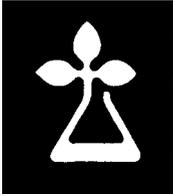




U.S. DEPARTMENT OF AGRICULTURE • FOREST SERVICE
FOREST PRODUCTS LABORATORY³ • MADISON, WIS.

In Cooperation with the University of Wisconsin



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FOREST PRODUCTS LABORATORY NATURAL FINISH¹

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Summary

A simple and durable exterior natural finish developed at the Forest Products Laboratory is described. The finish is classified as a semi-transparent oil-base penetrating stain that effectively retains much of the natural grain and texture of wood when exposed to the weather. The directions for preparation are included as are the recommendations for application to both smooth and rough wood surfaces.

^{1/} A revision of Forest Products Laboratory Report 2096, of the same title, originally issued in 1957 and revised in 1961, 1964, 1970, and 1972.

^{2/} Now with Simpson Timber Company, Bellevue, Wash.

^{3/} Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

Introduction

Many homeowners want a finish that retains a part of the natural color and the grain of new wood or one that enhances the rustic appearance of lumber or plywood. The commercially available natural finishes that form a clear film, such as varnish, have been so short-lived, however, that they are not recommended for exterior use.

One durable natural finish is the penetrating stain, developed at the Forest Products Laboratory in the 1950's. The FPL natural finish was formulated to overcome the more serious shortcomings inherent in such finishes of the film-forming type that are so susceptible to failure by cracking and peeling. Because the stain penetrates the wood surface and does not form a coating, there is no failure by blistering and peeling even in excessive moisture conditions. There is no coating to scrape before refinishing. Thus, the penetrating stain is easily maintained at a low cost on a variety of wood surfaces.

Test results indicate that the first application of the FPL natural finish to smoothly planed surfaces fully exposed to the weather should last about 3 years. When refinished after weathering, the finish will last much longer. Two coats of stain applied to rough-sawn or weathered surfaces may last 10 years or more.

Formulation

Color and Composition

The finish can be prepared in almost any color except a pure white. Three colors that are well suited for use on siding are cedar, light redwood, and dark redwood. These are now described in detail in Federal Specification TT-S-708a, "Stain, Oil; Semi-Transparent, Wood Exterior." Copies of this specification may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

The formulas for batches of slightly less than 5 gallons of FPL natural finish in the three colors are given in the following tabulation:

<u>Ingredients for slightly less than 5 gallons of finish</u>	<u>Quantity of ingredient for--</u>		
	<u>Cedar color</u>	<u>Light red- wood color</u>	<u>Dark red- wood color</u>
Boiled linseed oil.....gal.	3.0	3.0	3.0
Mineral spirits or paint thinner..gal.	1.0	1.0	1.125
Penta concentrate, 10:1.....gal.	.5	.5	.5
Paraffin wax.....lb.	1.0	1.0	1.0
Zinc stearate.....lb.	.125	.125	.125
Burnt sienna tinting colors.....pint	1.0	2.0	.333
Raw umber tinting colors.....pint	1.0	None	.333
Indian red iron oxide colors.....pint	None	None	.667

Further research has shown that a variety of modifications of these formulas are possible without detracting seriously from the durability and performance. The following general formula gives the approximate variations in composition which can be used to prepare a stain with acceptable performance characteristics.

	<u>Amounts to make approxi- mately 5 gallons</u>	<u>Percent of weight</u>
Boiled linseed oil	1-3 gal	20-60.0
Mineral spirits, turpentine, paint thinner	3-1 gal	43-17
Penta concentrate, 10:1	0.5-1.0 gal	13.0-26.0
Paraffin wax	0.25-1.0 lb	0.5-2.5
Zinc stearate	0-0.125 lb	0.0-0.3
Tinting colors	1.0-2.0 qt	8.0-16.0

Variations in the color can be achieved also with combinations of tinting colors. Some suggested colors are:

Green gold : 1 pint chromium oxide, 1 pint raw sienna
 Tan : 1 quart raw sienna, 3 fluid ounces burnt umber
 Chocolate brown: 1 quart burnt umber
 Forest green : 1 quart medium chrome green
 Fruitwood brown: 1 pint raw sienna, 1 pint raw umber, 0.5 pint burnt sienna
 Smoky gray : 1 quart white oil-base house paint, 6 fluid ounces raw umber,
 3 fluid ounces lampblack
 Charcoal black : 1 quart carbon black

By varying the ratio of tinting colors, various hues of the color desired can be obtained. The color pigments are available in most paint stores as tinting colors and in artist supply stores as colors-in-oil. The colors of high-quality iron oxide pigments are very durable and other colors may prove only slightly less so. Durability, however, depends largely on the amount of pigment or stain applied to the surface. Doubling the amount of pigment in the formula will therefore improve the durability, but will make the finish less transparent and the color more intense. The finish used without pigments produces a beautiful natural oil appearance but will need refinishing about every 2 years.

The boiled linseed oil, mineral spirits, or other paint thinner can be purchased at paint stores; the penta concentrate, at paint stores, lumberyards, farm supply stores, or mail-order houses; the paraffin wax, at grocery stores; and the zinc stearate, at drug stores. Zinc stearate, which prevents caking of the pigments during storage and helps to keep the pigments suspended during use, can be omitted if the stain is used soon after mixing, and is frequently stirred.

Penta, the common term for pentachlorophenol, is a widely used preservative, and protects the finish from mildew. Penta concentrate 10:1 is a commercially available solution that consists of about 40 percent by weight of industrial penta in a suitable solvent. A 5-gallon batch of the FPL finish contains about 1.9 pounds of penta. If the 40 percent penta concentrate is not available, but a 5 percent solution is, this solution can be used as the solvent or thinner for the stain.

Mineral spirits and paint thinners are common solvents used in making the FPL finish. Turpentine, kerosene, and No. 1 fuel oil are also suitable solvents. Fuel oil and kerosene, however, have a disagreeable odor that may persist for several weeks.

In the warm and moist parts of the country where resistance to discoloration by fungal growth (mildew) is important, the amount of penta concentrate should be increased to 1 gallon, the amount of solvents to 3 gallons, and the quantity of boiled linseed oil be reduced to 1 gallon. The ratio of solvent to linseed oil can therefore be varied from 1:3 to 3:1 without seriously affecting performance. Slightly better spreading properties and greater durability, however, are achieved with the high linseed oil content.

Substituting an exterior spar or marine varnish for the linseed oil may provide adequate fungal resistance in some areas without the use of penta as a fungicide.

Preparation

With proper care, a homeowner can prepare the FPL finish. Some paint manufacturers, however, now include a version of the finish in their regular lines.

To prepare the FPL finish, melt the paraffin in a top unit of a double boiler or other container heated by steam or hot water. When the paraffin is completely melted, stir it vigorously while slowly adding it to the mineral spirits or paint thinner.

Caution: Turpentine, mineral spirits, fuel oil, and paint thinner are volatile flammable solvents. Their concentrated vapors should not be inhaled or exposed to sparks or flames that could ignite them. The solvents should therefore be stirred vigorously, as hot paraffin mixture is added, to prevent heating to a temperature at which the solvent could ignite. The hot mixture can be handled more safely outdoors or in an open garage or porch than in a closed room.

When the turpentine or paint thinner solution has cooled to about 70°F (room temperature), add the pentachlorophenol concentrate, zinc stearate (if used), and then the linseed oil. (Avoid inhaling the fine zinc stearate powder when mixing.) Finally, stir in the pigments, a little at a time, until the mixture is uniform in color. It is then ready for use.

Mixing at temperatures above 70°F is preferred.

Application

On smoothly planed wood surfaces, a single application at the rate of 400 to 500 square feet per gallon is recommended. A second coat on smooth surfaces may not penetrate uniformly, and this produces a nonuniform appearance of glossy and flat areas. The first coat on a smooth surface may last only 2 or 3 years; but when refinished after weathering, the finish may last 8 to 10 years.

When finishing smooth surfaces of high-density species like Douglas-fir and southern pine, the surface may be treated with a water-repellent preservative and allowed to weather for a year before staining. The first coat of stain will then penetrate uniformly and be more durable because weathering has made the surface more adsorptive.

On surfaces that have been made adsorptive by weathering or rough sawing, a gallon of finish should cover 200 to 250 square feet. An effective method is to use wet coats, applying the second not more than 4 hours after the first. Both coats can then penetrate. Excess stain remaining on the surface 1 hour after application should be wiped off to prevent formation of glossy spots.

Caution: Sponges and cloths saturated with the finish are quite susceptible to spontaneous ignition. Therefore, it is important that they be disposed of promptly by careful burning, immersion under water, or burying.

The finish has been used with success over other penetrating natural finishes that have weathered until they needed renewal. If the finish penetrates well into the previously finished surface, it will appear flat. If the finish does not penetrate well, it will dry slowly with numerous glossy areas and probably will not be as durable as it is on new wood. Old varnish and paint films should be completely removed before applying the FPL finish. Again, stain that has not penetrated after 1 hour should be wiped from the surface.

For refinishing after a previous application has worn away, the stain may penetrate better if thinned with not more than 1 quart of mineral spirits per gallon of stain. To remove dirt before refinishing, it is frequently advisable to use steel wool or sandpaper lightly on the surface.

The finish can be applied by brush, roller, sponge, or spray equipment. Brushing, however, improves penetration and uniformity in appearance. Following the sun around the house and working only in the shade will help to reduce the tendency for lap marks to form. Having the entire wall in the shade will also prevent uneven penetration problems due to variation in surface temperature.

Using the Finish

Potential Uses

The finish was originally formulated in shades of red and brown to match reasonably well the heartwood colors of species such as redwood, western red-cedar, and Philippine mahogany. FPL natural finish is now recommended in all colors, except white, on all grades of commonly used species. The rougher the surface, the better for finishes, particularly on the high-density wood species. To decide if the color is satisfactory, apply the finish on samples of siding.

The finish was made low in hiding power to let the grain of the wood show through. Thus both grain and color of the wood contribute to the final appearance of the finished wood.

The FPL natural finish was developed for lumber siding but serves well also on plywood and on wood shingles, roofs, doors, exterior trim, and millwork. The finish can also be used with satisfaction on wood items such as fences, lawn furniture, sun decks, and boat decks; but because such items are often more fully exposed to the weather than siding, they may need refinishing more often. Because the stain does not fail by cracking and peeling a coating, it can effectively be used on buildings where serious moisture problems exist. It is also suitable for interiors where exterior colors are employed in the decor. For interior use, pentachlorophenol **MUST NOT BE INCLUDED**.

The use of rust-resistant nails, such as galvanized or aluminum nails, to secure the wood will reduce the unsightly discoloration and darkening that occurs around iron nails on weathering.

Specific Considerations

The FPL natural finish dries rather slowly; a day of good drying weather is generally required for thorough drying. Wax in the finish may interfere with subsequent painting. Laboratory refinishing tests, however, demonstrate that this finish can be painted over with house paints after as little exposure to the weather as 1 year. Where the finish is protected from the weather, as immediately under an overhang, it should be wiped well with a paint thinner or some other wax solvent before painting.

To avoid lap marks, the finish should be applied in the shade by brushing with the grain of the wood for the full length of the board or course of siding without stopping for more than 5 minutes. The finish also should be stirred frequently during application to maintain uniform suspension of the pigments.

Advantages

Among the advantages of this finish are good color retention, good durability on a variety of smooth and rough wood surfaces, and low cost of

initial application and maintenance. Evidence indicates that the first application of this finish should last approximately 3 years on smooth surfaces, and up to 8 to 10 years on rough surfaces and refinished surfaces which were initially smooth. The finish simply wears away or erodes; this produces a surface that can easily be refinished.

CAUTION: Wood preservatives (a type of pesticide) used improperly can be injurious to man, animals, and plants. For safe and effective usage, follow the directions and heed all precautions on the labels. It is advisable to wear unlined protective gloves and to cover nearby plant life when using any material containing pentachlorophenol such as the FPL natural finish or a water-repellent preservative. Do not use any preservatives containing pentachlorophenol indoors.

Avoid spraying wherever possible. Drift from a pesticide, applied as a spray, may contaminate the surrounding environment.

Store preservatives in original containers under lock and key--out of reach of children and pets--and away from foodstuff. Follow recommended practices for the disposal of surplus preservatives and preservative containers.

NOTE: Registrations of pesticides are under constant review by the Environmental Protection Agency and the Department of Agriculture. Use only preservatives that bear a Federal registration number and carry directions for home and garden use. Since the registration of preservatives is under constant review by State and Federal authorities, a responsible State agency should be consulted as to the current status of the preservative discussed in this report in your state.

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ALTERNATIVES TO PENTACHLOROPHENOL IN THE FPL NATURAL FINISH
AND IN WATER-REPELLENT PRESERVATIVES

The USDA Forest Service Research Notes, FPL-046, 'Forest Products Laboratory Natural Finish', and FPL-0124, 'Wood Finishing: Water Repellents and Water-repellent Preservatives', are out-of-date regarding the purchase and use of the wood preservative, pentachlorophenol (penta). Penta has been classified by the Environmental Protection Agency as a restricted use pesticide and is no longer readily available as a preservative for the formulas described in FPL-046 and FPL-0124 unless the user is a licensed pesticide applicator. In addition, penta has been removed from most, if not all, commercial stain and water-repellent preservative (WRP) formulations. All concentrations of penta have been restricted for sale including the 40% concentrate described in the publications.

Many wood preservatives are being used as substitutes for penta in commercial stain and WRP formulations. Most of these, however, may be difficult to obtain for mixing into your own formulation. These products would have to be purchased directly from the manufacturer, or from chemical supply houses. Some may be sold only to commercial operators. Wood preservatives are under regular review by State and Federal authorities; regulations pertaining to their purchase and use have been changing.

While it may be difficult to purchase preservatives to mix your own stain or WRP formulation, the original publications may still be used as guidelines for selecting a commercial product. Check with a paint dealer for WRP solutions and semi-transparent stains that contain a water repellent and a preservative (also referred to as a mildewcide or fungicide). Or, a paint dealer or chemist who is licensed to handle and mix preservatives may be able to prepare a similar formulation for you. Some alternative preservatives are effective at lower concentrations than penta; check to ensure that the proper amount is added to yield the recommended percentage composition (by weight).

Some observations on the chemical systems currently in use or contemplated for use in stains and WRP's are:

1. A mixture of bis (tributyltin) oxide and N-trichloromethylthio phthalimide, (the latter also commonly called "Folpet"). This combination of chemicals is in a number of commercial stain formulations, at a 0.5 to 1.0% composition by weight.
2. 3-Iodo-2-propynyl butyl carbamate (commonly called "Polyphase"). Now used in several commercial clear and WRP formulations and pigmented stains. Available in both solvent- and water-borne systems. Approximately 0.5% composition by weight is recommended by the manufacturer for best performance.

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3. Zinc naphthenate. Available commercially in WRP formulations and possibly in some new stains. Also available in solvent- and water-borne formulations. Approximately 2% composition by weight of zinc metal required.
4. Copper naphthenate. Also available commercially in WRP's. Solutions and treated wood are bright green. Will weather to pale green-brown in full sunlight. Available in solvent- and water-borne formulations. Approximately 2% composition by weight of copper metal required.
5. Copper-8-quinolinolate. Available in commercial WRP's and may be available in stains. Also has a green-brown color. Effective concentrations range from 0.25% to .675%.
6. 2-(Thiocyanomethylthio) benzothiazole (TCMTB), alone or in combination with methylene bis (thiocyanate) (MTC or MTB). Currently in use as anti-sapstain chemical treatments for green lumber. May also be effective as a mildewcide for WRP and stain formulations. Available in both solvent- and water-borne formulations. Concentrations required are 0.5% by weight of each component.

Some European commercial formulations available in the United States may contain preservatives other than those listed above. Other chemicals may be introduced and used in the United States.

CAUTION:

The pesticides - wood preservatives, mildewcides, and fungicides - reported on and recommended here were registered for the uses described at the time this publication was prepared. Registrations of pesticides are under constant review by the Environmental Protection Agency. Therefore, consult a responsible State agency on the current status of any of these pesticides. Use only pesticides that bear a Federal registration number and carry directions for home and garden use.

Pesticides used improperly can be injurious to humans, animals, and plants. Follow the directions and heed all precautions on the label. Avoid inhalation of vapors and sprays; wear protective clothing and equipment if specified on the label.

If your hands become contaminated with a pesticide, do not eat, drink, or smoke until you have washed. In case a pesticide is swallowed or gets in the eyes, follow first aid treatment given on the label and get prompt medical attention. If a pesticide gets onto your skin or clothing, remove the clothing immediately and wash skin thoroughly.

Store pesticides and finishes containing pesticides in their original containers out of reach of children and pets, under lock and key. Follow recommended practices for disposal of surplus finishing materials and containers. Scraps of chemically treated wood or finished wood should never be burned, either for heat or for disposal. Toxic fumes may be released.