FinishLine

Forest Products Laboratory

Iron Stain on Wood

Iron stain, an unsightly blue–black or gray discoloration, can occur on nearly all woods. Oak, redwood, cypress, and cedar are particularly prone to iron stain because these woods contain large amounts of tannin-like extractives. The discoloration is caused by a chemical reaction between extractives in the wood and iron in steel products, such as nails, screws, and other fasteners and appendages. This often occurs the first morning after rain or dew, when water enables the extractives and iron to meet and react. For hundreds of years, ink was made by mixing tannin and iron in solution, where the reaction takes place instantly.

If the wood is kept dry (indoors), no discoloration will occur. Steel used in contact with wood must not corrode. This can be accomplished by using stainless steel or by coating the steel.

Coatings for fasteners, such as galvanizing (zinc) or ceramic coatings, give a wide range of performance. Shiny galvanized fasteners are electroplated with zinc and have the thinnest coating. Dull-gray galvanized fasteners are mechanically coated and can last longer than electroplated fasteners, but the zinc coating contains iron and staining is likely. Hot-dipped (double-dipped) galvanized fasteners, recognized by their "globby" appearance, give the longest protection to the steel; however, the zinc globs can clog the head of a screw, making it difficult to use. Therefore, stainless steel is the best choice for fasteners, particularly screws.

Problems have been associated with traces of iron left on wood from cutting or slicing; cleaning the surface with steel wool, wire brushes, or iron tools; using finishes stored in rusty containers; and using iron-containing or iron-contaminated finishes. Iron dust from metalworking and even plant fertilizers can be sources of iron. Urine on wood floors will hasten the reaction of iron and wood extractives.

A simple test can determine if wood discoloration is caused by iron: Apply a saturated solution of oxalic acid or sodium hydrogen fluoride ($NaHF_2$, sodium bifluoride) in water to the stained wood surface. If the solution removes the stain, then iron is present on the wood. If the solution does not remove the stain, apply bleach to the stained area. If bleach removes the stain, the discoloration was probably caused by mildew. The appearances of discolorations caused by iron and mildew are distinctly different. After looking at examples of both, many people can identify them by sight.

Discoloration can occur long after finishing if the finish repels water. When water reaches the iron (possibly from the back side), discoloration appears. In this instance, the finish must be removed to access the discoloration, to test it, and to treat it.

If the iron stain is spotty, try viewing the stained wood under a 40× microscope. "Chunky" discoloration is usually a result of molten metal and looks like clinkers from a grinding operation. Particles that resemble slivers or flakes could be from steel wool. An even discoloration throughout the stain indicates that the iron was in solution when it contaminated the wood, probably in a contaminated finish.

Contaminating wood is easy. For example, a wood processor routinely treated wood with a solution of oxalic acid to prevent iron staining, not realizing that the treatment tank itself contained iron, which contaminated the wood. Merely striking wood with a hammer can cause iron stain on some wood. (Covering the head of the hammer when nailing redwood and western redcedar siding is a good idea.)

Iron staining can be removed, at least temporarily. Oxalic acid reacts with iron tannates to form a colorless chemical complex. After treating wood with oxalic acid, thoroughly wash the surface with fresh, warm water to remove excess acid. If all sources of iron are not removed or protected from corrosion, staining will occur again. In other words, oxalic acid treatment is only a temporary solution if iron remains on the wood. In time, oxalic acid breaks down with exposure to sunlight, and if wetted, discoloration occurs.

Aluminum contamination produces a similar stain, although it is usually less dark. Aluminum stain is removed in the same way but with greater difficulty.

Note: Oxalic acid is usually available at paint supply stores labeled as wood bleach (check ingredients). Always apply a saturated solution, or at least 5% by weight. For oak, a chemical reaction between oxalic acid and extractives can leave a pink stain if the solution is left on the wood too long. Sodium bifluoride appears

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to not break down with exposure to sunlight and so may be a better choice if rinsing is not practical; start with a 5% solution.

Caution: Use extreme caution when using oxalic acid or sodium bifluoride. Irritation and burns of the skin, eyes, and mucous membranes can occur, and ingestion of a few grams can be fatal. Sodium bifluoride (which will dissolve glass) is available only to professionals in retail quantities from Sigma-Aldrich (800–325–3010) and will be shipped only to a school or business.

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