FinishLine

Forest Products Laboratory

Paint, Stain, Varnish, or Preservative? It's Your Choice

If you've ever admired an old, unpainted barn that has survived 100 years or more of weather, it's easy to wonder why you should use a finish on your home. However, the cracks, fissures, and air spaces that give weathered barn siding its character wouldn't be acceptable on most houses. For a discussion of weathering and decay see the FinishLine "Outdoor Furniture, Artwork, Fences, and Play Equipment."

Although you can't completely arrest or reverse the weathering of exterior wood, you can slow the process dramatically by using the right type of finish. Appearance, durability, cost, surface type, ease of application, and maintenance should all be considered when selecting an exterior finish.

Two basic types of finishes or treatments are used to protect wood surfaces from weathering: those that form a film or coating on the wood (film-forming finishes) and those that penetrate the wood surface. Film-forming materials include paints, solid-color stains, and varnishes. Penetrating finishes include preservatives, water repellents, and pigmented semitransparent stains.

What you choose to protect and enhance the beauty of wood always involves trade-offs. You should select the finish that best suits the application.

Film-Forming Finishes

Paints—Latex is Best

Paints form a thin layer over the surface to which they're applied. The pigments in the paint protect the surface completely from the damaging ultraviolet (UV) rays of the sun and erosion. The finish retards the movement of moisture into and out of the wood and seals in the natural resins. However, paint won't prevent decay if conditions are favorable for fungal growth. Moisture in wood approaches an equilibrium content that depends mostly on relative humidity. Finishes can only slow changes caused by humidity. The value of finishes with regard to moisture is in blocking liquid water from entering.

Oil-based or alkyd paints are essentially suspensions of inorganic pigments in an oil or modified oil vehicle that binds the pigment particles to the wood surface. Latex paints are suspensions of inorganic pigments and various latex resins in water. Acrylic latex resins are flexible and very durable. A good acrylic latex outdoor house paint will generally outlast a good oil-based house paint. Latex paints are also more porous than oil-based paints; they can "breathe" while they shed water. This characteristic may contribute to their longevity. If water enters the wall from an interior source, it's more likely to get trapped in the wood beneath an oil-based finish, and it can cause the paint to blister and encourage decay. Moreover, oil-based paints tend to become brittle.

Acrylic polymers are more resistant to sunlight than oil-based paints and therefore do not weather as quickly. However, woods like redwood and cedar have water-soluble extractives that can bleed through latex paints. The best way to prevent this is to seal the wood with an oil-based or stain-blocking latex primer paint, then topcoat with acrylic latex paint.

Oil-based primers block better than latex-based stain-blocking primers; however, they are more brittle, which is problematic for woods that move a lot. Cedar does not move a lot and has been traditionally primed with oil primers. Extractives might bleed into latex stain-blocking primers but rarely continue into the topcoat if fully cured. A second coat of primer might be needed in a few spots.

In older homes finished with an oil primer and perhaps oil topcoats, surfaces are subject to a brittleness issue as the finish continues to crosslink over time. A surprising situation can occur when a latex paint is applied over brittle oil. In the curing process the latex shrinks and can actually pull off the brittle oil. (This phenomenon is yet to be optimized as a method of stripping paint.) When it occurs, it is likely that the paint was destined to fall off in a few years anyway. This headache could be avoided if tape with a strong adhesive (such as a plastic bandage) is firmly applied to the paint and then snapped off. If the paint is removed, it is time to strip, even if it otherwise looks intact (see the FinishLine "Stripping Paint from Exterior Wood Surfaces").

Wood is easier to repaint before the first coat fails. Paints weather away; self-cleaning paints weather at a faster rate than other

Life span of various finishes

Water repellents	6–12 months
Clear water-repellent preservatives	1–2 years
Pigmented water-repellent preservatives	2–3 years
Varnish	2–3 years
Solid-color stains	3–7 years
Semitransparent stains	3–8 years
Paints	7+ years

Note: The life span of water repellents, water-repellent preservatives (clear or pigmented), and semitransparent stains can be extended by refinishing if discoloration caused by mildew or other factors is a problem.

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paints. Ideally, wood should be repainted when the topcoats have weathered to the point that the primer is just starting to show. Painting too often can build up too many layers of paint.

The north side of a building does not need to be repainted as often as other sides because it is exposed to less direct sunlight. Apply one topcoat to this side instead of two, or paint this side less often. The optimum thickness for a primer and two topcoats is 4 to 5 mils (1 mil = 1/1,000 of an inch), about the thickness of a sheet of newspaper.

If the paint has peeled, the easiest way to prepare the wood for repainting is by power-washing. Power-washing or sanding (with 50–80 grit sandpaper) also improves the ability of new smooth siding to hold paint and removes weathered fibers of unfinished wood that have been exposed to sunlight for more than a few days.

Before applying paint, treat wood siding and trim with a paintable water-repellent preservative. This can be done by brush after the siding or trim is in place, or by dipping the wood before installation (see the FinishLine "Construction of a Dip Tank for Finishing Wood Siding or Decking"). All lap and butt joints of solid wood and all panel edges should be especially well saturated.

Allow the treatment to dry for at least 2 warm, sunny days before applying the primer. If the wood has been dip treated, let it dry for about a week. Two coats of a good-quality acrylic latex house paint should be applied over the primer. In general, quality is directly related to price.

Brush application is always superior to roller or spray application, especially with the first coat. The job can be done faster if one person sprays the paint and another uses a brush to work the paint into the wood and even it out (see also the FinishLine "Why House Paint Fails") .

Temperature is important. Don't paint on a cool surface that will be heated by the sun within a few hours or at the end of a cool day when heavy dew will form at night. The temperature must stay above 40 °F (4 °C) for 24 hours for oil paints and above 50 °F (10 °C) for latex. Some paints are formulated for colder temperatures, but it is possible you will be making a tradeoff (shorter life, higher cost, or other factor) so it is better to work in warm weather if possible.

Solid-Color Stains

Solid-color stains also form a film. They look and act like thin paints. Use a primer and two coats of stain. Refinishing may require only one coat. Like paints, latex solid-color stains are usually more durable than oil-based stains. Solid-color stains are preferable to paints when the wood is refinished frequently.

Varnishes

Varnish is another film-forming finish. However, because varnishes are clear, they require frequent maintenance to be attractive. Sunlight degrades both the varnish and the wood fibers directly beneath it. Some varnishes have chemicals that partially block UV radiation, but varnishes all soon begin to crack, peel, and flake, taking along the fibers of photochemically degraded wood. The wood needs to be cleaned and revarnished as soon as this breakdown occurs. Varnish lasts only 1 to 2 years on wood exposed to full sun, but longer on shaded wood. The life span of varnish can be extended by first staining the wood and then applying many coats of varnish.

Penetrating Finishes

Penetrating finishes absorb into the wood, saturating the surface fibers and partially or completely filling the surface pores. Many penetrating finishes contain water repellents, usually in the form of paraffin wax dissolved in mineral spirits.

Water repellents are usually clear. They can be used alone as a natural penetrating finish or as a treatment prior to painting. Check the label of the finish to make sure that it is paintable if painting is desired.

Many clear penetrating finishes contain wood preservatives in addition to water repellents; these penetrating finishes are much better for outdoor use. The preservatives control the growth of mildew and other fungi. Some preservatives also discourage insect infestation. This is especially important in moist, shady locations.

Water-repellent emulsions have been developed for waterborne formulations, but these may not penetrate as well as the formulations made with mineral spirits.

Semitransparent Stains—Oil is Best

Semitransparent stains are penetrating finishes with inorganic pigments. High-quality stains contain wood preservatives and water repellents. Semitransparent stains penetrate the wood without forming a film, allowing much of the wood grain to show through the finish. Latex-based semitransparent stains are film-forming finishes and will not perform like true penetrating stains. Oil-based semitransparent stains allow the wood to "breathe," so the finish doesn't blister or peel even if the moisture content of the wood is high. The pigment in a semitransparent penetrating stain greatly increases the durability of the finish by absorbing much of the UV radiation that would otherwise degrade the wood. The properties of the pigment, resin, preservative, and water repellent determine the durability of exterior stains.

UV inhibitors are organic molecules that sacrificially absorb UV photons or breakdown in the process of quenching degradation processes. Their life and effect is limited and may only double the life of a finish, which if it has no pigments could be less than a year. Pigments are inorganic, essentially ground up rocks. Rocks are very resistant to UV radiation. Asphalt shingles have small rocks to block sunlight. When the rocks wear off (not break down), shingles fail soon after. These rocks are massive when compared to pigments. Pigments are in the size range of the wavelength of light; in fact, when they are ground extra

fine they can fit inside the wavelength of visible light, making them transparent. They are still large enough though to block UV light, which has a smaller wavelength. So a semitransparent stain containing these smaller pigments can look very lightly pigmented, but the wood and any mildewcide are protected from UV. These smaller pigments are called transparent iron oxides (transoxides) and may contain finely ground titanium dioxide. A pencil mark drawn on the wood prior to application will be clearly visible to the human eye, but little UV reaches it. In addition to protecting wood, pigments add color and greatly extend the life of mildewcides and some other preservatives. A possible way to identify a product with these transoxides is if it appears to have little pigment on wood, but that it requires stirring (on label) so it likely has pigment. Transoxides will stay in suspension longer than traditional pigments. These pigments do cost more to make, so it is unlikely they would be in the least expensive products. However, just because a product is very expensive does not guarantee that it contains transoxides.

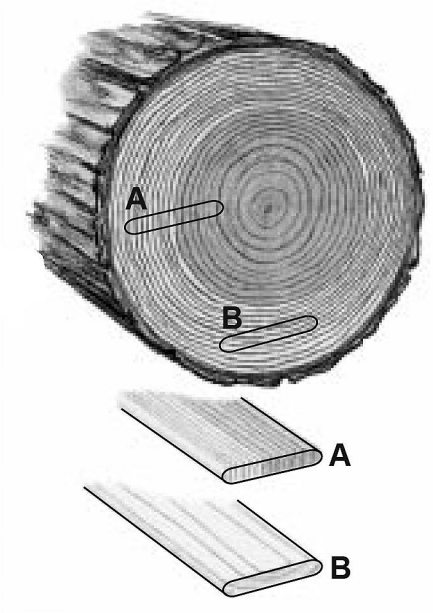

Figure 1—The position of wood in the log determines the grain of the sawn lumber. A, vertical- or edge-grained lumber; B, flat-grained lumber.

The properties of the pigment, resin, preservative, and water repellent determine the durability of exterior stains.

Penetrating stains perform best on rough-sawn, weathered, or coarse-textured wood. If you are finishing smooth wood, powerwash, sand, or wet the surface to relieve stresses and open the surface pores. Unlike paints, stains can be applied to weathered surfaces without preparing the surface. If the surface is dirty or has mildew, clean it with bleach and detergent before applying the finish. Penetrating stains are suitable for siding, trim, exposed decking, fences, and roof shingles.

Stains may be applied by brush, spray, or roller. To prevent lap marks, finish the board or panel in one working session.

Working in the shade will give the best results because longer drying time means greater penetration of the stain.

For best results, rough-sawn or weathered lumber should be treated with two coats of penetrating stain. Disagreement exists whether to apply the second coat before the first coat is dry (when the potential for chemical bonding exists) or wait until the first coat is dry and solvents have evaporated (leaving more space for a second coat). To prevent formation of a film, an hour after applying the second coat, use a cloth, sponge, or dry brush lightly wetted with stain to wipe off any excess stain that did not penetrate the wood. Remember that sponges or cloths soaked with oil-based or alkyd-based stains are particularly susceptible to spontaneous combustion; they should be buried, immersed in water, laid out flat on cement, or sealed in an airtight metal container.

Natural Finishes

A natural finish means different things to different people. To some, a natural look means rough, gray, and weathered (nature's "natural finish"). To others, a successful natural exterior wood finish is one that retains the original, attractive appearance of the wood with the least change in color and the least masking of the grain and surface texture. In this case, the finish should inhibit the growth of mildew micro-organisms, protect against moisture and sunlight, and not change the surface appearance or color of the wood.

The "weathered look" can be obtained in several ways. Do nothing until the wood turns gray, then treat the wood regularly with a water-repellent preservative or a gray semitransparent stain. This will extend the life of the wood. If you want to obtain a weathered look quickly, apply a gray stain; as the stain weathers, the wood will turn gray naturally. Maintain the finish with a stain or water-repellent preservative.

You can preserve the original color of the wood in several ways. From the start, treat the wood with a water-repellent preservative at least once a year, or apply a semitransparent oil-based stain (containing a water repellent and preservative) of the same color as the wood. The pigment in the stain protects the wood and extends the life of the preservative. If the wood turns gray, the preservative has failed. Most gray discoloration is caused by mildew. Power-washing, bleach, and some commercial cleaners remove gray discoloration. Aggressive physical cleaning and power washing remove fibers that would have absorbed finish, so you are shortening the life of the finish you then apply. These extra fibers may require 10%–30% more finish, but the result could mean years of additional life.

Wood Properties

Because wood properties vary, the type of wood is an important consideration in choosing a finish. Wood that has minimum tendency to shrink and swell is the best for painting because there's less chance that the paint will crack as the wood shrinks and swells. Vertical-grained (edge-grained) wood is subject to about half the shrinking and swelling of flat-grained lumber (Fig. 1). Wood density also affects swelling. Low-density woods are better for painting than denser species. Low-density softwoods like western redcedar and redwood have excellent properties for finishing; pine and fir also retain paint well, particularly if the wood is free of knots. As more wood is being cut from younger trees, more boards are containing juvenile wood—wood formed

during the first few years of growth. Juvenile wood shrinks and swells at a very high rate and requires a penetrating finish. Like wood with knots, juvenile wood easily releases extractives, which bleed through paint.

In general, it is best to paint over a fairly smooth and stable surface. Flat-sawn and dense woods can be stabilized with a resin-treated paper overlay. This type of lamination is most frequently applied over exterior plywood or stabilized fiberboard, and it makes an excellent surface for painting.

Rough-sawn exterior plywood siding is best finished with a semi-transparent penetrating stain or solid-color latex stain.

Preservatives

Preservative-treated wood, such as wood treated with alkaline copper quat (ACQ), copper azole (CA-B), micronized copper azole (MCA), DCOI-imidacloprid (EL2), and propiconazole-tebuconazole-imidacloprid (PTI), are frequently used for outdoor porches and decks. After a few years, some boards may check or crack as part of the natural weathering process. Weathering can be reduced by using a penetrating finish that contains a water repellent early in the finishing process. Allowing a deck to weather for a year opens the surface pores and permits the wood to accept more finish, but this weathering damages the wood. Research indicates that it is better to finish a deck as soon as it is dry (a few weeks after construction) and to refinish it in 2 years after gentle cleaning.

To paint treated wood, make sure the wood is clean and dry. Porches and decks can be painted, but be prepared for problems like decay, a slippery surface, cracking, checking, and flaking. Use a very good porch and deck enamel for the two topcoats. A thinned solvent-based porch enamel can make a good first coat. Water-repellent preservatives and semitransparent penetrating stains must be reapplied more frequently than paint, but reapplication is easy. Simply brush a generous amount of finish onto the wood; after 20 to 40 minutes, wipe off any excess finish that remains on the surface.

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