



Alternatives to the Madison Formula, the Original Do-It-Yourself Semitransparent Stain

The Madison Formula

The “Madison formula” was developed at the Forest Products Laboratory around 1950 as a simple linseed-oil-based finish that could be made from readily available components. It was one of the first formulations of its type—a penetrating finish that eliminated the problems with cracking and peeling commonly found with the oil-based paints available at that time. The finish could be made with pigment to give a semitransparent stain or without pigment to give a water repellent preservative (WRP). For more information, see the original 1979 document, [“Forest Products Laboratory Natural Finish.”](#)

Linseed-oil-based finishes that do not include a fungicide are prone to mildew. The critical ingredient in the Madison formula and similar penetrating finishes manufactured during that time was “penta” (pentachlorophenol) concentrate, a fungicide that was commonly used as a wood preservative. Penta was available from most hardware stores until approximately 1985. It is no longer available, except to registered pesticide applicators.

Since the mid-1980s, penta has been used only by commercial wood-preservative treaters for treating wood for industrial uses, such as railroad ties and telephone poles. Because no suitable substitute for penta is available to the general public, it is no longer possible to make the Madison formula. In addition, I know of no commercially available finishes that contain penta.

It is still possible to make a water repellent, but the performance of homemade water repellents is poor compared with that of commercially available WRPs, which contain a fungicide (see Water Repellent Preservatives, page 2). Water repellents that do not include a fungicide provide almost no protection against mildew growth.

Semitransparent Stains

Commercial oil-based semitransparent stains are available in a wide range of formulations, all of which must comply with EPA rules that restrict the amount of solvents or volatile organic compounds (VOCs). The stains are formulated with or without a registered pesticide (fungicide). If the stain contains a fungicide, it is usually labelled as a “preservative.” Stains with fungicide generally have better resistance to mildew growth, though the fungicide is not the only component that affects mildew resistance.

A semitransparent stain that includes unmodified linseed oil is prone to mildew, even if it contains a fungicide. Linseed oil is obtained from flax seed. Raw (unprocessed) linseed oil is a mixture of several fatty acids, which have two interesting properties. First, these acids are natural products and as such are “food” for many organisms. Just as mold can grow on leftover potato salad, mildew grows very well on surfaces that contain linseed oil. Second, the chemical makeup of some of these acids makes it possible for them to react with oxygen in the air to form a solid. For raw linseed oil, this reaction is extremely slow.

When linseed oil is boiled, changes occur in the chemical structure of the fatty acids that enable them to react with oxygen more quickly. The term “boiled” also includes linseed oil that has catalysts (also called “driers”) that make it react with oxygen more quickly. Boiled linseed oil can be used to make finishes. However, in most modern finishes, linseed oil is modified to form an “alkyd” resin, which makes the finish less prone to mildew.

Many modern commercial finishes are better than the Madison formula, particularly those that are formulated with modified linseed oil. The finish should have the following attributes.

- Be oil-based—The finish must be made from oil, but the oil should be modified to form an alkyd resin.
- Contain about 10% to 20% alkyd or similar resin—If the finish contains too much alkyd, it is prone to form a film instead of penetrating the wood.
- Contain an inorganic pigment—The more pigment in the finish, the longer the service life, but the less natural the finish. The Madison formula contained about 8% to 16% pigment.
- Be solvent-based—Water-borne formulations do not penetrate wood as well as do solventborne ones. The use of solvents in architectural finishes continues to be restricted, and many types of oil/water emulsions are available. Because the chemistry of these finishes varies considerably, it is not possible to generalize about their ability to penetrate wood.
- Contain a fungicide—The fungicide is usually listed as an “active ingredient” and typically has a concentration of 0.5%.
- Include 1% to 2% wax or a similar water repellent.

Other Stains

In addition to semitransparent stains, several other finishes are marketed under the term “stain.” These are latex semitransparent,

oil solid-color, and latex solid-color stains. Solid-color stains are also called heavy bodied or opaque stains. All of these “stains” form films on wood and therefore they are really paints, not stains. They do not penetrate wood well and should not be used in place of the Madison formula.

Water-Repellent Preservatives

A water-repellent preservative (WRP) is similar to a semitransparent stain, but generally does not include pigment. Some WRPs are tinted with a small amount of pigment; these WRPs last about twice as long as the untinted ones.

The guidelines for choosing a WRP are generally the same as those for semitransparent stains. Avoid WRPs made with unmodified linseed oil. Solventborne formulations penetrate wood better than do waterborne ones.

Some WRPs are based on mineral oil. Since mineral oil is not a natural product, it is not prone to mildew. These WRPs penetrate well into wood. Because WRPs based on mineral oil do not cure, they can be applied in multiple coats and give the wood an “oiled” appearance. They usually contain a fungicide, are not pigmented, and need to be applied much more frequently.

Formulations containing a fungicide give much better protection to wood than those without one. Therefore, commercial finishes should be used rather than homemade ones. Because I receive many requests for a do-it-yourself water repellent, instructions for a simple formulation are given here.

Note: The following formulation is not as good as a commercial WRP, and I would not use it on my own home or deck.

Formulation for a Simple Water Repellent

Spar or polyurethane varnish*: 20%

Paraffin wax: 1% to 3%

Mineral spirits: 77% to 79%

*Spar varnish usually contains about 50% alkyd or similar resin. If the percentage of resin in the varnish is less than 50%, adjust the amount to obtain 10% alkyd in the water repellent.

Mix the ingredients outdoors. Dissolve the wax in the mineral spirits, then add the appropriate amount of varnish. It may be necessary to melt the wax to get it into solution. Use electric heat, not an open flame. Pour the melted wax slowly into the mineral spirits with stirring. Do not heat the mineral spirits.

Caution: Extreme fire danger.

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For more information, consult our website: www.fpl.fs.usda.gov