. P. Lichthardt
Senior Chemical Testing Engineer

Mr. Chairman and members of the National Paint, and Varnish Production Club. I feel like a stranger. I probably will be on the defensive. Naturally, I write specifications and I am going to try to defend the reasons why we have to write the specifications in our State work. Some manufacturers rather agree with us and some do not.

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I have taken the liberty of changing the caption which reads, "Metal Bridge Finishing Systems", because with us we can use no one set system. Our work is so diversified that we have to use those materials which in our judgment render the best service. I can point out an example for you of a system that was worked out in a laboratory. It is not very far away from here and some parts of it have been exposed for almost four years. I refer to that little strip of metal from here to Goat Island.

The development of a system of painting for the protection of steel and iron structures demands an extensive study of the problem at hand; and the investigation must cover not only the formulas of the various coats, but also the condition of the metal upon which the paint is to be applied as well as the climatic conditions of the area where the structure is to be erected. There is nothing new in this observation, but often one or more of the statements is ignored.

It has been our experience that failures have occurred in certain locations, whereas in other sections the same paints used have given good service;and our laboratory has been called upon to determine the cause.

The greatest trouble encountered has been where the bridges are located on or near the seacoast, and it has been learned by costly experience that painting systems must be

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devised so as to cover each individual case and that a standardized procedure will not yield the results desired.

The practice of the Bridge or Maintenance Department is to first institute a thorough investigation of the location where the structure is, or will be erected, taking note of the climatic characteristics such as wind, fog, distance from the ocean, rainfall, as well as destructive fumes or gases; in fact, all factors which may affect the application of or the life of the paint. The painting system for the particular project is selected only after this information is obtained.

Overhead railroad crossings require a special study as in these cases the paint will be subjected not only to ordinary influences but also to heat, blast, sand, and acid fumes. The subject of writing the state paint specifications is not a simple procedure as it is in the matter of house painting.

The writer may mention a bridge adjacent to the ocean in the southern part of the state. Here it was impossible to protect the steel for a reasonable length of time and extensive studies were made to ascertain the cause of failure. Chemical analyses revealed that the atmosphere contained hydrogen sulphide which immediately attacked the newly sandblasted steel and the invisible film of gas could not be observed. The application over this surface entrapped the deleterious

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material and consequently rusting occurred under the protective coating.

Citing another instance, reference is made to a bridge exposed to salt air where again difficulty was encountered. In this case the structure was built by one of the counties many years before and had been sandblasted and painted several times with various systems but small rust spots with pitting continually appeared after a short time. As the steel was rather rough, it was thought that there was some impurity in the metal which caused the failure. A small minor member was removed and sent to the laboratory for photo-micrographic examination. In preparation for this the section was sandblasted and thereafter washed with distilled water. These washings responded to the chemical tests for salt. In this case the metal had evidently been at the bridge site for some time before erection and had rusted in the salt contaminated air. While the sandblasting removed the rust and exposed the bare metal, the salt which had crystallized on the original slightly rough surface was still present.

Chemical examination of surfaces requiring repainting or additional coats has revealed hazards usually neglected in that the orthodox procedure is to simply brush off the adhering dirt and apply the paint, trusting that this will present a proper foundation for the first and succeeding applications.

As an example, it was noticed that the read lead primer on a bridge turned white under the accumulated soot from the nearby industrial sections and shipping. This condition was caused by the sulphur compounds carried by the collodial carbon of the smoke. The absorbed sulphur dioxide was the disturbing factor and caused localized failure.

Washings from structures gave a pH value of as low as 4 in certain locations, as well as 42 milligrams of salt per square foot of surface. Manifestly one cannot remove this by brushing or wiping with mineral thinner. Actual washing with an alkaline solution of proper hydrogen ionization concentration is indicated.

The revised State Specifications for Paints which will appear in the new editionof the California Division of Highways Standard Specifications are the result of the study of our needs for some 18 years. The formulas have been gradually adopted and changed to meet the conditions in this state and the very special requirements presented in state work. As for an instance, the primer for reinforcing bars, drift bolts, and iron handrails is a special primer designed to overcome the undesirable features of the standard redlead primer when used for the purpose mentioned above. Complaints were made that the standard paint did not dry quickly enough so that the material could adhere uniformly upon the round

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sections.

The formula for the traffic lacquer or paint was developed in 1932 after long experimentation so as to obtain a product which will meet the very stringent requirements of fast drying, reasonable life, economical cost, and uniformity at all times.

While it is recognized that there may be commercial products on the market under trade names which equal the paints specified, the state, being a public corporation, cannot, in justice to all concerned, specify any particular manufacturer or brand; nor has the term "or equal" been satisfactory in that it is necessary that not only the formula of both the standard selected and that of the substitute be determined, but records of long time service tests of each under like conditions are required.

The use of the formula specification secures definite products manufactured under State control and enables the engineer to obtain the paints which in the light of research and experience have proven the most desirable for the purpose intended.

As our knowledge progresses, changes and additions can be made from time to time and these improvements are made available by the use of special provisions in contracts, thus gaining the advantage of the latest developments.

CHAIRMAN GRIEVE: Are there any questions you would like to introduce?

DR. LICHTHARDT: From what I heard, Mr. Chairman, out in the hall from time to time this ought to be a very vital subject to the paint production men, because as I stated before some of them don't like definite specifications and so forth from foreigners. I will be glad to give any experience that we have had in the light of our work.

DR. GARDNER: Could I ask the speaker whether it would be desirable, because of the trouble you have had with the deposition of salt and other chemicals on the bare steel before painting, would it be desirable if the steel would be primed at the mill before it is shipped.

DR. LICHTHARDT: Dr. Gardner, we have tried that. We are too far away from the factories. We have tried factory priming and we have fair control sometimes and sometimes we do not. Usually by the time the steel gets out here, it comes by boat, we have to take it all off and do it all over again. Just recently we had a section that was so large it could not get into the hold of the boat and was on deck and you ought to see it. We received it over here in Oakland. We like to do our own shop coating, if possible. That is, with the contractors under our supervision. However, we have had several contracts where the original painting was done but it was

injured by the time it got here and it has had to be practically taken off.

MR. HAWLISH: You mentioned a great deal about the prime coats. If the metal is properly treated and primed, what factor does the finish coat play?

DR. LICHTHARDT: Our experience has been that the prime coating is a protection to the steel. On the San Francisco-Oakland Bay Bridge here we have three coats of red lead. The first coat weighed 28 pounds per gallon, the second weighed 25 pounds and the third weighed 21 pounds. The last coat was aluminum.

While we like to have pleasing appearances for bridges and structures we think more of the protection of the steel than we do about the beauty. Every once in a while we are called on to develop some green paint to match the foliage or something like that and we make the best of it. Usually it is when architects are entering into the scheme of bridges development and we have, for instance, on the Funston overhead here, through the Presidio, formulated a green paint. The engineers wanted it to be a permanent, non-fading green that would stay out in salt air and so we based it upon chromium oxide grain and I was afraid it was not bright enough. However, we got away with it and I think we are going to have a pretty permanent green.

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To get back to our question. The succeeding coats, as you all know, are just to protect the prime coat. In writing the specifications for the San Francisco-Oakland Bay Bridge we searched history from about 1860 and months and months were spent on experiments. Also on accelerated tests, and what have you, to try to see if we could find something better, but that was our judgment. I do not say it is the best but in our judgment it was the best.

You heard the paper on ship bottoms. If you want to take and scrape off some of the dirt and incubate it, you would be surprised to see what you get. You don't get sponges or oysters but you get microscopic plants of all kinds hanging on. We had a section of the bridge next to the curb that was originally painted yellow. We thought we would have to repaint it but, unfortunately for you paint producers, in washing it off we found the paint was intact underneath, so some one lost a contract.

The State of California is quite a large user of paints. We purchase about 10,000 gallons a year of our guard rail paint and for the traffic paint we purchase about 100,000 gallons a year. It is a big business and the paint boys on the Pacific coast like it. They must because they sharpen their pencils on it.

CHAIRMAN GRIEVE: Thank you for your conversation on

this subject. (Applause).

Is Mr. C. S. Hamilton in the audience? Apparently not. He was in charge of the maintenance of the painting of the Oakland-San Francisco Bay Bridge and I thought he could give us a few problems, but he was taken sick here the other day and did not know whether he could meet with us. Apparently he could not.

The next subject is, "The White Lead Content of a Good House Paint" by Mr. L. A. Thompson.

THE LEAD CONTENT OF A GOOD HOUSE PAINT

L. A. Thompson

Mr. Chairman and members of the Paint, Varnish and Lacquer Association.

What is the correct amount of White Lead for a good house paint?

That is a question that nowadays brings forth varied opinions and answers. White Lead we know has some defects when used in certain areas, but there is not a single white pigment manufactured today that in comparison is 100% perfect. We also know that White Lead throughout the years of its use when properly formulated cannot be excelled as a primer on new wood.

When three coats have been applied on new wood and thoroughly brushed out, allowing sufficient drying time between

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coats - the master painter knows he has conpleted a job that will produce longevity, economy and satisfaction to the home owner. If we follow this three-coat job through its normal life under normal atmospheric conditions on a vertical surface, we will find chalking after from 8 to 16 months; then a gradual retardation up to 30 months; then more chalking, until the paint is completely eroded. After from 6 to 12 months a condition of surface-checking will be evident. This in no way impairs the durability of the film. On some jobs dust collects on the surface but with the next winter's rain the chalking surface will wash and appear again like a new paint job.

Thousands upon thousands of homes are being painted with a 100% White Lead paint now as they were many years ago, and we know that this practice will be followed indefinitely in the future.

In sections of this country where relative humidity is high, chalking and fading of paint is stimulated,while cracking and flaking are retarded; also paints are subject to the growth of mildew. For such a climate it is advantageous to interject into the pigment portion of the paint a contect of zinc oxide - at times as high as 50%. Good paints of this type are characterized by unusual freedom from dirt in the soiling stage and tend to prevent mildew. However with this

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combination of White Lead and zinc oxide if painting is postponed for too long a period of time, cracking and flaking will have ruptured the film, and repainting is extremely costly.

From 1924 to the present time Titanium and zinc sulphide pigments have been marketed and have qualities that White Lead or zinc oxide do not possess. Pigment manufacturers have also made rapid strides in improving the properties of these pigments in the last few years, so that they possess more durability as a single pigment than before, which aids in stabilizing the films which are too hard or too soft. These pigments with their great hiding power have been compounded with White Lead or zinc oxide, or both - to produce a more perfect paint. However, in a great many of the mixed pigment formulas White Lead plays a spectacular part, often representing as high as 40% of the pigment content.

Basic lead sulphate and confumed leaded zincs have been improved both from a color and durability standpoint, qualities very helpful in producing better paints.

The following conclusions which I have set down may aid in a discussion of this problem:

1. Under normal conditions a most satisfactory house paint will contain 100% White Lead.

2. In areas of high humidity the percentage of White Lead should be between 50 and 75% - the balance being zinc oxide.

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3. In combination with Titanium barium pigments and inert - or Titanium barium, Lead titanate, zinc oxide and inert, the White Lead content should be between 35 and 45%.

4. In combination with zinc sulphide pigments the White Lead content should be from 25 to 50%.

5. In combination with confumed leaded zincs the White Lead content should be between 50% and 60%.

6. In areas where hydrogen sulphide is prevalent the content of White Lead should be eliminated from the formula.

CHAIRMAN GRIEVE: Are there any comments to add to Mr. Thompson's report?

MR. HEYMES: I would like to know if I understood Mr. Thompson correctly. Did he mean to say in his first suggestion that 100% white lead was superior to the one where he said a combination of white lead and titanium and zinc. Did he mean that pure lead was better than that combination?

MR. THOMPSON: I said that under normal conditions 100% white lead was a good paint. I did not make any preference between the lead and the zinc content in the house paint.

MR. HEYMES: I was not referring to lead and zinc but to lead, zinc and titanium dioxide. I understood the 100% white lead was the best.

MR. THOMPSON: No, I did not say it was the best. I said under normal conditions it was a good house paint.

CHAIRMAN GRIEVE: I think his report is truly a

masterpiece. Are there any other comments?

MR. HARLOWE: I have something I would like to add to that. The National Lead Company probably know how to paint a house but there are two houses in Oakland within a block of each other. Both have been painted over a period of time with white lead. Both have the same number of coats. One is the picture of a big failure. It is terrible. The other is in perfect repairable condition. It brings it up to this point. When a can of paint is sold we do not know where it is going. The reason for the abject failure lies in the fact that an intermediate coat or coats were sprayed on by an inexperienced painter. The good job was all brush. There was a very bad advertisement and a good advertisement for white lead, 100%, adjacent to each other.

CHAIRMAN GRIEVE: The next subject is, "Does 45° South Exposure of Test Panels Yield Relative Test Results?" This is to be presented by Mr. Cornell.

DOES 45° SOUTH EXPOSURE OF TEST PANELS YIELD RELATIVE TEST RESULTS?

James P. Cornell,
Paraffin Companies, Inc.

This question is one about which there has been much difference of opinion in the past and about which much work has been done to prove or disprove the value of 45° exposures.

Test panel exposures of paint films, whether vertical

or at 45°, generally experience more severe conditions than are encountered in actual house service. This acceleration of failure is due to abnormal stresses set up in a test panel by changes in temperature and by higher moisture content.

45° south exposures are considerably more accelerated than vertical (about 1½-2 years for 45θ to 3½ years for vertical for complete failure) and often give misleading results. For instance, a paint which on the vertical shows mildew and collects excessive dirt may present a clean, satisfactory appearance at 45° due to excessive washing action. Again, this washing action may proceed so rapidly as to obscure any aging stresses in the film and thus reduce the tendency to crack.

For tint retention, 45° tests may proceed so fast that differences are lost before they can be observed, or abnormal chalking may exaggerate differences that would not be significant in actual service. Also, 45° tests being at an angle will tend to collect dirt faster. This layer of dirt may mask changes in tint, andmay obscure paint failure by acting as a protective film.

45° tests accelerate erosion and would show an eroding type paint to be unsatisfactory due to rapid weathering to wood. In contrast, if a hard paint which normally fails by moderate cracking were exposed at 45°, it would resist this

erosion and would tend to fail by severe cracking and scaling due to the greater extremes of temperature at 45°.

Moisture failures are more pronounced in 45° tests due to backing up of water under the panel and the retention of moisture on the surface. This surface moisture in droplets might be considered to act as small magnifying lenses to intensify the sun's action to destroy the film or to cause darkening of the paint due to photochemical reactions.

To summarize the above, it would seem that 45° tests should not be used for determining the durability of exterior paints; or, if used, the results should be considered with great reservation. However, an experienced person should be able to correlate his 45° results to vertical sufficiently accurately to enable him for a series of tests to weed out the poor formulations. The remaining formulations which show up satisfactory should be re-exposed on vertical sections to obtain final durability results.

To emphasize the above, 45° test panels do not always give reliable test results and therefore should not be used alone but should be used in conjunction with vertical test panels and actual service jobs.

Bibliography: Physical and Chemical Examination of Paints, Varnishes and Lacquers, H. Gardner; Testing House Paints for Durability, F. L. Browne, Forest Products

Laboratory; The Significance of Test Fence Exposures, G. W. Ashman, New Jersey Zinc Co.; Results, Seven Years of Exterior Paint Development, Krebs Pigment and Color Corporation. (Applause).

CHAIRMAN GRIEVE: Is there any contribution? I think Mr. Cornell covered the subject pretty thoroughly. I know there has been a lot of contention throughout the industry as to the relative merits of the 45° exposure.

The next subject is, "The Establishment of a Convenient Covering Standard with a Numerical Rating Acquired by Practical Application Methods," by Mr. Greenberg.

THE ESTABLISHMENT OF A CONVENIENT COVERING STANDARD WITH A NUMERICAL RATING ACQUIRED BY PRACTICAL APPLICATION METHODS

S. U. Greenberg

Gentlemen, in spite of this title being so long, the hour is late and I will try to make this talk one of the shortest. Briefly, it amounts to this. We would like to be able to paint out a paint on a card something like this that was furnished by the Moritz people who made hydropower cards. Let's say we will call this 25, 50, 75 and 100. We could therefore say the paint has a coverage of 25. The application would be made with the lower syringe, something that is done in almost every laboratory and is quite simple. The Moritz people made this for us on the basis of the Muncell Color

system. The Muncell system in the gray provides for various numbers which are mixtures of fundamental colors. From that standpoint the background was good. You might guess putting a white paint over this would give an altogether insufficient covering. That is, a white paint would not even cover the bar. We put a flat coat on this and decided to step down the whole thing. Then, from that we put a white enamel over this and we took the same white enamel and reduced the covering in it by 10%, which figure should be about the average difference that a person could be able to detect if we were going to make such a system. I am sorry to say, at least on our test, you could not get that difference, the 10% difference was not there. We checked it up with several people and none of them were able to find it.

Dr. Gardner's laboratory several years ago did work similar to this and the main difference as I remember was that the bars were close together and Dr. Gardner mentioned that if the bars were apart the eye might be able to detect these differences. At least on our test, Dr. Gardner, we were not able to get this. We wondered if any one here used any system of being able to get any numerical rating on covering power. (Applause).

CHAIRMAN GRIEVE: Does some one have a system that they will tell us about, a numerical rating? There is no

question but what it would be an ideal situation. You could have a rating giving varying degrees of covering capacity.

DELEGATE: I would like to ask Mr. Greenberg if he tried something like Parks film applicator or something whereby he could get absolute uniform tone, as to thickness, that would make quite a difference if you were trying to discern a small difference of covering, I would think.

MR. GREENBERG: We have such a film applicator that we worked with before. We have noticed this that when you pull that film out on a card, such as this where you have quite a bit of surface varying shades, the eye, again it brings the question down to the eye and the eye wanders around and does not get a difference. I have no doubt if some club would take this work up that they could probably work it out very well. We had no success.

CHAIRMAN GRIEVE: The next topic will be "Exterior House Paint Primers" by Mr. Peterson.

EXTERIOR HOUSE PAINT PRIMERS

E. PETERSON

Exterior house paint primers of the controlled penetration type are comparatively new in the history of exterior painting systems. Their theory is one of controlling penetration through the use of treated oils or varnishes to give a uniform foundation for the finish coat. Protection by

a top coat system in place of the usual three.

Different pigment and vehicle combinations have shown that a large number of primer variations are possible. In practice, top coats of varying degrees of hardness are used which necessitate a carefully balanced primer. Controlled penetration results in thicker films remaining on the surface than with the orthodox primers, this requires a control of flexibility, and a higher pigment volume. No definite pigment volume percentages have yet been established. However, the range, depending upon the formulation, varies between 32 and 40% based upon the total solids. Flexibility is controlled in general by two methods, by the use of zinc oxide and the use of varnishes. It is yet to be established which is the more durable.

In practical application an educational program is felt necessary with the painters to prevent the addition of oils or other materials which destroy the balance of a primer. Experience has also shown that painters are prone to accept such primers as cure-alls in preventing all house painting difficulties.

Many of us have had several years experience with primers both in the laboratory and marketing to the trade with very good results.

CHAIRMAN GRIEVE: Are there any questions you would

to ask Mr. Peterson?

MR. HAWLISH: I would like to ask Mr. Peterson from the standpoint of durability. I don't know just how to put this, but let's suppose in our three-coat system and two-coat system that we have the same film thickness. When that top coat of paint that is supposed to match the primer erodes away by chalking, how does the primer act then? Does it have to be coated immediately?

MR. PETERSON: That depends a lot on your primer, the type of pigmentation in the primer. Some types of primers, where you use lead titanium, for example, will not erode quite as fast as others where you use zinc sulphide, but on the other hand, others would show just the opposite.

MR. HAWLISH: From the standpoint of recoating a house every six yearsI believe the primer set up is very well but from the standpoint of some one that does not keep their house up that well, how about the final erosion of that? Would that present a good painting surface after ten or twelve years? Have you any data on that?

MR. PETERSON: All test exposures show that it would. I don't know. Is there some one else that has had experience of that nature?

CHAIRMAN GRIEVE: Does any one have results on actual painting exposure?

MR. TIBBETTS: I have had a little experience in running some test panels on primers. One thing that must be guardéd against is taking too heavy a film of primer. Some painters seem to be inclined to put the stuff on as heavy as possible, getting on two or three times the thickness of the paint which they would have in their first coat ordinarily and that seems to produce not a wrinkling effect when the paint is first put on, but after the paint has been exposed for a couple of years there seems to be a tendency for the top coat, even if it does not all break down, to break down in the worst manner over the heavy coat of primer and not over the coats of their own material. I imagine where the paints are thinned down, as the primers are thinned down, you will have a heavier coat of paint on the surface with your primer because of its non-penetrating qualities than you would have in your normal paint that penetrates into the surfact. We know the paint as long as it adheres to the surface needs no penetration. You undoubtedly get a thicker film on the surface, which is a big advantage.

DELEGATE: What about an aluminum primer on wood?

MR. PETERSON: One thing, of course, it is very difficult to cover with a white paint.

MR. McINTYRE: Where you have tinted paint you still have a further problem of having a white primer and

having to color that with a tint, so we designed our primer so even when it had 25% or 50% of the finish coat of paint and still retained non-penetrating properties we could get a perfectly uniform job in two coats and that appeals to the painter because of the fact that he can brush his paint up very well.

CHAIRMAN GRIEVE: That special primer that you spoke of, was it formulated so it had to be used that way?

MR. PETERSON: No, not necessarily. It can be used straight if you wish. We have had exposures on coatings of that kind on panels for three and a half years at 45° angles facing south, both on straight plain wood and sash with excellent results.

CHAIRMAN GRIEVE: Is there any one else? (No response)

Mr. Walter Steigerwalt has prepared a short paper for us here on the subject of "Maintenance of Warehouse Floors." He was called out of town the early part of this afternoon. He brought along a number of pamphlets here and they are available for distribution. We will have Mr. Steigerwalt's paper printed along with the rest of them.

MAINTENANCE OF WAREHOUSE FLOORS

Walter Steigerwalt

Since practically all heavy duty warehouse and storage floors were built of concrete, I will confine my

remarks to this type of construction.

The old adage, "An ounce of prevention is worth a pound of cure", applies very definitely to the maintenance of industrial floors, and particularly to concrete wearing surfaces. Following this thought, I wish to discuss, to some extent, the proper construction of concrete floors.

The three fundamentals of a good concrete floor are: careful selection of materials, skilled supervision, and careful workmanship. These are the ingredients of which good floor surfaces are made. The "goodness" will be in direct proportion to the efforts expended, by the architect, engineer and contractor in making certain that all three above essentials -- not any one -- are maintained throughout the construction of the whole job. The top surface of the floor takes the wear and grind. For that reason, they deserve all the attention possible during construction. If this is properly done, concrete floors will resist extremely severe conditions indefinitely and "dusting" -- that most troublesome of floor diseases -- will be unknown.

Too often floors are specified to be given a "cement finish". Then, inadequate requirements as to materials or procedure to be followed during construction are lacking. Then comes the inevitable sequence -- trouble.

There are certain basic principles of concrete making

which every user of concrete should understand. Because of the thinness of floor finish, the nature of its surface, it is particularly important to observe these principles. A different manipulation, or working of the concrete into place, is used in making floor finishes than in other parts of the structure. It is important that directions for constructing the wearing surfaces of factory floors be observed very carefully.

Fundamentals of Concrete Making.

Concrete can be made to have a wide range of qualities. Thus, the strength, resistance to wear, watertightness and other characteristics may be varied by changes in the materials or the proportions of the ingredients used and by differences in the manipulation of the concrete.

The quality of the materials affects the quality of the concrete. Portland cement is made to meet standard specifications. It should be protected from moisture while in storage to prevent deterioration. Water used for mixing should be clean. Clean, hard, tough, suitably graded aggregates give more wear-resistant concrete than materials which are inferior in these respects.

The less water used in mixing concrete, the stronger, more wear-resistant and more watertight it will be, providing the concrete can be placed properly.

For uniform concrete, a mixture that does not permit segregation of the ingredients must be used. The proportions of the various sizes of aggregate and aggregate to cement and water should therefore be such as to prevent their separation during handling and placing.

The chemical combination of cement and water to produce hard, strong concrete requires time. During this time moisture must be available, either by preventing evaporation of the water used in mixing or by replacing that which does evaporate.

Applying these basic principles to concrete floor finishes, the following requirements should be observed:

1. Use only suitable materials.
2. Use not more than $4\frac{1}{2}$ to 5 gal. of mixing water per sack of cement. This includes water introduced as surface moisture on the aggregates.
3. Use mixtures and construction methods which will not permit segregation resulting in free water and fine material on the top surface.
4. Prevent early evaporation of water by keeping the concrete wet as long as practicable.

The aggregates constitute such a large proportion of the concrete volume and have so much influence in producing

wear-resistance that they are of first importance.

Aggregates for Floor Finish.

Since the aggregates in the wearing course are subject to abrasion, they should be of sufficient toughness and hardness to resist that abrasion. Where conditions are severe, traprock of a dense, fine-grained and interlocking crystalline structure or hard, fine-grained granites and quartzites are excellent. Where the duty imposed is not so severe, such a floors of a decorative nsture, aggregates of less hardness may be selected.

Aggregates may be either gravel or crushed stone. Materials containing a large proportion of elongated or thin fragments should never be used. All aggregates should be clean, free from dust or highly weathered fragments and should consist of particles which will not alter in physical or chemical nature in the presence of moisture. New and untried aggregates should be subjected to study before they are used in finishes intended for long service under severe conditions.

Grading of Aggregates.

The grading or granular composition of the aggregates is equally as important as their hardness, shape and other characteristics. The fine aggregate or sand should consist chiefly of coarser grains ranging from 1/16 to 1/4 in. in

size. Not more than 5 per cent of the grains should pass a 100-mesh sieve, and not more than 15 per cent should pass a 50-mesh sieve. Sand consisting chiefly of very fine particles should not be used. Stonedust, clay and silt are particularly objectionable. Coarse aggregate should be well graded pea gravel or crushed stone, the particles ranging between 1/8 and 3/8 in. in size, with all particles passing a ½-in. sieve.

Workability of Concrete.

Concrete should be of such proportions and have such workability that it can be compacted and each aggregate particle becomes completely surrounded by cement-water paste, leaving no honeycomb nor voids. Floor topping is laid in a relatively thin layer and is compacted by tamping, rolling, floating and troweling. Therefore a stiff mixture can be used. Stiff mixtures are advantageous, as they permit less mixing water and more aggregate with a given amount of cement and prevent segregation of the materials. Such concrete is best mixed in the open top paddle type mixer.

It is desirable to have as much as possible of the coarse aggregate near the surface of the floor to take that abrasion and wear of service. An excess of fine aggregate should therefore be avoided as it tends to work to the surface during compaction, thus defeating the purpose of the coarse material. On the other hand, the mix should not be too harsh

for the methods of construction used. Harshness should be corrected by adjustment of the proportions of fine and coarse aggregate and the total amount of aggregate. The specified amount of mixing water should not be increased to produce workability.

Thickness of Floor Finish.

The wearing finish of concrete floors should be not less than 1 in. thick, whether it is placed at the same time as the structural slab or after the concrete in the structural slab has hardened. The thickness of structural slab, will, of course, depend on design requirements.

When floors are placed over a membrane waterproofing or over insulation, a reinforced slab at least 3 in. thick should be placed over the membrane or insulation. The top 1 in. may constitute the wearing finish.

Mechanical Floats and Special Methods.

Mechanical floating equipment is available which will compact and float mixtures that are much stiffer and harsher than can be finished by hand methods. When these mechanical floats are used, the mixture should be so stiff that when a sample is squeezed in the hand only a slight amount of moisture is brought to the surface.

Resistance of Concrete to Industrial Products.

Impervious concrete is highly resistant to the action

of many materials which would attack porous concrete. Lactic acid formed from milk products, weak acetic acid, brine solutions and some of the other materials used in industry will attack porous concrete, but will have little effect on dense, watertight concrete. Watertight concrete requires impervious aggregates thoroughly incorporated in a cement-water paste which is itself impervious.

Hard, dense aggregates meeting the requirements for wear resistance are impervious. Impervious paste is produced by using a low amount of mixing water, not exceeding 4½ to 5 gal. per sack of cement and keeping the concrete wet for a period. These conditions are necessary for the chemical process of hydration.

The requirements for thorough incorporation of the aggregate makes necessary the use of sufficient cement-water paste to fill the voids in the aggregates and provide a mix that will be thoroughly compacted when worked into place.

The Importance of Curing.

The chemical reactions between cement and water which cause it to harden continue indefinitely if moisture is present and temperature is favorable. Through this curing process, the internal structure of the concrete is built up to provide strength, resistance to wear and watertightness. Floor finishes present such a large surface area that loss of

moisture through evaporation takes place rapidly unless measures are taken to prevent such evaporation. Rapid drying not only stops the chemical reactions, but may cause dusting and also cracking of the surface due to shrinkage taking place at a time when the concrete has little strength.

To prevent drying out, water for curing should be applied to the new concrete as soon as this can be done without marring the surface. It should then be kept wet or the moisture should be sealed in by covering the floor with waterproof paper. The longer this curing period can be extended, the stronger, harder and denser will be the concrete. The curing period should be at least a week when using standard Portland cement and 3 days when using high early strength Portland cement. Special attention should be given to areas near warm radiators or other sources of heat, to prevent evaporation during the curing period.

Some things to Avoid.

Mortar mixes, that is, those containing sand and no coarse aggregate, should be avoided.

Overly-wet mixes and mixes containing more than 5 gal. of water per sack of cement should be avoided.

Mixes which permit water or fine material to collect on the top surface should be avoided.

Dusting on fine material to absorb excess water on

the surface should be avoided for heavy-duty floors.

Excessive troweling which brings water or a large amount of fine material to the surface should be avoided.

Early drying should be avoided.

COLOR WITH PIGMENTS

A wide range of color is obtainable with the use of mineral color pigments mixed with the concrete finish. A single uniform color such as red, green or brown is most widely used in floors of this type, although a border of one color and field of another as well as simple patterns involving two or more colors have been used to some extent.

Only pigments resistant to alkali should be used. Mortar colors containing a large percentage of filler are not suitable. Pure mineral pigments and factory prepared mixtures of cement and mineral pigment are available for the purpose. Manufacturer's directions should be carefully followed. Where mixing is to be done on the job, it should be very thorough to secure uniform dispersion and full color value of the pigment.

The color values of pigments vary with their fineness and purity. In comparing them, one should be guided by the amounts required to produce the desired color and shade. This can best be done by making test samples, allowing them to dry.

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STAINED FLOOR FINISH

Attractively colored floors are secured with the use of certain inorganic chemicals. These are applied to the hardened floor and react with the cement to form new compounds in the concrete to produce the color. Several applications are often necessary before the desired effects are attained. A mottled or multi-tone effect is generally produced, depending somewhat on the amount of troweling done in finishing.

PAINTED FINISH

Concrete floor finish may be painted to attain any color effect. Oil paints, rubber-base paints and synthetic resin paints are available for this purpose. It should be realized that any traffic causes a certain amount of wear and in aisles and other places where foot traffic is heavy, touching up at intervals may be necessary and an occasional complete repainting required to keep a good appearance. Painting is not advisable where there is heavy truck traffic or dragging of boxes or other objects over the floor.

Concrete should be clean and thoroughly dry when it is to be painted. The painting should not be done for several months after construction to give ample time for curing and drying. The surface should be neutralized by mopping it with a solution containing 4 lb. of zinc sulphate

per gallon of water. After allowing 48 hours for this solution to react with the concrete and dry, the surface should be cleaned with water to remove all crystals. It should then be allowed to dry thoroughly before applying the paint.

Three coats of paint are recommended. The first coat should be very thin -- about equal parts of thinner and paint give about the proper consistency. Some thinner may be used for the second coat and the third coat may be applied as it comes from the can.

ACID-PROOF FLOORS

Floors in chemical laboratories, acid plants, dye houses, storage battery buildings and similar structures in which strong acid solutions or other strong corrosive materials are manufactured or handled may require the protection of an acid-proof covering. Asphalt mastics, asphalt blocks or acid-proof brick or tile laid in acid-proof mortar may be used for this purpose.

NON-SLIP FLOORS

In certain locations, more non-slip quality than usual is desired in floor finish. This may be accomplished by roughening the surface immediately after final troweling or by incorporation of non-slip aggregates. Roughening may be done with a fine hair brush but this finish is seldom used for interior floors because of the difficulty in keeping

the floor clean.

Non-slip aggregates may be mixed with the concrete or sprinkled on the surface of the wearing course just prior to finishing. More of the aggregate is required when it is mixed with the concrete but the distribution is more uniform. Approximately 3/4 to 1 lb. of non-slip aggregate is required per square foot of floor.

CHAIRMAN GRIEVE: Mr. Eastwood, on your subject, "The Painting of Non-Ferrous Metals" do you wish to take the floor or do you think, the hour being late, that you could give us the copy of your paper?

MR. EASTWOOD: I don't believe it will be necessary. While my short paper this afternoon does not cover the same ground as the paper presented at Chicago last week, there are enough points of similarity so that I believe we can dispense with the reading of this paper this afternoon and give the boys a chance to get dressed for tonight.

THE PAINTING OF NON-FERROUS METALS

H. Eastwood

This subject has recently taken on added importance, because of the tremendous war-induced increase in the use of the light weight metals, aluminum and magnesium, by the aircraft industry.

The non-ferrous metals are most commonly used in the fabrication of factory produced articles, hence finishing is usually carried out under factory conditions, rather than by the ordinary painter, or amateur brush-hand.

This is fortunate, because the adhesion of paint products to these metals is seldom as satisfactory as it is to steel. Not only is the initial adhesion apt to be poor, but metals such as zinc, magnesium and cadmium are subject to "alkaline peeling." This phenomenon is caused by moisture passing through the paint film, reacting with the metal to form the hydrate or carbonate, this alkaline reaction product then loosening the protective coating.

To obtain satisfactory results, several things are necessary:

First, thorough cleaning, either by mechanical means, by solvent wash, by vapor phase degreasing, or by treatment with acid or alkaline solutions.

Second, a chemical surface treatment. These are many types, including the well-known amodic treatment, oxide coatings, and a variety of chromate and phosphate coatings. In general they combine a surface roughening with a corrosion inhibiting coating. Choice is determined by type of metal or alloy, kind of exposure and permissible dimensional change.

Third, a proper selection of primer. Primers depend

chiefly for their effectiveness on three properties, adhesion, permeability and corrosion inhibiting effect. Here again, the inhibiting effect of chromates is useful, the most generally satisfactory primer being the U. S. Naval Aircraft $P_{27}b$, made of zinc yellow in a combination of an alkyd and a phenolic dispension resin. There are other special cases, such as the use of zinc dust in primers for zinc metal.

Given correct preliminary treatment and primer selection, finish coats present no serious problems. The most satisfactory types are alkyd enamels or aluminized synthetic spoors, either alkyd or phenolic.

Specific information on most of these points can be found in the paper on "Primers for Non-Ferrous Metals", published at the Federation Convention in Chicago last week, or in the bibliography attached hereto.

CHAIRMAN GRIEVE: The next paper we will hear will be from Mr. H. W. Crockett on, "Of What Value is the 5% Caustic Test in Specification Varnishes Where Alkali Washing is Not a Practice".

OF WHAT VALUE IS THE 5% CAUSTIC TEST IN SPECIFICATION VARNISHES WHERE ALKALI WASHING IS NOT A PRACTICE (Formula Specification Versus Performance Specification)

H. W. Crockett

The 5% caustic test is a rapid and convenient means of determining adulteration and to a certain extent the completeness of kettle reactions when dealing with successive batches

of an individual varnish. However, the test should not be taken as an indication of durability.

Considerable dissimilarity exists between the action of alkali and the action of water on a varnish film, the former being that of saponification attacking the carboxyl group, the resulting soap increasing emulsification properties whereas with the latter there is a swelling colloidal solution effect. Although in many cases there is a direct correlation between water resistance and alkali resistance, many exceptions can be found such as the addition of resin acids and fatty acids which will decrease the alkali resistance without any decrease in the water resistance. Films of China wood oil varnishes have been noted to possess a decreasing resistance to alkali upon several weeks aging, probably due to the formation of acidic components.

A common practice being indulged in by resin manufacturers now is to recommend the addition of bodied linseed to China wood oil-resin varnishes which addition materially reduces the alkali resistance but improves durability. Varnish formulators frequently find a resin-oil combination with good alkali resistance to be inferior in durability to another resin-oil combination possessing in turn a decreased alkali resistance.

It is felt that if the alkali test is to be continued its importance as a means of specification control should be

minimized. As a means of indicating a factor of durability the water test now used should be improved so as to afford a better or a numerical measure of the results of the test. H. A. Gardner in his 1939 Physical and Chemical Examinations of Paints, Varnishes, Lacquers and Colors has recommended the use of the percentage decrease of the seconds taken by the hardness rocker on films before and after water treatment. This test appears promising. The use of varnish films on black glass or glass with a painted back are two further contributions.

CHAIRMAN GRIEVE: That concludes our Forum Discussion for the afternoon. The meeting is adjourned.

... The meeting adjourned at 5:30 P. M. ...