

Words: 972  
Spell: Chaille  
Proof: Chaille  
Date: October 11, 2017  
Publication: PE

## **Outdoor Pallet Storage and Discoloration**

By Marshall (Mark) White, Ph.D.

Several times a year I am asked about a brown discoloration found on unit loads of product stored outside. The most common product on the pallet when this occurs are cement pavers, block or brick. An example of this discoloration can be seen in the Figure 1 on the outside of the stretch film. Unfortunately, depending on how the pavers or blocks are wrapped, this will also discolor the product as shown in Figure 2. The problem occurs after prolonged and heavy rainfall. Such as during hurricanes and heavy rain storms. This has been an unusual hurricane season in the United States, and a number of pallet companies have witnessed discoloration on some loads.

### **What Causes the Staining?**

There are chemicals in wood that are water-soluble. Chemically, they are a complex combination of aliphatic acids and tannins. The color and concentration of these water-soluble extractives in wood will vary from species to species. Table 1 lists the concentration of these chemicals in different woods. Clearly, the oaks and hickories will stain the most. These dark brown, water-soluble chemicals will leach from the wood in pallets when pallets are exposed to rain, especially during strong storms or hurricanes.

Most of the leaching of these extractive chemicals comes from the end grain of wood, that is, from the ends of the deck boards and stringers. What happens during prolonged rain, is the end grain absorbs the rain water to the point of saturation (about 200%). At this point of saturation, the water containing the brown soluble matter starts to leach from the end grain and down onto the product below.

Sometimes this discoloration will appear as a salt like crust on the pallet as shown in Figure 3. This occurs when the paver or block is also exposed to rain. The lime in the cement forms calcium hydroxide with water. Upon exposure to carbon dioxide in air, some of the calcium hydroxide is converted to calcium carbonate, a process called “efflorescence” in the refractory industry. This is a white salt. This is often mixed with a brown crust which is calcium acetate. Both are shown in Figure 3. If you remember your high school chemistry, you know that when you mix an acid such as acetic acid in wood, with a base such as calcium hydroxide from the paver or block, you will form a salt – calcium acetate. These are not toxic materials and can be safely washed off the pallets or pavers with water.

**Figure 1 Staining cause by pallets during outside storage of unit loads**



**Figure 2 Discolorations on pavers and blocks cause by pallets during outside storage**



Figure 3 Salty crust like material near the end grain of the pallet deck boards and stringers



### Preventing the Staining

#### *Change wood species*

Table 1 contains the relative concentration of water-soluble material for various wood species. Oak is clearly the highest, containing 7-11% extractive materials. Most other hardwoods and softwoods are typically between the 2-5% range, and are less likely to stain such products. Avoiding the oaks or hickories, reduces staining.

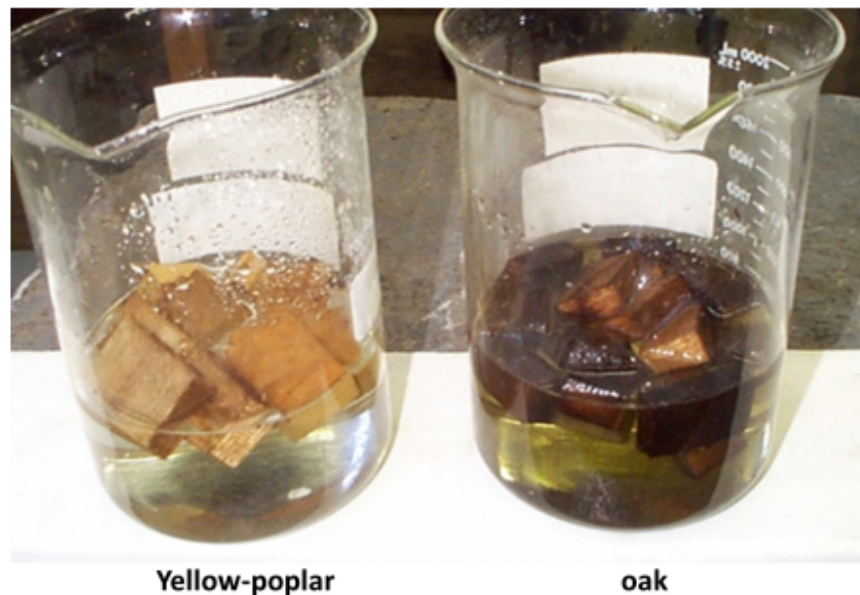
**Table 1 Concentration of water soluble materials in different wood species:**

| Wood Species Group | Percent by Dry Weight of Wood |
|--------------------|-------------------------------|
| Oak                | 7 – 11                        |
| Elm                | 2 – 3                         |
| Maples             | 3 – 4                         |

|                       |       |
|-----------------------|-------|
| <b>Beech</b>          | 2 – 4 |
| <b>Hickories</b>      | 5 – 6 |
| <b>Ash</b>            | 7     |
| <b>Sweetgum</b>       | 3     |
| <b>Black Tupelo</b>   | 4     |
| <b>Aspen</b>          | 4     |
| <b>Yellow-Poplar</b>  | 2     |
| <b>Firs</b>           | 3 – 4 |
| <b>Spruces</b>        | 2 – 4 |
| <b>Southern Pines</b> | 3 - 5 |

This wood species effect can be demonstrated by a simple experiment. By placing small blocks of yellow-poplar and oak into beakers of water as shown in Figure 4, the color difference is dramatic. The water around the oak (7-11% water soluble matter) blocks is much darker than the water surrounding the yellow- poplar (2% water soluble matter) blocks.

**Figure 4. Wood species in a pallet impacts the level of staining caused by out side storage**



### ***End coat pallet parts***

Since most of the staining comes from the end grain of deck boards and stringers, lumber end coating can be applied to these parts prior to pallet assembly. This will significantly reduce the

staining problem. These are specialized paints that seal the end grain. As shown in Figure 5, they actually enhance the appearance of the pallet. This product is commonly used when air drying hardwood lumber to prevent end checking. Thus, an added benefit of the end coating is the reduction of deck board splitting, which improves pallet quality. These end coatings come in many colors and are easily sprayed on to the deck boards and stringers when the parts are dead piled in bundles prior to pallet assembly.

**Figure 5 Pallet with end coating on the stringers and deck boards**



***Place a hood on top of the unit load***

To prevent the formation of the salt like crust and to prevent staining of the block or paver, a plastic hood should be placed over the top of the unit load prior to stretch wrapping or a shrink film hood or stretch hood should be used. Stretch wrapping alone, leaves the top of the unit load

exposed to the rain and permits the staining to contaminate the product and results in the salt formation on product and pallets.

### ***Store products under cover***

Clearly, the ultimate solution to the staining problem is to store product under cover. This can be a roof over the storage area. Unfortunately, this is an expensive solution. An alternative but not nearly as effective is to place portable roofs over each stack of unit loads. These can be removed as the unit loads are de-stacked and can be placed back on top when unit loads are placed into storage. Such portable roofs are used when air drying hardwood lumber to reduce degrade of the top layer of boards.

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