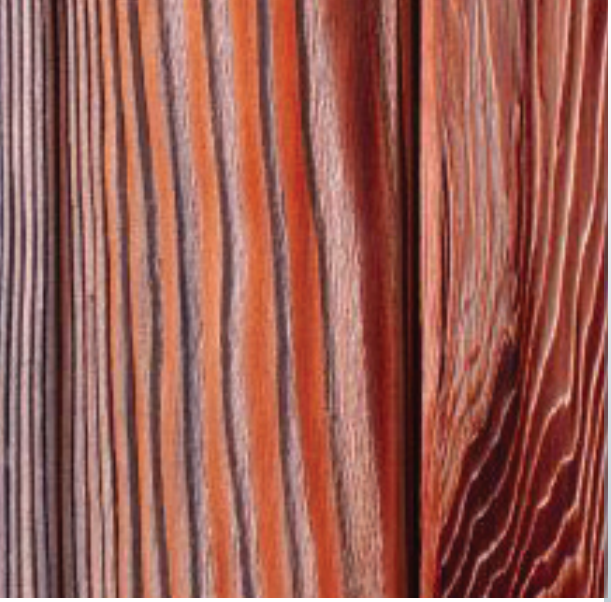

UNDERSTANDING EXTRACTIVE BLEED

Joint Coatings/Forest Products Committee;
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WOOD EXTRACTIVES: DISTRIBUTION, PROPERTIES, AND CLASSES

Color, odor, and natural durability of heartwood are characteristics imparted by a class of chemicals in wood known collectively as extractives.[1] Wood is converted by the tree from sapwood to heartwood by the deposition of extractives, typically many years after the growth ring undergoing this change was formed by the tree. Extractives are thus not a part of the wood substance, nor do they play a major role in the mechanical strength of wood, but rather are additional materials added as a part of the natural aging process of the tree. Most commercial species that are valued for their appearance owe their merchantability, at least in part, to characteristics imparted by their extractives.

In the wood of most species, extractives are most highly concentrated in knots, which are remnants of branches. When knots appear in boards, they can be problematic for extractive bleed in three main ways. First, knots often have the highest concentration of extractives per unit volume. Second, knots are effectively all end-grain in plain-sawn boards and thus are perfectly positioned to bleed extractives efficiently. Third, knots commonly check and crack during drying or over time in service, thus opening routes through the knot for rapid movement of water (water is used in this article to indicate liquid water), air, or other substances (such as turpentine in pine resins), which often carry extractives with them.

For these (and other) reasons, clear boards (those without knots) have always been preferred for most applications in which wood is finished. As we harvest ever smaller and younger trees, the availability of clear boards will decrease and their price will increase, so it behooves us to learn to mitigate the negative effects of extractive bleed from knots. The changing wood resource also makes the harvest and use of sapwood increasingly more likely, but within that sapwood, knots will each likely bear a small core of heartwood, so the knot–heartwood–extractive dilemma is likely inescapable.

Extractives can be grouped into two broad categories—water-soluble extractives (WSE) and solvent-soluble extractives (SSE)—depending on the type of liquid in which they dissolve. Grouping extractives in this way is a simple scheme to sort them by broad chemical properties. All WSE share certain fundamental char-

acteristics, as do all SSE. In theory, all woods have both WSE and SSE, but in practical terms, comparatively few commercial North American species have problematically high concentrations of either type of extractive. Extractive problems for finishes often result from their chemical properties or the structures in which they are found, rather than their concentration in the wood. For example, iron-staining caused by a reaction between steel fasteners and extractives of oak or western redcedar can occur even when extractive concentrations in the wood are at a normal level. Additionally, when extractives are problematic in a species, they are typically extractives of only one class, either WSE or SSE. For example, iron-staining is a phenomenon that takes place when wood becomes wet with water; if it were wetted with mineral spirits or another solvent, one would not expect to see this problem.

Historically, species used and finished for exterior applications have been those with predominantly WSE, such as western redcedar and redwood. In exterior applications, once a piece of wood is installed and finished, for it to be inundated by solvents is almost unheard of, but it will be flushed by water (in the form of rain) regularly, depending on the climate. For these reasons, finish formulations have been developed that are effective at blocking these stains from coming to the surface of the finish; that is, we have designed finish systems to combat the most common forms of WSE bleed.

WSE bleed is not purely a problem of extractives in wood but rather is a problem of wood–water relations. As we outline the main ways in which WSE bleed manifests itself and then prescribe methods for eliminating it, water will clearly be seen as the culprit, and only in association with water can WSE bleed become problematic.

Figure 1—Diffused extractive bleed.

WATER-SOLUBLE EXTRACTIVE BLEED

When WSE discoloration occurs, water is the primary cause. The secondary cause is long exposure to high humidity, during which time the moisture content (MC) in the board increases beyond acceptable limits. Extractives can migrate to the wood surface during kiln drying, manufacturing, storage, installation, or after wood is installed on a structure, as moisture (either water or water vapor) leaves the wood and brings extractives nearer the surface.[2] If concentrations at the surface are high enough, extractives may interfere with penetration, absorption, and drying of some finishes, though this is rare. A more common problem, particularly with waterborne finishes, is the diffusion of WSE into the paint film shortly after application. Most of the WSE diffuse into the paint while the paint film is still wet. Discoloration of the finish by WSE can be eliminated by drying the lumber to less than 19% MC, keeping it dry prior to and during the application of a finish, using the proper finish with a stain-blocking primer, and painting the back side of siding with a water-repellent preservative or primer. Most extractive-related paint discoloration problems occur because water comes in contact with the unpainted back side of siding or the paint used does not adequately block the extractives. Extractive discoloration can show up in a variety of ways, and the discoloration itself may provide clues to the source of water creating the discoloration.

Root causes of WSE bleed are numerous (note that all examples involve water in some form interacting with the wood):

- Diffused discoloration of paint (*Figure* 1) typically results from penetration of the paint film by water or water vapor. This diffused discoloration usually occurs in the first few cycles of wetting or high humidity after paint application and can be attributed to a porous or thin paint coat that is insufficient to prevent water penetration. The water present as the carrier in waterborne finishes can also cause diffused discoloration. In these cases, discoloration is evident at the time of coating application, even before the coating has dried. Traditional stain-blocking primers were formulated with oil alkyds, which have proven to be best in preventing extractive bleed when applied as the first or primer coat. Recently, coating manufacturers have formulated waterborne stain-blocking primers to comply with regulations restricting solvents in paint. The waterborne systems do not work as well as traditional oil-alkyd-borne formulations, but manufacturers continue to improve them.