University of Wisconsin

University Extension And The College of Engineering

Engineering Institute
"Paints for Today's Architect"
November 30 - December 1, 1961
Madison, Wisconsin

# "EXTERIOR FINISHES FOR WOOD"

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# Exterior Finishes for Wood

The simplicity of the title "Exterior Finishes for Wood" is rather disarming - actually the exterior finishing of wood has become a very complex topic. We no longer have to deal with just bevel or simple patterns of siding but with a tremendous variety of wood surfaces, so complex that they have to be lumped together under some comprehensive term such as "Forest Products."

Paints are no longer simple lead-in-oil or colors limited to natural oxides but now include a wide variety of multi-pigment white house paints for different end uses and an almost infinite variety of tints and colors. Even exterior clears are no longer simple oils or phenolic varnishes but include some very sophisticated high polymers, often with ultraviolet absorbers or special film fortifiers.

Today's paints, stains and varnishes may appear as either solvent or emulsion types. "Solvent paints" refer to those paints in which the binder is dissolved in organic solvents, such as mineral spirits, although organic binders soluble in water have become available. "Emulsion" or "latex" paints (we consider the terms practically synonymous) refer to those paints which are dispersions of fine droplets of polymers or binder and pigment in water.

This expansion in the variety of coatings for the exterior finishing of wood has provided much better finishes than were available years ago. More specialized formulations with superior performance for specific end usages are the order of the day. Therefore, we in the paint business have a responsibility to keep you informed on what we have to offer, what our products can do and how they should be used - so you can select, specify or use the right materials.

Changes in the requirements for paint coatings are an almost daily occurrence. Witness the recent surge of interest in mill priming of many types of wood siding materials, and even in complete production finishing systems to parallel those being applied successfully on metal siding. This constitutes one of the greatest challenges that has faced paint technologists in a long time.

While we intend to explore the topic of production finishing of wood later, we would like to mention two points that illustrate the immediate problems that are involved. We have become accustomed to the thought that regular solvent type house paints require 24 to 48 hours' drying time per coat. Now we are asked to supply production type coatings which must dry in a few minutes, perhaps with the help of some heat or catalyst for rapid cure. And we are asked to do this with no sacrifice in the life expectancy of the films.

We have also become accustomed to the thought that four to six years should elapse between repaintings on our houses. The prefinished metal siding industry has forced some change in this concept, too. It has been shown that aluminum siding with properly formulated finishes can go ten years or more without requiring refinishing. Therefore there already is a desire for exterior finishes for wood which would have a normal life expectancy of ten years before they would require refinishing. These are real challenges.

To lay a groundwork for a discussion of how we are attacking these problems we should review our current paint products. A logical start would be with solvent type house paints, and with the first coats, the primers or undercoaters. In solvent type house paint systems the same undercoater usually is recommended for both bare wood and as the first coat for weathered repaint surfaces. The undercoaters are generally of the controlled penetration type, achieved by the use of substantial quantities of processed oils in the binder. We limit the amount of raw linseed oil in the formula and advise against the further addition of raw oil so there will be no excessive penetration of the raw oil into the depths of the wood structure, where it would serve no useful purpose and could actually be harmful.

It would be impossible to explore here all the variations which may appear in primer formulations. However, we have certain recommendations for our own products which we believe pertain equally well to many of the house paint undercoaters offered by the paint industry. We think there is no coating that goes on a house which is more important than the first coat - if mistakes are made here they probably can never be corrected until some time when the whole paint job has to be removed, probably by some expensive operation such as burn-off, power sanding, or the use of paint remover. Therefore it is most important that the first coat be right - formulated right and applied right.

Actually there are several important steps to be taken prior to the application of any paint on exterior siding which will have significant effects on the performance of the house paint. The Forest Products Laboratory has provided a listing of the various species of wood normally used for exterior siding, arranged in the order of their paintability, their ability to hold paint. They have described the differences in paintability within a species caused by density, direction of grain, rate of growth and many other characteristics of the wood. Some of these differences are reduced by processing, use in particle form, by overlaying, etc. In any event, it should be recognized that wood is not necessarily just wood, and that all woods are not necessarily the same when we paint them.

The architect and the builder both assume a responsibility to the homeowner when they recommend or specify the exterior siding to be used. The selection should not be made solely on the basis of how well it saws, or how easily it can be nailed, or how fast it can be put up, or how many otherwise waste scraps can be put together into a continuous piece of usable siding. Paintability deserves serious consideration, and the homeowner has a right to know what he gets for his money. This means that both the architect and the builder must be well enough informed to deal fairly and honestly with his customer in discussing how well the siding he recommends will hold paint.

The same holds true for special designs for wood exteriors. We have no quarrel with designs which increase the aesthetic appeal of wood used on the exterior of a house or building - provided the designs do not create problems in paintability which may be almost insurmountable on a practical basis. There is a real need here for cooperation between the lumber and paint industries.

At the risk of sounding absurd to some, we believe that knots should be avoided in any exterior siding. We know of no real solution to the problem of holding house paints over knots. As far as our own laboratories are concerned, we have not found that shellac or any of its modifications, aluminum house paints, butyral formulations, emulsion paints or any other special treatments are complete answers. The more frequent repainting required, vulnerable to the reappearance of the scaling over the knots, can involve expenses far exceeding any initial saving effected through the use of lower grades of siding.

Now as to fastenings. It is inconsistent to recommend the finest wood siding and then permit the use of common nails to fasten it to the house. There really should never be a problem of nailhead rusting. It can be avoided so easily by the use of rust resistant nails, such as galvanized nails, lead coated or cadmium coated nails, aluminum nails or similar types. Yet this simple step is often overlooked.

While there are other steps prior to actual painting which lead to good paint performance, time dictates that we move on to the painting itself. And here we would like to emphasize a point which may have escaped your attention. In applying house paints, have the painter follow the carpenter as closely as possible. To illustrate how important this can be we would like to show you three slides which demonstrate how even brief weathering of wood prior to painting can affect how well paint performs.

A producer of Southern Pine siding cooperated with us in this study by selecting twelve pieces of pattern siding in sets of four, equally divided between heart and bark faces, and matched for wood characteristics. The siding was shipped to our Chicago test station in a sealed container. Immediately on receipt, one set of four panels was painted with our top grade two coat oil paint system, undercoater and topcoat, applied at standard spreading rates and under optimum conditions.

The remaining eight boards were placed on our vertical exposure fences at our Chicago test station, facing south, unpainted. One of these sets of four panels was removed from the fence after only one week of exposure unpainted and given the same two coat house paint system. The remaining four unpainted boards remained on the fence for one month before receiving the same paint system. The following slides show the condition of the three sets of panels after four years south vertical exposure at our Chicago test station.

Slide 1.

No Weathering of Wood Prior to Painting
(Paint in good condition. Very slight cracking.)

Slide 2.

Wood Weathered One Week Prior to Painting
(Paint in fair condition. Some cracking and flaking.)

Slide 3.

Wood Weathered One Month Prior to Painting
(Paint in rather poor condition. Cracking and flaking.)

The slides should establish the point that even a minor amount of weathering of unpainted wood can detract from its paintability, especially of any species having less than maximum ability to hold paint. We have urged that starting at the mill the face of any wood surface which subsequently will receive an exterior paint should be turned inward in any stacking or piling, or should be protected from the weather by a tarpaulin or other weatherproof and opaque covering. The same recommendation applies to the siding when in the hands of a dealer or after delivery to the building site. And once the siding is on the home or building it should be given a primer coat as quickly as possible.

The discussion of application of paints by another speaker may include the need to insist on good painting practices, - to follow label instructions, to avoid addition of thinner or oil unless specifically recommended, to apply at specified spreading rates to obtain the proper film thickness, to avoid unsuitable weather, and so on. One more point - today most paint manufacturers urge very strongly that their exterior solvent type primers be followed by the topcoats within a relatively short time rather than the two weeks quite common in the recommendations years ago.

We suggest recoating within two days in good weather, and within four days in cooler, less favorable weather. In this way the two coats knit together and operate as a double film thickness rather than according to the individual film thickness of each coat. And remember - other things being equal, durability is proportional to film thickness. Naturally we have to build in tolerance for longer intervals of drying between application of primer and application of topcoats. We have tested up to a year. But the best results are obtained with relatively fast recoats.

Solvent type topcoat house paints usually are based on oil, semi-alkyd or full long oil alkyd vehicles. By far the majority of white house paints and tints are still based on oil binders, usually a combination of raw and bodied oils. This preference for oil in whites and tints is dictated by the reliance on zinc oxide, either as such or in the form of leaded zinc. It provides mildew resistance, self-cleansing and, in some instances, better tint retention, among other properties, when used in conjunction with titanium oxide and extenders. So far there has been no mass take-over in the field of white and tinted house paints by alkyds. This is due to the fact that in the absence of the fungistatic protection of zinc oxide or leaded zinc, difficulties have been encountered in protecting such semi-alkyd or alkyd paints against mold growth. Zinc oxide as used currently with alkyds has been found to reduce the margin of safety against blistering and peeling where moisture problems exist.

The basic move in 1943 to oil paints having a lower total oil content but with a relatively high ratio of bodied oil was a major technological advance in house paints, comparable to the advent of titanium pigments some two decades earlier. In one move we gained better pigment dispersion, better flow, better through drying, better gloss and gloss retention, less dirt collection, greater mold resistance and greater durability. We can now set 4 mils (four thousandths of an inch) as an adequate film thickness for a modern two coat oil type house paint system (undercoater plus topcoat), rather than the 5 mil thickness formerly considered necessary with the older, high oil house paints based on raw linseed oil. All this with checking no longer a problem in properly formulated oil paints.

The validity of these claims has been proven on a multitude of exposure fences throughout the paint industry, on tens of thousands of test houses, followed by use on millions of houses painted since 1943. Let's look at just one set of comparisons drawn from the many panels in our various "History of House Paint" series put out by our own department at various locations around the United States.

Slide 4 - History of House Paints

(Comparison of four year exposures at Coffeyville, Kansas, of house paints of 1927, 1938, 1942 and 1957 vintage.)

The 1927 paint is representative of the lead-zinc-extender pigmentation in a raw linseed oil vehicle characteristic of that period, as a self-primed system in which the first coat was reduced with a generous amount of raw oil. Coffeyville, Kansas is a location which emphasizes checking failures, which show clearly on this paint. The 1938 paint illustrates an early use of a specialized primer, which combined with some pigmentation changes and the use of a small amount of bodied oil in the topcoat has reduced checking and cracking tendencies.

The 1942 paint illustrates the continued improvement up to 1942, the last of the high raw linseed oil vehicle formulations. The 1957 paint illustrates the excellent flow and durability of the modern bodied oil house paint, with higher pigment volume concentration and lower actual oil content. Note the tremendous improvement in appearance qualities and resistance to checking, even in Kansas.

Many of you are familiar with the performance of lead-in-oil, so it may serve as a good yardstick to measure the value of modern paints.

Slide 5 - Modern House Paint vs. Lead-in-Oil

(Panels showing comparative performance of modern three coat house paint system vs. three coats of lead-in-oil after one, two, three, four and five years' south vertical exposure in Chicago, Illinois; Coffeyville, Kansas and Miami, Florida.)

The interesting point of this illustration is the uniform appearance and good protection of today's multi-pigment bodied oil paint, regardless of time of exposure or location of exposure. Lead-in-oil shows its characteristic dirt collection in northern areas followed by its usual reticulate checking. In southern sections of the country dirt collection may not be a problem but checking is highly developed as early as at one year. Protection is lost in all cases for lead-in-oil as the exposures proceeded.

Still on the subject of white house paints, among our own products we consider our leaded zinc-titanium oxide-extender gloss white the work horse of the line. However, where hydrogen sulfide is present in the atmosphere, a lead-free formula should be used. The common white lead pigments can react in the presence of moisture with sulfide gas to form a black lead sulfide, which discolors the paint. Sulfide gas is often found in areas where there are industrial plants - especially near rubber manufacturing, petroleum refining, steel production, where there are burning culm heaps connected with coal mining, where there is decaying vegetation as along seacoasts or canals, especially in the south, or where hydrogen sulfide is present in ground water. So-called "fume resisting" whites should be used in such areas.

When the paint is to be applied on a previously painted surface it is often possible to use one of today's good one coat house paints, if the old surface is in reasonably good condition. This is particularly good practice if the home or building is painted fairly frequently to maintain maximum appearance, as it avoids heavy accumulation of old paint.

White paints of the types described so far are usually formulated to develop a fair degree of chalking when weathered, to shed dirt and stay white. Therefore, they should not be tinted as they will develop a white face and fade prematurely. Instead, regular tints should be used or special tints should be made by adding colorants to regular tints or to tinting whites. They are formulated with chalk resistant titanium oxides. In some cases the slower chalking tinting whites are recommended both as a trim and tinting white, and for use as the white body above darker paints or brick surfaces, where a white chalk might be apparent as a wash-down over a darker lower surface.

The darker tints, bright trim colors and deep colors in a modern exterior house paint line are usually at least semi-alkyd paints, and more probably are based on full long oil alkyd vehicles. Their original gloss and their gloss retention, color retention and durability are truly outstanding. As an example, we have whole series of long oil alkyd colors on the fences at our Chicago exposure farm that have been there for the equivalent of twelve years on houses in the same area. Their only change is a slight surface dulling - they still have high angular sheen and no other film failures. The improvement in colored house paints has been tremendous.

Now we must turn to "latex" or "emulsion" house paints. Events of the past eight years have shown that exterior emulsion paints are here to stay. They have captured an important segment of the exterior house paint market, and the shift from solvent to emulsion house paints has proceeded at a substantial rate. Note that we do not say that emulsion house paints will replace <u>all</u> solvent types in the foreseeable future. Both types have their place - each will have areas in which they will show superior performance. We believe we will have both types with us for a long time.

Considering the good properties of solvent type house paints we have extolled so far - why have emulsion house paints gained wide popularity so quickly? First of all, the earlier and sustained acceptance of interior emulsion paints had shown that these paints had the application qualities painters and other consumers had been waiting for. Their ease of application, their quick drying and the easy cleaning of tools or spills gave them real appeal.

Obviously, these same advantages hold for exterior emulsion paints. They can be applied over temporarily damp surfaces, so the painter can start earlier in the day, even though there still may be dew on the siding. Further, the fact that they gain water resistance quickly (usually in less than a half hour) means there is less danger of damage from closely following showers or evening dews. We must caution against shaving the time too close - evening dew actually condensing on the wet paint could rivulet and deface the film, or rain could mar wet paint. But the fact remains that exterior emulsion paints do extend the number of hours suitable for painting outdoors and increase the number of days on which outside painting can be done.

Exterior emulsion paints arrived at just the right time - when there was a great increase of interest in color. Here is where emulsion paints stand out - their ability to hold their bright, clean color. This is especially true in pastel to medium tints, which has made possible a much wider selection of colors in both tone and depth, to lend distinction to houses which otherwise might have some similarity in architecture.

Another speaker is handling the topic of exterior finishes for masonry, so references to such surfaces here will be confined to the remark that emulsion paints show to advantage on masonry. Furthermore, emulsion paints are available which can be used on both masonry and wood surfaces, eliminating the need for different paints for the different surfaces. Actually, and in contrast to solvent type house paints, it was easier to develop emulsion paints for masonry than for wood.

Wood is more directly affected by exposure to weather and by changes in weather than holds true for most masonry surfaces. Wood is subject to greater dimensional changes, and these changes are greater across grain boundaries than along the grain. The problem of splitting along grain boundaries by wood coated with emulsion paints has been a serious one.

There have been differences in the approaches by the various paint manufacturers to the solution of the problem of applying exterior emulsion paints to wood. The majority recommend the use of a solvent undercoater of either oil or alkyd type on bare wood. This retards the penetration of moisture into the wood and the escape of moisture out of the wood. This in turn reduces the magnitude of the dimensional changes in the wood and slows down the rate of movement of the wood. The net result is less shock to the emulsion topcoat, and cracking along the grain boundaries can be eliminated.

Other manufacturers offer an all emulsion system for wood - certainly the ultimate goal of all suppliers of exterior emulsion paint systems. This is usually accomplished by using a low pigmented emulsion first coater or by modifying the emulsion topcoat with some oil or alkyd. So far such coatings have had more success as first coaters on chalky repaint surfaces, where straight emulsion paints by their very nature may fail to bind the chalk. There are still problems with modified emulsion first coaters on bare wood, in some instances problems with drying, or discoloration on cedar and redwood due to colored water extractibles. Certainly the problems eventually will be solved, and then the all emulsion system will make exterior emulsion paints even more popular.

Slide 6 - Undercoaters for Exterior Emulsion Paints

(Panels exposed 3-1/2 years Chicago south vertical. Four emulsion paints based on different latices. Left one coat emulsion paint over oil type solvent primer, right two coats emulsion paint self-primed. Cedar and Ponderosa Pine.)

Even those emulsion paints which crack and peel off bare wood quite rapidly when applied self-primed show practically no failure, except for fading when applied over a solvent primer, for the 3-1/2 years' duration to date of this test. The preferred system of two coats of emulsion paint over the solvent primer would be considerably better than the best shown in this illustration.

Latex paints have lower solids than the usual solvent type house paints. Therefore it is important to apply them generously, preferably two coats of emulsion paint over the primer. It is also important not to take advantage of their easy brushing and spread them out too far. Weather conditions from the standpoint of minimum temperatures are perhaps even more critical than with solvent paints. If the temperature is too low the emulsion paints will not coalesce or form a film. We recommend that exterior paints should not be applied at temperatures below 50° F.

Exterior emulsion paints are the products of modern research - with all the potentials that scientific technology can give them. The greatest danger to their ultimate success is that the consuming public would think of them as "miracle paints." Specifically, one of the great dangers is that wishful thinking will convince people with moisture problem houses that all they need do is to put on a latex or emulsion house paint and all will be serene. This is not so.

Let's face it - no house paint can overcome deficiencies in construction nor other conditions which harbor permanent moisture. Faults in construction which cause moisture problems must first be corrected, and other sources of moisture eliminated. Then siding must be allowed to dry out and any damage to the old paint must be taken care of, not by just scraping off any actual blisters or peeling spots but by removing all the paint in those areas where there is marginal adhesion. This must be followed by treating the bare wood as one would in initial painting.

While the discussion of exterior finishes for wood up to this point has been concerned primarily with pigmented coatings, there has always been interest in a durable exterior clear finish. Natural wood has an inherent beauty which cannot be matched by metal substrates, and to hide this beauty with an opaque paint may not appeal to everyone. It must be acknowledged, however, that the current interest in colors on houses would dictate a high percentage of opaque coatings.

Those who have been interested in using clear finishes on their siding have probably encountered very conservative opinions from suppliers as to their value. They have usually been told in advance that the clear vehicles are not as durable as their properly pigmented counterparts, and that much more frequent maintenance will be required. Since the failures will not be uniform in all directions, certain areas will accumulate considerable film thickness of aged clear coating. If and when a decision is made to change to paint, certainly all heavy coats (and preferably all remaining clear) must be removed to bare wood by some means such as power sanding or equivalent before applying the paint.

There have been some definite improvements made in the quality of exterior clear finishes for wood. Some of the improvements have been made by going to newer types of vehicles, polyurethanes or polyesters as examples, or by incorporation of ultraviolet absorbers or film fortifiers. Since no concentration on a specific type has developed so far in the industry, the consumer should check the specific product he has in mind as to the claims made and the evidence presented to support such claims.

We have heard criticism of the paint industry because they have not developed better exterior clears, of perhaps five years' life expectancy. Such critics may not realize that almost invariably when a new type of binder is developed it is exposed as a clear finish as well as in pigmented form. In addition, the wide studies made of interior clears have always included consideration of their possible use outdoors. Therefore there actually is a considerable amount of work going on all the time to find a superior exterior clear finish.

Semi-opaque exterior pigmented stains are now available which are easy to apply, which are durable and which provide considerable protection to the wood, especially against erosion of the springwood. Some lines of exterior pigmented stains are offered in several attractive colors. It must be conceded that in contrast to clears they do obscure the beauty and character of the wood to a degree, but they possess aesthetic value of their own. Should a decision be made later to go to opaque paints, the weathered pigmented stains provide a repaintable surface with minimum preparation necessary.

Whether one elects to use solvent type or emulsion exterior paints on wood, it is important to use or to specify paints of recognized and proven performance. Low cost or "bargain" paints may be anything but bargains if one figures the cost of labor in applying paint against the actual cost of the paint itself. If the "bargain" paint fails in a manner requiring extensive removal or other preparation prior to repainting - and usually if this is true the paints generally fail much faster than they should - then even if the paint were supplied free it would still be an expensive paint.

Slide 7 - Low Priced House Paints

(Exposure series one year south vertical Chicago of high grade two coat proprietary house paint system vs. group of low priced house paints.)

Low priced house paints are a gamble. Some may perform reasonably well, a few have checked badly within six months, and others have shown varying degrees of dirt collection, mold, yellowing and checking or cracking. The illustration shows the appearance of a small group of low priced white house paints taken from an extensive series of comparisons of such paints against a high grade proprietary two coat house paint system. It is self-evident that a good quality paint is the best investment, and is the real bargain in the long run.

How can one tell if he has a good house paint? There are many routine laboratory tests which establish the degree of conformance to certain requirements or which can be used for quality control. However, at present most paint manufacturers place the greatest reliance on exterior panel tests, often supplemented by test houses.

A modern panel exposure farm has become a much more complex facility than it was ten or fifteen years ago. In those days probably the majority of panels were redcedar or redwood bevel siding, usually painted white, buff and gray. Today an exposure farm is often a kaleidoscope of colors, applied on a wide variety of substrates, on various species of wood, on masonry, metal and plastics. The wood surfaces range from bevel or pattern siding to flat boards in horizontal or vertical positions, shingles and raked shakes, exterior plywood with and without overlays, wood in various special patterns, hardboard, particle board, and all the other variations in which wood is offered as a siding material.

The studies of exterior clears or paints on wood may spread into evaluations of multiple recoats, mixtures of paint systems, coatings on undereave areas, chalk washdown tests, behaviour over water repellents, performance of topcoats over preprimed siding, tests using various types of fastenings, and many others too numerous to list here. Many of the findings on panels are checked on houses in various parts of the country. All of these tests are time consuming but so far are necessary before they can be offered with confidence for volume sales to consumers.

This has brought us by a circuitous route back to the production priming or finishing of exterior siding. We mentioned the problem of radical reduction of drying time required for production prepriming or, eventually, prefinishing. A certain amount of exposure experience was available on fast drying exterior primers and complete systems. It is not surprising that in certain cases modifications have to be made in these coatings to fit them to specific production lines and schedules.

How can we predict how such changes will affect the exposure results obtained with the original formulations? To pose a greater challenge - how can we know if one of our systems will give satisfactory performance on wood for ten years or more? Taking a very practical viewpoint, we all realize we can't wait for ten years of exposure on our fences or on houses before we can go to our customers and say a particular material will fill the bill. How can we shorten this, the most time consuming portion of all paint testing?

Naturally we have many years of experience with all sorts of pigments, extenders and binders. It is possible to do considerable projection about a new combination from exposure experience with similar or related formulations or from the knowledge gained about the individual components. However, eventually verification of such predictions is essential. Therefore the need for a faster way to evaluate the exterior performance and life expectancy of paint films continues to grow.

We may have uncovered a promising lead in our work which led to the selection of a certain type of emulsion polymer for an exterior emulsion house paint which could be used on both wood and masonry surfaces. Some polymers were eliminated because of inability to control efflorescence, or deficiencies in mechanical stability, freeze-thaw resistance, or some other property. But others were eliminated because tests of free films of the weathered pigmented paints on the Instron Tensile Tester showed loss of elongation or embrittlement long before there were any changes visible to the naked eye.

The interesting point is that paints which showed advanced changes in such properties eventually failed on regular outdoor exposure by checking, cracking or flaking. Naturally the question occurred to us - were we on the trail of a technique for relatively rapid appraisal of the durability of an exterior paint?

We started simultaneous exposures of the candidate polymers as pigmented paint films on tinfoil at our Chicago test station and in our Twin Arc Weather-Ometer. We have voiced very conservative opinions in the past of the validity of results we obtain in so-called "accelerated weathering" units. We said that perhaps we could accept chalking and fading results if we had a similar control paint of known performance in the same series. But we felt that we couldn't place much reliance on the evaluation of checking or cracking tendencies in these "accelerated weathering" machines. Probably this was because we could rate the chalking or fading visually, but we couldn't look down inside the film to see the changes that were going on in elongation, modulus or tensile strength. Now we can do this with the Instron Tensile Tester.

As we measured the changes in the stress/strain properties of the emulsion paint films weathered for various intervals under the two conditions a story started to unfold. Loss of elongation appeared with certain polymers after only a few months of outdoor exposure and after only a few hundred hours of Weather-Ometer exposure. Others showed much better retention of elasticity through the 15 months of exterior exposure we could check before we ran out of film, or 1500 hours in the Weather-Ometer. In fact, 100 hours in the Twin Arc Weather-Ometer developed about the same changes in film properties as one month's exposure in Chicago.

Let's run quickly through some of the devices or facilities that are used in such a study.

Slide 8 - Panel Exposure Farm

(A typical section of a panel exposure farm.)

Slide 9 - Atlas Twin Arc Weather-Ometer

(A carbon arc unit designed to accelerate normal outdoor weathering.)

Slide 10 - Special Weather-Maker Cabinet

(A unique cabinet to provide cycles of temperatures ranging from -20° to + 200° F. and humidity controlled in a temperature range from 35° to 185° F.)

Slide 11 - Instron Tensile Tester

(Floor model. Used to determine stress/strain properties.)

The Instron Tensile Tester as we use it is installed in a room controlled at 77° F. and 45% R.H. An environmental cabinet will be installed to permit measurements over a temperature range from -110° F. to 350° F., with humidity control from 20 to 95% through a temperature range from + 35° to 185° F. It will be of special value in the study of the effect on tensile properties of paint films of changes in temperature and humidity of their external environment and as caused by contact with wood of varying moisture content.

Slide 12 - Infrared Spectrophotometer

(May be used to identify inorganic or organic compounds or changes therein.)

Slide 13 - X-ray Spectrograph and X-ray Diffractometer

(May be used in this work to identify elements;
i.e., to determine composition of chalk.)

When we studied the candidate emulsion polymers described earlier as to changes in their tensile properties at 77° and 45% R.H. after various intervals of outdoor weathering and exposure in the Weather-Ometer, we obtained the following interesting correlations, using decrease in elongation as a criterion of durability.

Slide 14. Polymer A - Elongation

Slide 15. Polymer B - Elongation

Slide 16. Polymer C - Elongation

The three slides show a striking correlation in the graphs of the data - elongation plotted against months of outdoor weathering in Chicago and elongation plotted against hours in the Weather-Ometer. At this time we have some support to the hope that we can predict the durability of coatings in at least one seventh the time now required for outdoor weathering tests.

We need more evidence before we can say we have proven our case. At least, we already have a great deal of the tedious outdoor exposure work out of the way. We have exposures of many types of exterior paints for wood already completed covering formulations which have failed in perhaps a year or less to others which are still continuing in good condition for upwards of ten years. We can now repeat these tests in the Weather-Ometer and on these other instruments to see how soon we could have predicted the ultimate performance of these paints. Eventually it may be possible to incorporate such determinations into performance specifications, although the present instrumentation involved represents a major financial investment.

We should mention that elongation is not the only property evaluated in this study. The changes in tensile strength can also be used to project a film's durability. During exterior exposure the elongation of a film usually decreases to a point where it levels off. The tensile strength usually increases to a point where it levels off and in some cases, at least, it may decline. When we encounter significant declines in tensile strength we believe the polymer film is actually degrading.

The formulation and evaluation of exterior finishes for wood is obviously becoming a complex and comprehensive science. Compositions change so rapidly that it is almost impossible to set up a composition specification without setting up obstacles which make it difficult to take advantage of progress in research. Our aims should always be to provide the ultimate consumer with the most value in performance for each dollar invested. We believe the constant increase in the scientific knowledge of coatings for wood will ensure steady progress towards this goal.

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